Spatiotemporal Impacts of Ideology and Social Vulnerability on COVID-19: Supplemental Appendix

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Contents

Appendix Overview

Summary

Below are examinations of COVID-19 cumulative deaths adjusted by population, at a county level. We look at spatial and temporal variations for the entire United States, as well by region.

Part 1: Study Area and Regionalization

Regionalization is based on United States(US) Health and Human Services (HHS) health regions.

- Region 1 and 2 (combined): NorthEast: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New York and New Jersey
- Region 3: MidEast: Pennsylvania, West Virginia, Maryland, Delaware, Virginia and the District of Columbia
- Region 4: SouthEast: Florida, Georgia, South Carolina, and North Carolina, Alabama, Mississippi, Tennessee, and Kentucky
- Region 5: Midwest: Ohio, Indiana, Illinois, Michigan, Wisconsin, and Minnesota
- Region 6: MidSouth: Texas, Louisiana, Arkansas, and New Mexico, Oklahoma
- Region 7: Middle West: Iowa, Missouri, Nebraska, and Kansas
- Region 8: MidNorth: Montana, Wyoming, Utah, Colorado, North Dakota, and South Dakota
- Region 9: West: California, Nevada, and Arizona
- Region 10: Pacific Northwest: Idaho, Oregon, and Washington

Part 2: Datasets and Modeling Framework

Part 2 of our analysis documents the datasets and modeling methodology employed as part of this effort.

Part 3: Exploratory Data Analysis and Regression Modeling

Our regional analysis examines COVID-19 parameters for the entire United States, as well as for each of the nine (9) regions listed above.

- The first plot (1) shows fatality rates vs. logarithmic population density, categorized by voting ideology summarized by the 2020 Presidential Election. 100-75% vote for Biden = very liberal, 75-50% for Biden = moderately liberal, 100-75% for Trump = very conservative, and 75-50% for Trump = moderately conservative. Each observation represents one county.
- The second plot (2) shows cumulative cases, adjusted for population, vs. cumulative deaths, adjusted for population, categorized by voting ideology - as noted above.
- The third (3) and fourth (4) plots show the relationship of the four ideology groupings across the specified region, over time - examining deaths for a rolling window, as well as cumulative deaths. These plots provide a summary view of the change in ideological and regional associations with cases and deaths.

For each region, we have outputs for three linear linear models, with population adjusted deaths (by county) as the dependent variable - for each of the three time windows (alpha, delta, and omicron variant). In addition, we have standardized coefficients graphs, that indicates the effect for each variable, for each model.

Part 4: Spatial Autocorrelation

The second portion of this analysis evaluates the spatial autocorrelation of population adjusted county deaths, for all three time periods examined.

Part 5: Geographically Weighted Random Forest (GWRF) Modeling

The third portion of this analysis attempts to model spatial variation for the entire United States, using geographically weighted random forest modeling (GWRF). Our model incorporates the same independent variables that are used as part of our regionalized linear models.

Geographical Weighted Random Forest (GWRF) is a spatial analysis method using a local version of the Random Forest Regression Model. It allows for the investigation of spatial non-stationarity, and the relationship between a dependent and a set of independent variables. The latter is possible by fitting a sub-model for each observation in space, taking into account the neighboring observations. This technique adopts the idea of the Geographically Weighted Regression Kalogirou (2003). The main difference between a tradition (linear) GWR and GRF is that we can model non-stationarity coupled with a flexible non-linear model which is very hard to overfit due to its bootstrapping nature, thus relaxing the assumptions of traditional Gaussian statistics. Essentially it was designed to be a bridge between machine learning and geographical models, combining inferential and explanatory power. Additionally, it is suited for datasets with numerous predictors, due to the robust nature of the random forest algorithm with regards to high dimensionality.

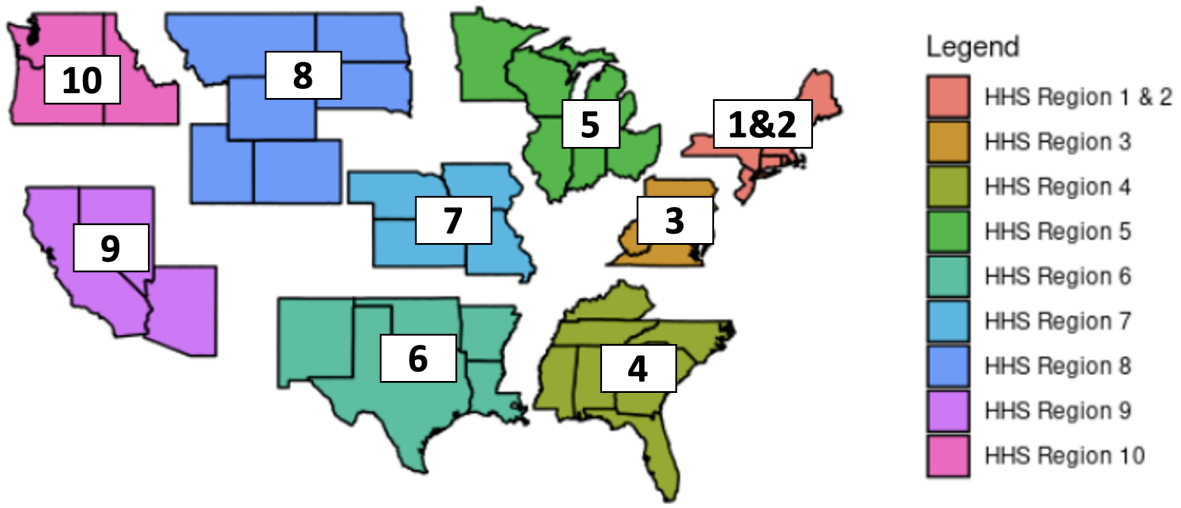
For this analysis, We generate GWRF localized model fits and feature importances (IncMSE). The feature importance algorithmic process is:

1. Compute model MSE
2. For each variable in the model:
    a. Permute variable
    b. Calculate new model MSE according to variable permutation
    c. Take the difference between model MSE and new model MSE
3. Collect the results in a list

Part 1: Study Area and Regionalization

For the initial portion of our analysis, we examine COVID-19 cases and deaths for the entire United States, as well as by U.S. Human Health Services (HHS) regions, as noted in Figure S1 below.

Figure S1: Study Area



Part 2: Datasets and Modeling Framework

We utilize fifteen (15) independent variables and one (1) dependent variable for our analysis, which are as follows:

Table T1: Variable Descriptions

Table 1: Table T1: Variable Descriptions. * = dependent variable

Variables	Description	Data Source
Socioeconomic Status	Index which represents income, poverty, employment, and education.	Social Vulnerability Indices (SVI) taken from the US Census agency for toxic substances and disease registry (ATSDR)
Household Composition and Disability	Index with represents age, single parenting, and disability.	
Minority Status	Index which represents race and ethnicity.	
Housing Type and Transportation	Index which represents housing structure, crowding and vehicle access.	
Obesity	Number of people who are obese, at a county level.	University of Wisconsin's Population Health Institute
Unemployment	Number of unemployed adults per county.	
Uninsured Adults	Number of uninsured adults per county.	
Social Associations	Number of people who are members of a social organization (churches, clubs, etc).	
Diabetes	Number of people with diabetes at a county level.	
Food Insecurity	Index indicating the relative level of food insecurity in a county.	
Broadband Access	Number of people without broadband access.	
Population Density	Population density at a county level.	2020 US Census
Population Age 65+	Number of people age 65 or older in a county.	
Democratic Voting Percentage	Represents voting outcomes from the 2020 presidential general election.	Massachusettes Institute of Technology's (MIT) Election Lab
Vaccination Rate	CDC data for two dose vaccination rates at a county level, ending in April 1, 2022.	US Centers for Disease Control (CDC)
Population adjusted COVID-19 deaths*	Population-adjusted COVID-19 deaths per county.	

Using this framework, we constructed three (3) temporal model time frames:

1. Alpha variant time window (deaths calculated from December 1, 2019 to May 1, 2021)
2. Delta variant time window (deaths calculated from May 1, 2021, to December 1, 2021)
3. Omicron variant time window (deaths calculated from December 1, 2021 to April 1, 2022)

Figure S2: Model Framework

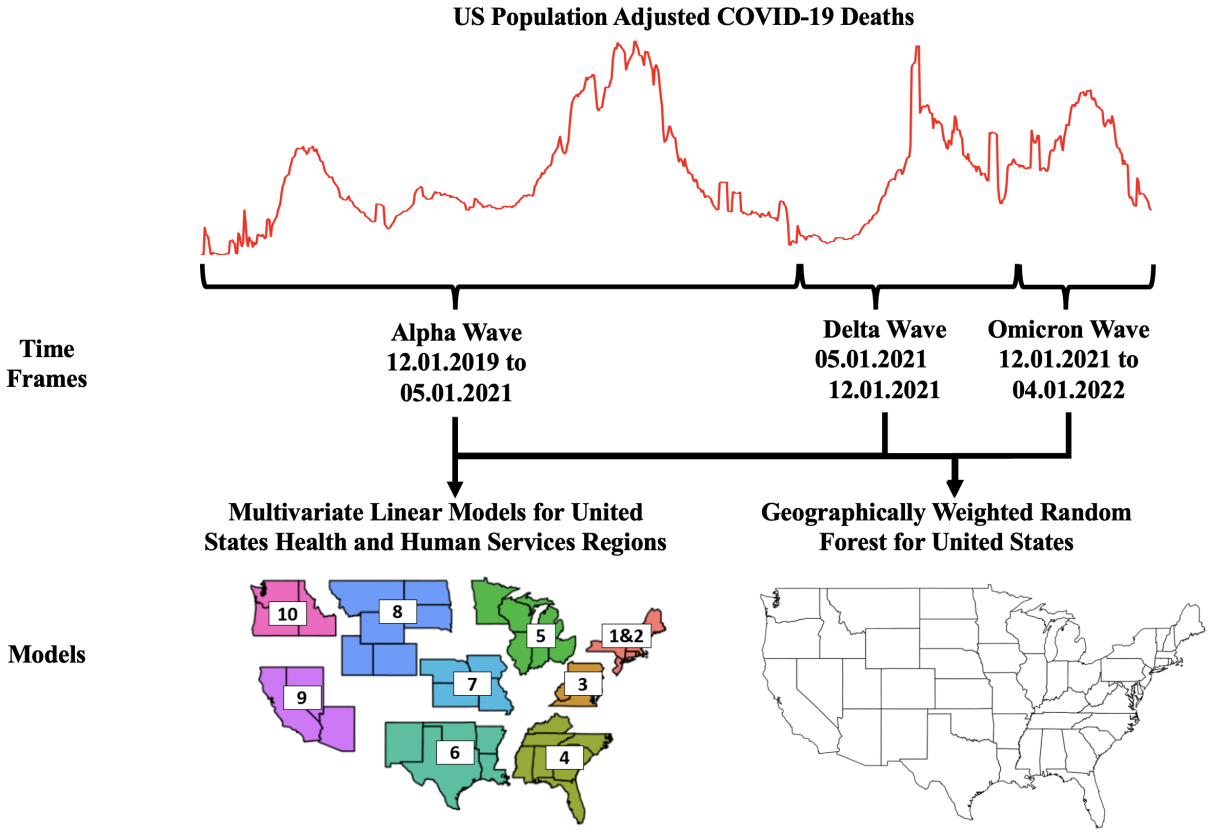
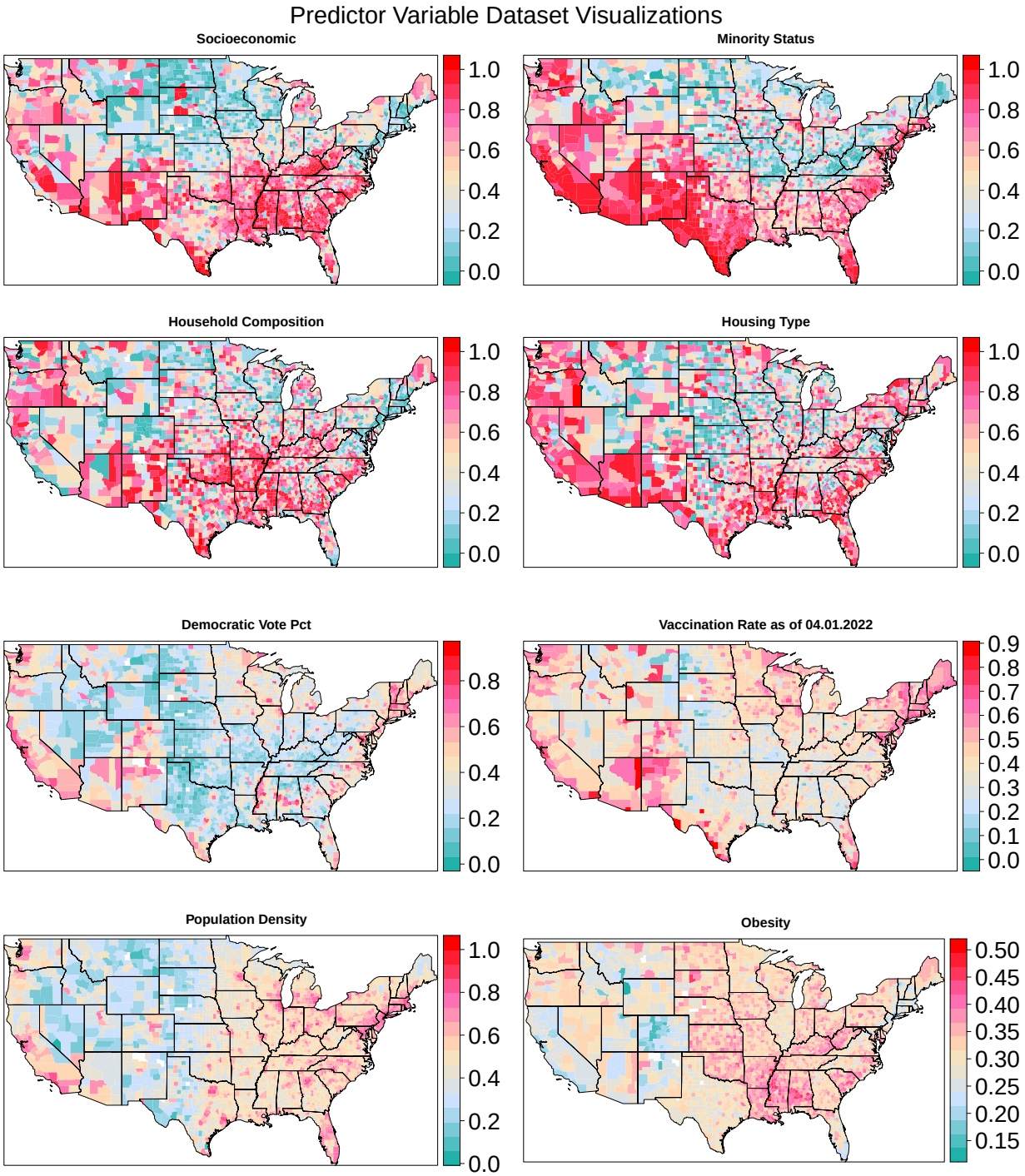
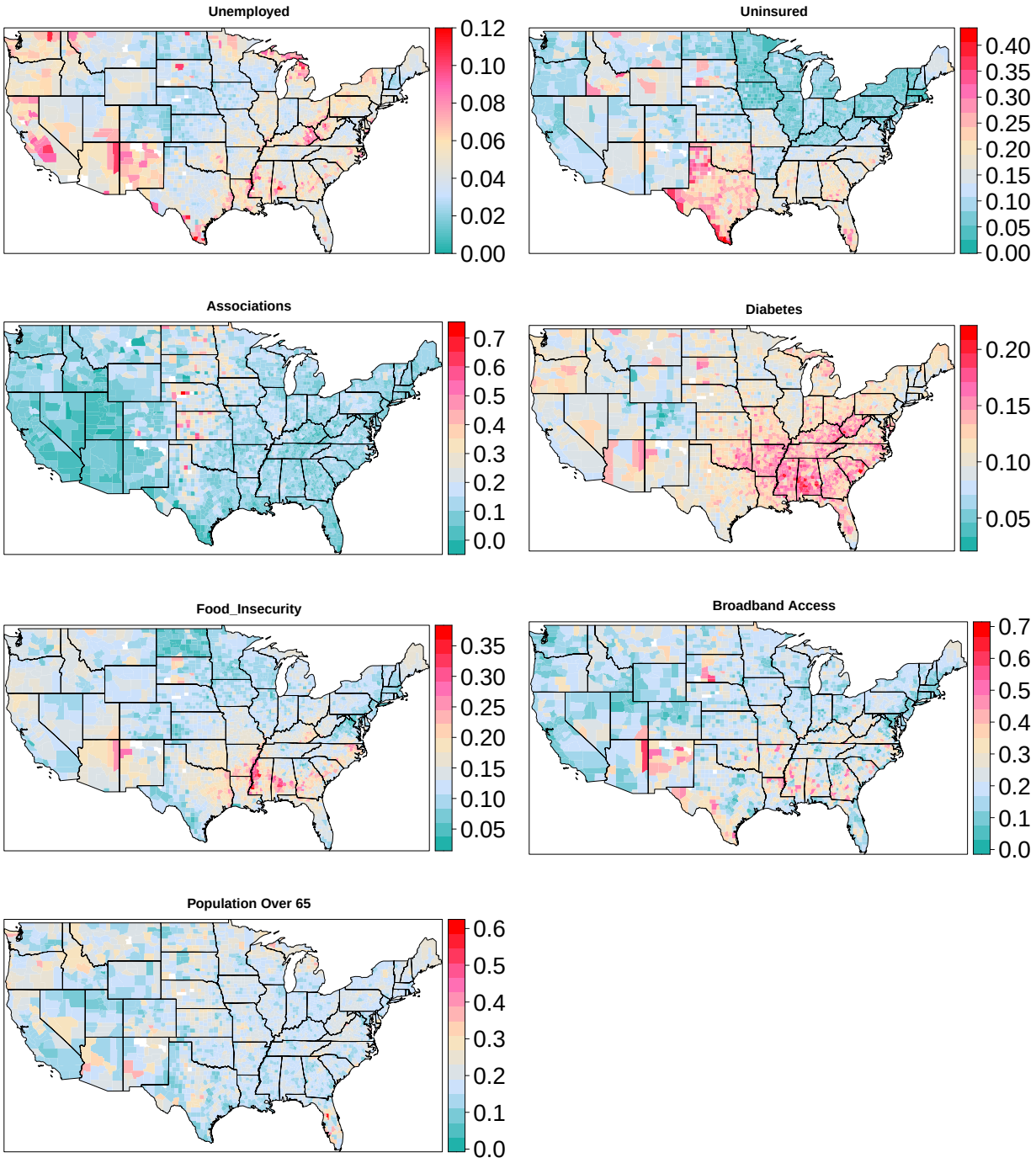
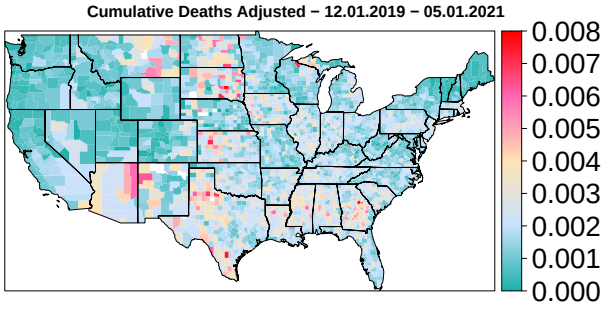


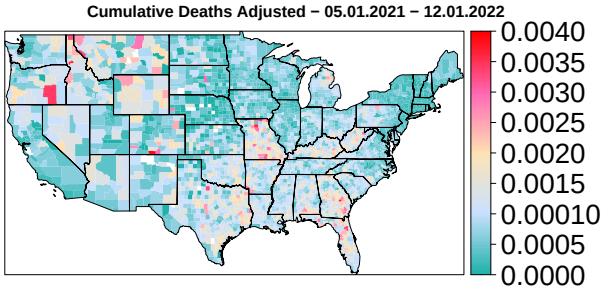
Figure S3: Dataset Visualizations




Unemployed
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Uninsured
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Associations
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Diabetes
0.20
0.15
0.10
0.05
Food_Insecurity
0.35
0.30
0.25
0.20
0.15
0.10
0.05
Broadband Access
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Population Over 65
0.6
0.5
0.4
0.3
0.2
0.1
0.0

Response Variable Dataset Visualizations





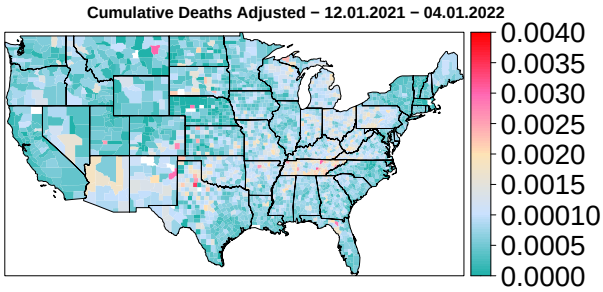
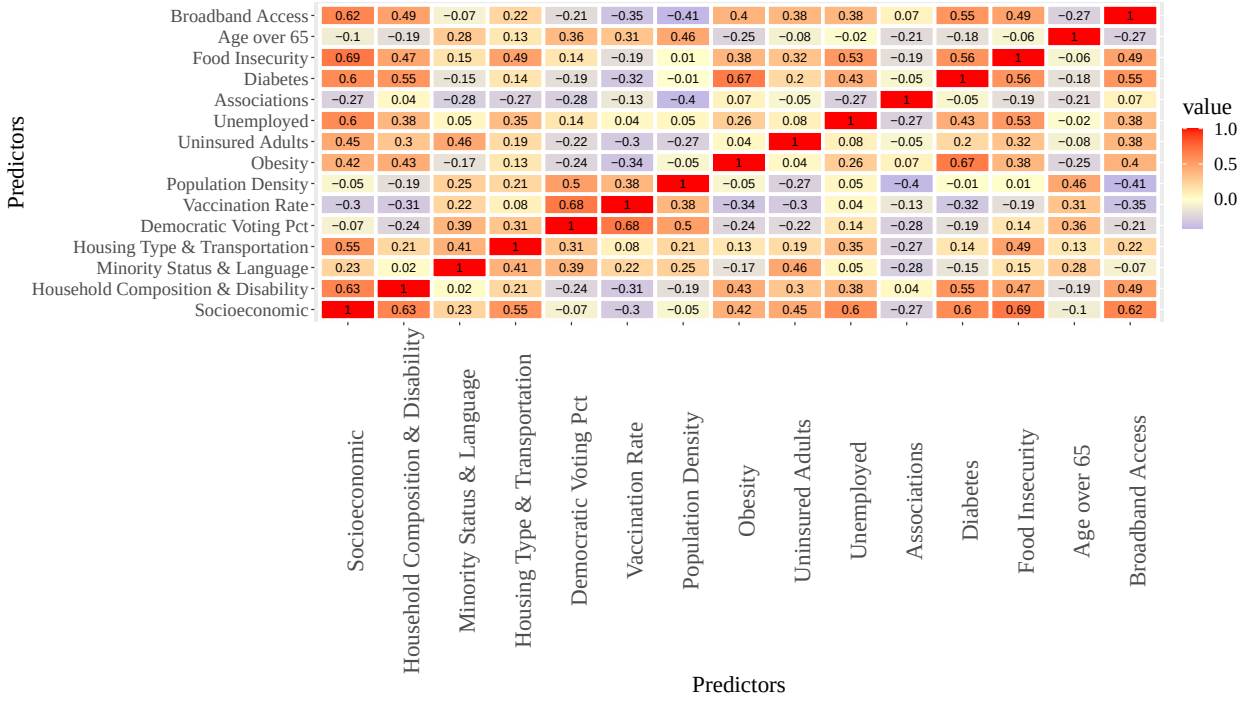


Figure S4: Correlation HeatMap



Part 3: Data Analysis and Regression: United States

Figure S5: Fatality Rate vs. Population Density

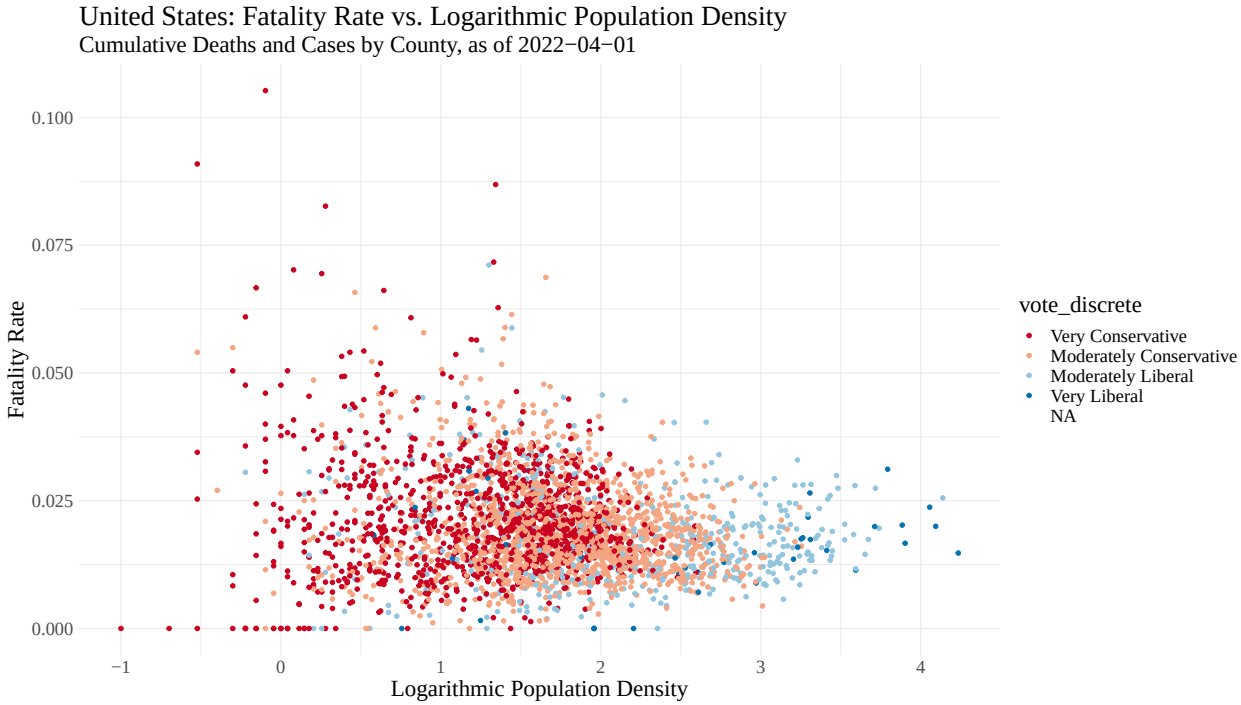


Figure S6: County Level Cumulative Cases vs. Cumulative Deaths

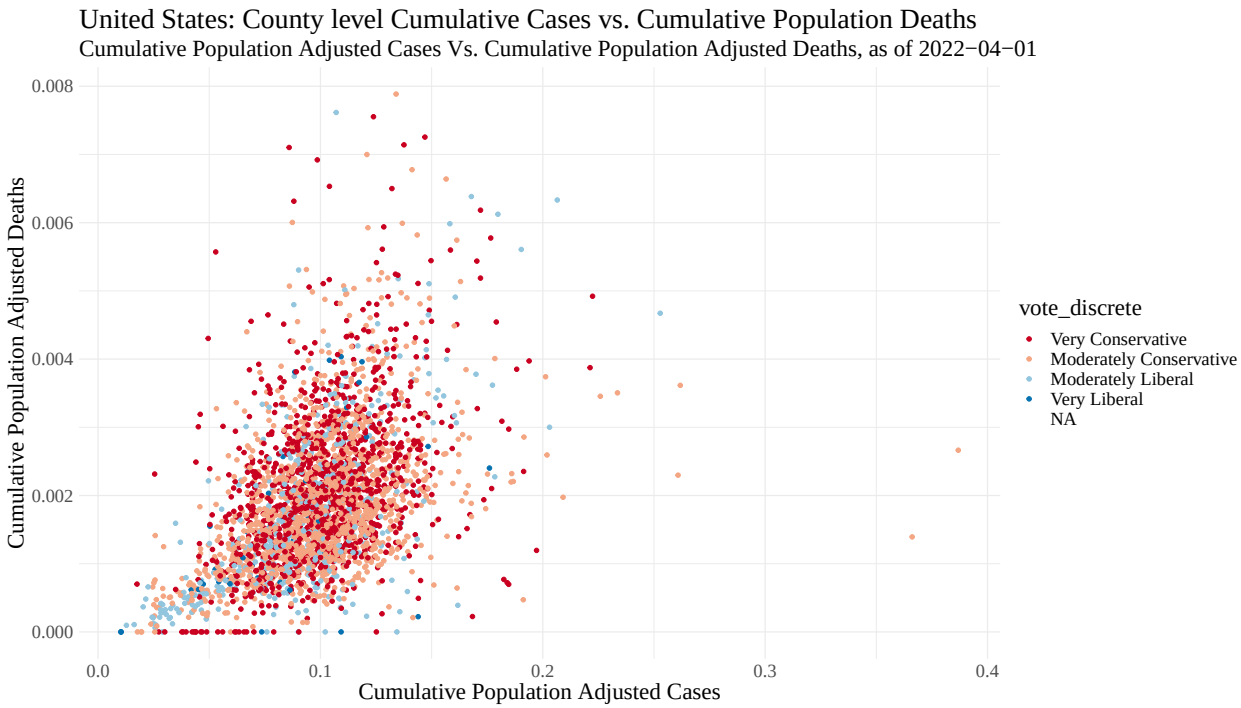


Figure S7: Population Adjusted Cumulative Deaths vs Ideology over time

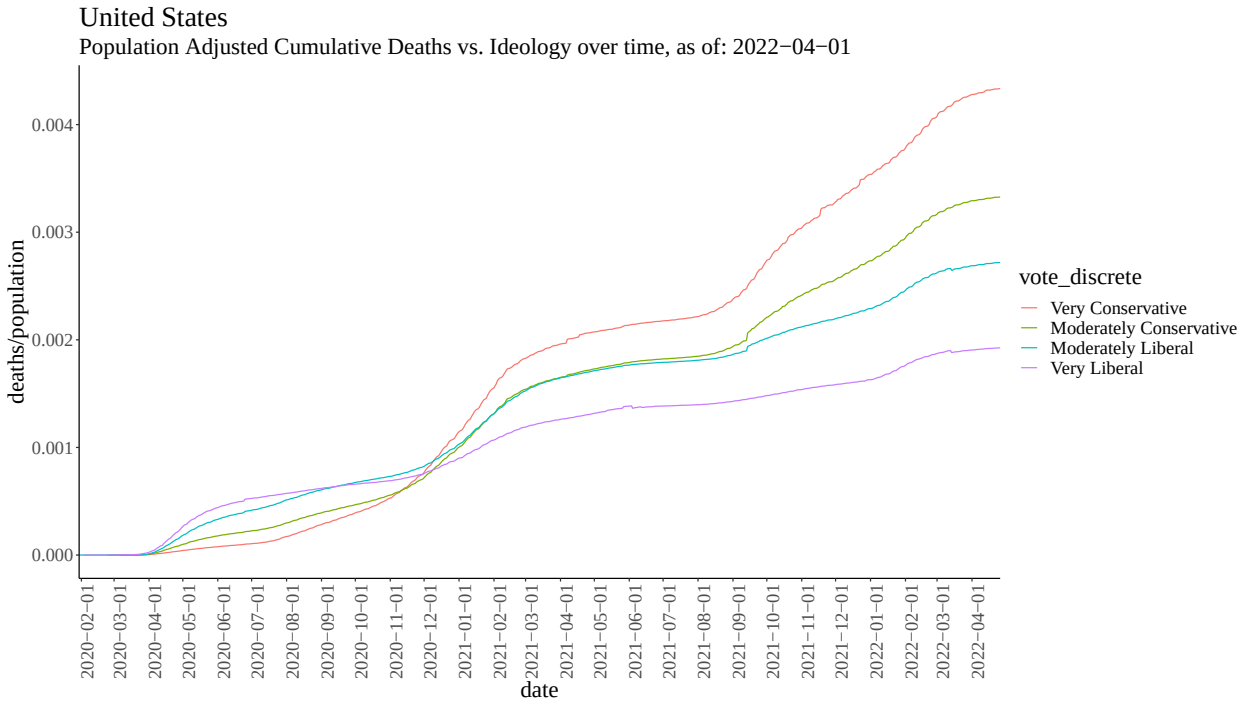


Table T2: United States: Regression Model Results

	Alpha Wave Deaths		Delta Wave Deaths		Omicron Wave Deaths	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
Intercept	-0.00070	**<0.001**	0.00115	**<0.001**	0.00053	**<0.001**
Socioeconomic	-0.00000	0.984	0.00017	**0.010**	0.00041	**<0.001**
Household Composition & Disability	0.00026	**0.002**	0.00022	**<0.001**	0.00019	**<0.001**
Minority Status & Language	0.00038	**<0.001**	-0.00019	**<0.001**	-0.00029	**<0.001**
Housing Type & Transportation	0.00011	0.185	0.00015	**<0.001**	-0.00004	0.304
Democratic Voting Pct	-0.00066	**<0.001**	-0.00097	**<0.001**	-0.00079	**<0.001**
Vaccination Rate	0.00036	0.104	-0.00059	**<0.001**	0.00015	0.106
Population Density	0.00005	**0.003**	0.00001	0.292	0.00005	**<0.001**
Obesity	0.00075	**<0.001**	-0.00074	**<0.001**	-0.00041	**<0.001**
Uninsured Adults	0.00108	**<0.001**	0.00049	**<0.001**	-0.00011	0.124
Unemployed	0.00047	0.074	0.00059	**<0.001**	0.00018	0.109
Diabetes	0.00050	**0.016**	0.00075	**<0.001**	0.00054	**<0.001**
Food Insecurity	-0.00041	0.064	0.00040	**<0.001**	-0.00030	**0.001**
Social Associations	0.00280	**<0.001**	-0.00044	**<0.001**	0.00034	**<0.001**
Age over 65	0.00000	**0.001**	0.00000	0.580	0.00000	0.542
Broadband Access	0.00328	**<0.001**	-0.00031	0.061	0.00046	**0.001**
Observations	3093		3093		3093	
R^2 / R^2 adjusted	0.256 / 0.253		0.358 / 0.355		0.282 / 0.278	

Part 3: Data Analysis and Regression: Regions 1 and 2 (Northeast)

Figure S8: Population Adjusted Cumulative Deaths vs Ideology over time

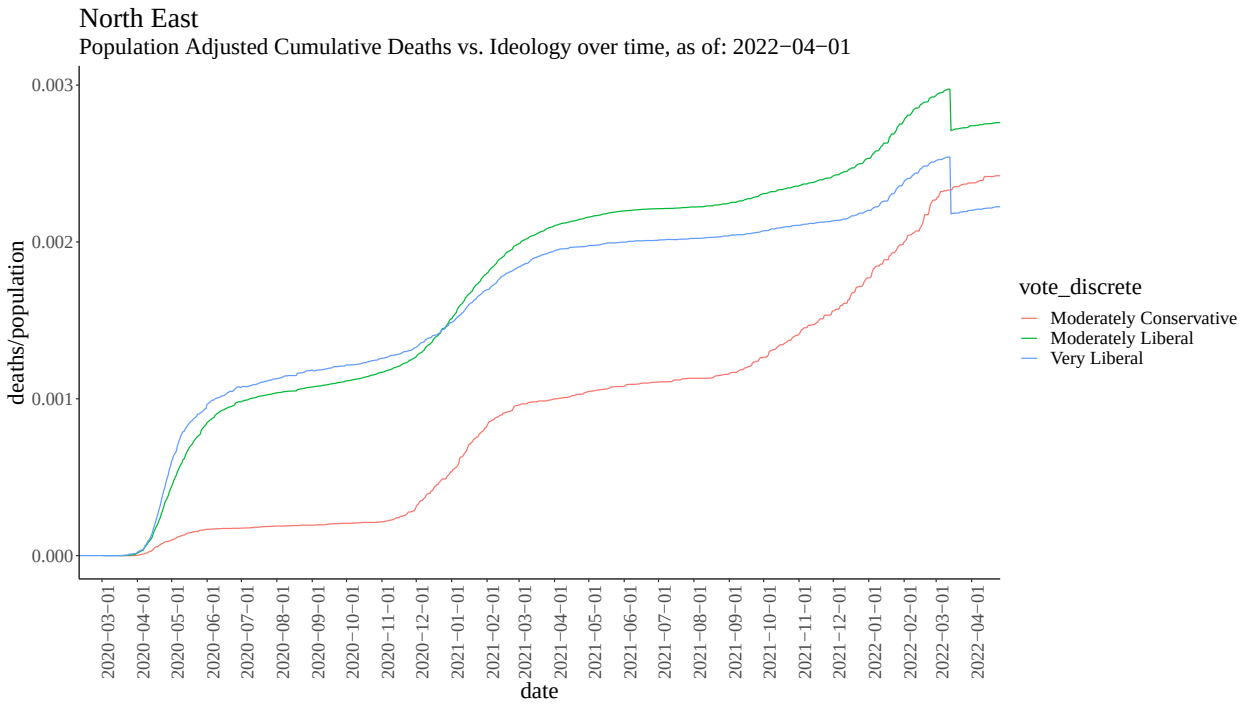


Table T3: Region 1 & 2 (Northeast): Regression Model Results

	Alpha Wave Deaths		Delta Wave Deaths		Omicron Wave Deaths	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
Intercept	-0.00093	0.243	0.00026	0.253	0.00031	0.271
Socioeconomic	0.00086	0.112	-0.00010	0.512	-0.00034	0.076
Household Composition & Disability	0.00062	0.051	0.00031	**0.001**	0.00032	**0.004**
Housing Type & Transportation	-0.00047	**0.029**	0.00010	0.104	-0.00006	0.454
Unemployed	0.00087	0.393	-0.00013	0.662	-0.00081	**0.028**
Food Insecurity	-0.00234	**0.033**	0.00031	0.323	0.00104	**0.008**
Broadband Access	0.00230	0.187	-0.00028	0.565	0.00026	0.675
Diabetes	0.00066	0.414	0.00001	0.961	-0.00051	0.080
Obesity	-0.00024	0.733	0.00030	0.146	0.00060	**0.020**
Population Density	0.00041	**<0.001**	0.00002	0.283	0.00004	0.055
Associations	-0.00088	0.477	0.00012	0.724	0.00014	0.751
Age over 65	0.00000	0.312	0.00000	0.588	-0.00000	0.532
Democratic Voting Pct	-0.00056	0.372	-0.00032	0.076	-0.00107	**<0.001**
Vaccination Rate	-0.00038	0.480	-0.00021	0.168	0.00023	0.224
Minority Status and Language	0.00092	**0.006**	-0.00006	0.500	0.00013	0.260
Uninsured Adults	0.00045	0.443	0.00025	0.132	0.00082	**<0.001**
Observations	145		145		145	
R^2 / R^2 adjusted	0.769 / 0.742		0.474 / 0.413		0.540 / 0.486	

Part 3: Data Analysis and Regression: Region 3 (Mideast)

Figure S9: Population Adjusted Cumulative Deaths vs Ideology over time

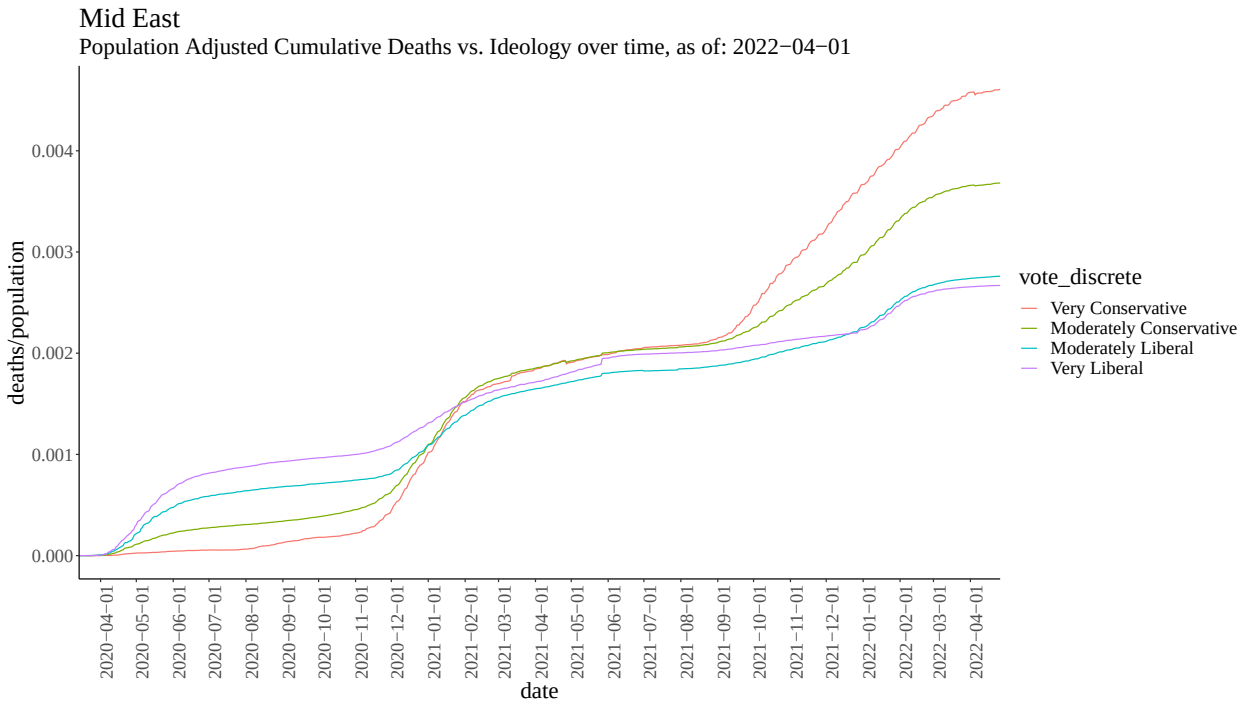


Table T4: Region 3 (Mideast): Regression Model Results

	Alpha Wave Deaths		**Delta Wave Deaths**		**Omicron Wave Deaths**	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
Intercept	-0.00130	0.202	0.00198	**0.022**	0.00022	0.757
Socioeconomic	-0.00117	**0.046**	0.00031	0.520	0.00045	0.267
Household Composition & Disability	0.00034	0.283	0.00034	0.195	0.00026	0.233
Housing Type & Transportation	0.00059	**0.041**	0.00011	0.639	0.00014	0.486
Unemployed	0.00013	0.891	0.00050	0.536	0.00017	0.798
Food Insecurity	-0.00010	0.946	0.00126	0.310	-0.00101	0.328
Broadband Access	-0.00042	0.766	-0.00240	**0.045**	0.00059	0.547
Diabetes	0.00255	**<0.001**	0.00006	0.915	0.00039	0.412
Obesity	0.00024	0.773	0.00038	0.581	0.00016	0.786
Population Density	0.00021	0.050	-0.00023	**0.011**	0.00012	0.112
Associations	0.00295	**0.014**	0.00092	0.351	0.00014	0.863
Age over 65	0.00000	0.418	0.00000	0.128	0.00000	0.867
Democratic Voting Pct	-0.00222	**0.022**	0.00014	0.862	-0.00129	0.055
Vaccination Rate	0.00048	0.639	-0.00009	0.919	-0.00009	0.900
Minority Status and Language	0.00056	0.129	-0.00057	0.066	0.00006	0.800
Uninsured Adults	0.00070	0.756	-0.00332	0.081	-0.00008	0.959
Observations	82		82		82	
R^2 / R^2 adjusted	0.500 / 0.386		0.608 / 0.518		0.466 / 0.344	

Part 3: Data Analysis and Regression: Region 4 (Southeast)

Figure S10: Population Adjusted Cumulative Deaths vs Ideology over time

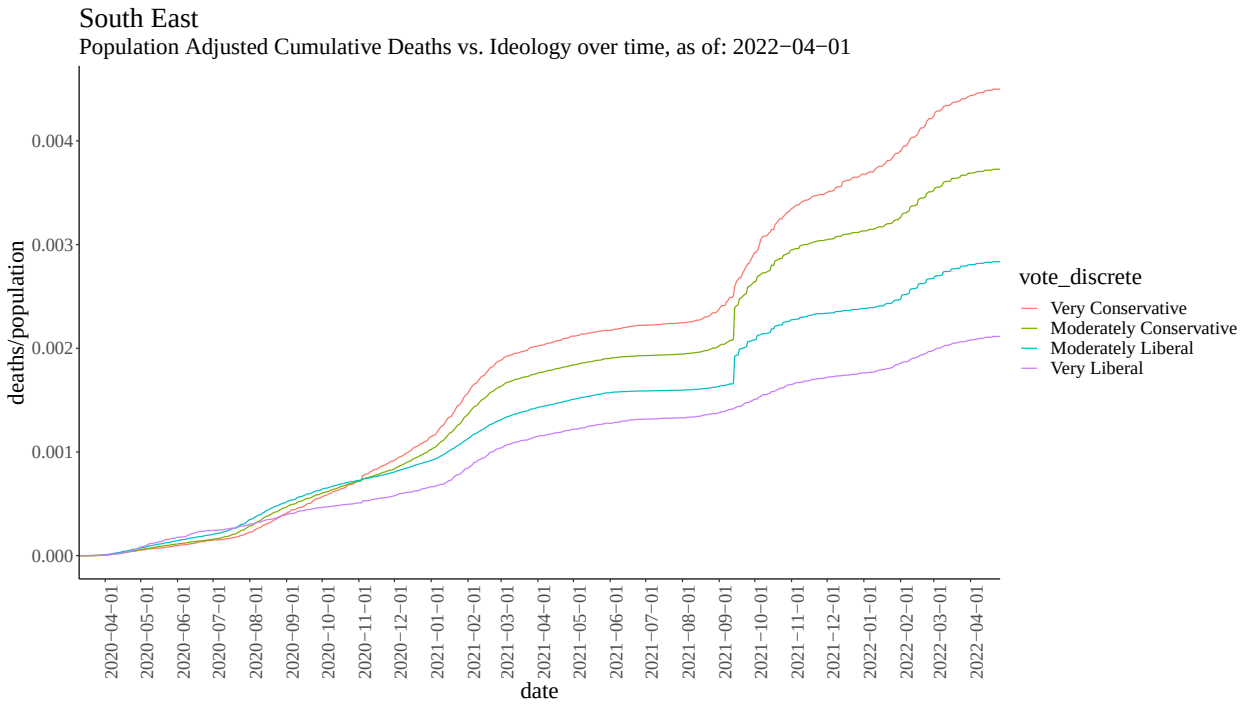


Table T5: Region 4 (Southeast): Regression Model Results

	Alpha Wave Deaths		**Delta Wave Deaths**		**Omicron Wave Deaths**	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
Intercept	0.00119	0.131	0.00084	0.163	0.00014	0.638
Socioeconomic	-0.00056	0.202	0.00008	0.802	0.00028	0.083
Household Composition & Disability	-0.00003	0.888	0.00001	0.960	0.00004	0.645
Housing Type & Transportation	0.00073	**0.001**	0.00046	**0.009**	0.00007	0.425
Unemployed	0.00214	**0.041**	0.00080	0.318	-0.00025	0.519
Food Insecurity	0.00159	0.053	0.00145	**0.021**	0.00024	0.430
Broadband Access	0.00203	**0.017**	-0.00078	0.231	-0.00011	0.724
Diabetes	0.00204	**<0.001**	0.00181	**<0.001**	0.00075	**<0.001**
Obesity	-0.00076	0.257	0.00018	0.720	-0.00008	0.746
Population Density	0.00003	0.730	0.00014	**0.018**	0.00009	**0.002**
Associations	0.00059	0.539	-0.00091	0.216	0.00057	0.106
Age over 65	0.00000	0.050	0.00000	**0.004**	0.00000	0.142
Democratic Voting Pct	-0.00124	**0.038**	-0.00328	**<0.001**	-0.00097	**<0.001**
Vaccination Rate	-0.00260	**<0.001**	-0.00097	0.055	-0.00033	0.168
Minority Status and Language	-0.00011	0.763	-0.00041	0.124	-0.00022	0.085
Uninsured Adults	0.00048	0.506	0.00116	**0.037**	0.00018	0.507
Observations	383		383		383	
R^2 / R^2 adjusted	0.408 / 0.384		0.424 / 0.400		0.288 / 0.259	

Part 3: Data Analysis and Regression: Region 5 (Midwest)

Figure S11: Population Adjusted Cumulative Deaths vs Ideology over time

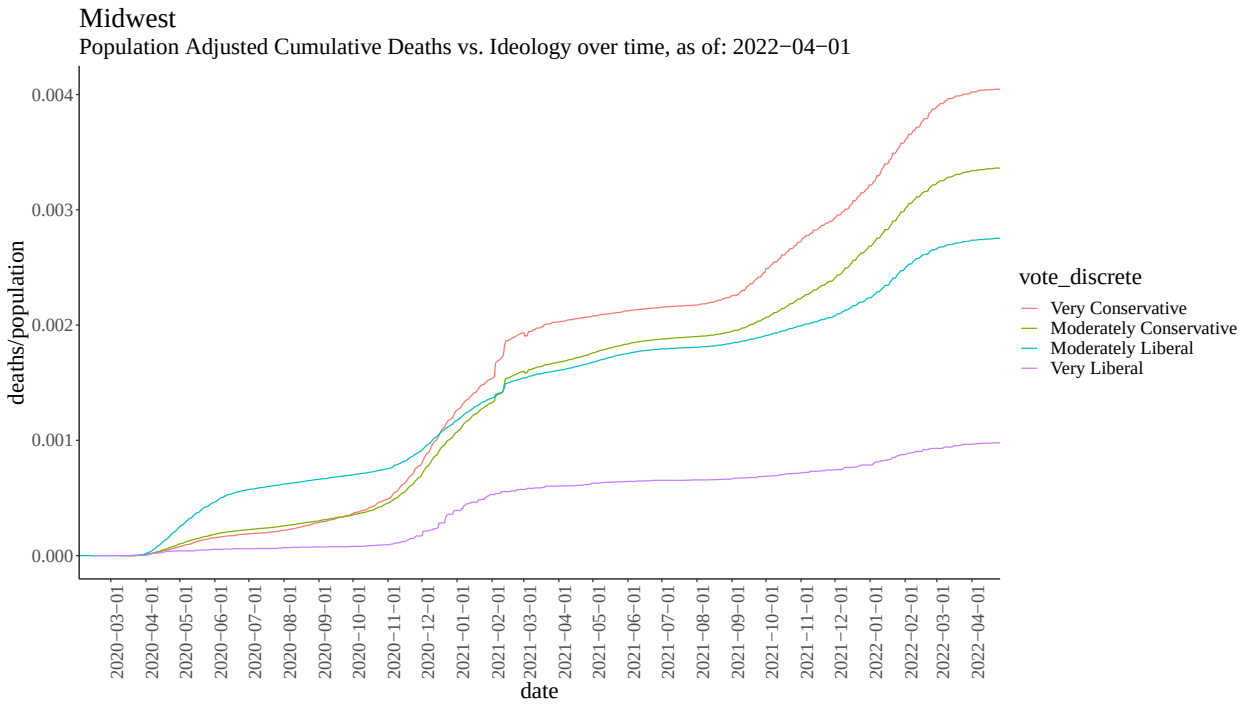


Table T6: Region 5 (Midwest): Regression Model Results

	Alpha Wave Deaths		**Delta Wave Deaths**		**Omicron Wave Deaths**	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
Intercept	0.00127	**0.009**	0.00062	**0.001**	0.00045	**0.031**
Socioeconomic	0.00048	0.178	0.00027	0.057	0.00023	0.128
Household Composition & Disability	0.00042	**0.015**	0.00011	0.099	0.00013	0.079
Housing Type & Transportation	-0.00002	0.925	0.00003	0.656	-0.00007	0.338
Unemployed	-0.00037	0.530	0.00102	**<0.001**	0.00057	**0.023**
Food Insecurity	0.00046	0.577	-0.00042	0.197	0.00005	0.889
Broadband Access	-0.00121	0.201	-0.00016	0.665	-0.00142	**<0.001**
Diabetes	0.00077	0.136	0.00076	**<0.001**	0.00115	**<0.001**
Obesity	-0.00069	0.125	-0.00005	0.765	0.00040	**0.034**
Population Density	0.00006	0.232	0.00002	0.266	0.00003	0.090
Associations	0.00178	**0.001**	-0.00021	0.333	0.00002	0.915
Age over 65	0.00000	0.073	-0.00000	0.750	0.00000	0.967
Democratic Voting Pct	-0.00213	**<0.001**	-0.00019	0.408	-0.00025	0.296
Vaccination Rate	0.00076	0.195	-0.00061	**0.009**	-0.00044	0.079
Minority Status and Language	-0.00010	0.669	-0.00029	**0.002**	-0.00022	**0.028**
Uninsured Adults	0.00082	0.295	0.00014	0.650	0.00025	0.454
Observations	523		523		523	
R^2 / R^2 adjusted	0.204 / 0.181		0.427 / 0.410		0.421 / 0.404	

Part 3: Data Analysis and Regression: Region 6 (MidSouth)

Figure S12: Population Adjusted Cumulative Deaths vs Ideology over time

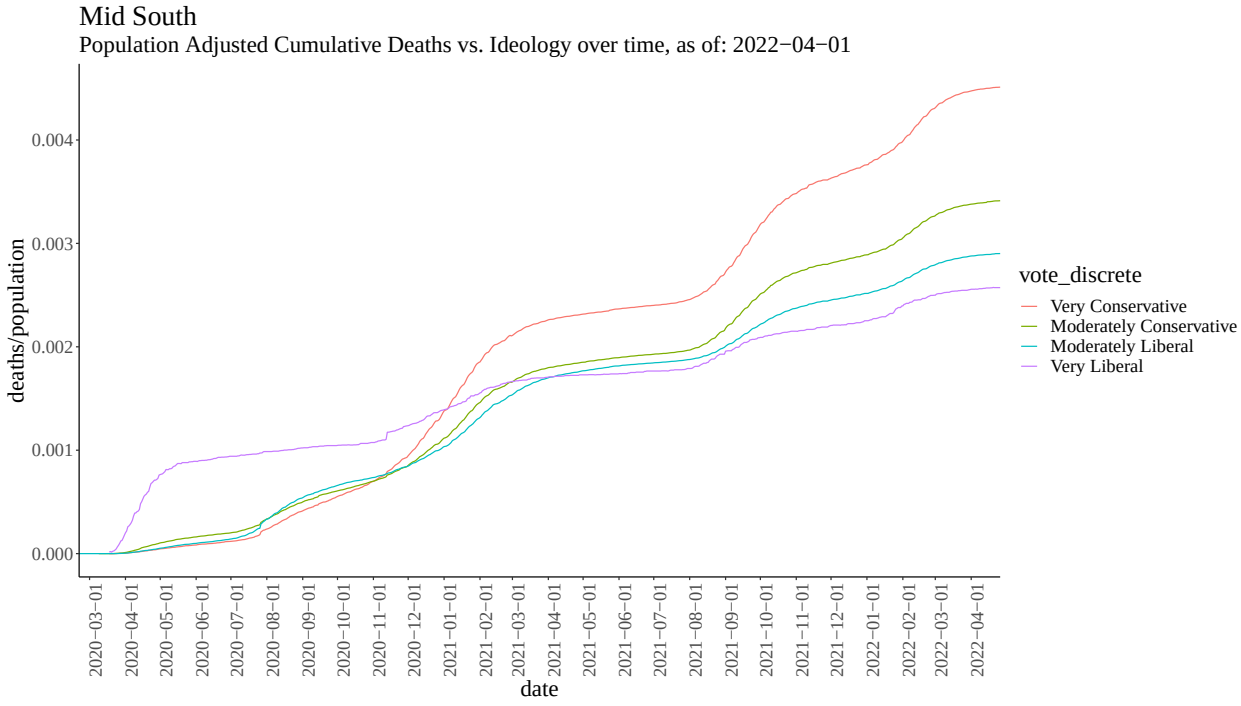


Table T7: Region 6 (Midsouth): Regression Model Results

	Alpha Wave Deaths		**Delta Wave Deaths**		**Omicron Wave Deaths**	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
Intercept	0.00041	0.424	0.00108	**<0.001**	0.00075	**0.001**
Socioeconomic	0.00034	0.334	-0.00007	0.708	0.00039	**0.009**
Household Composition & Disability	0.00059	**0.004**	0.00032	**0.003**	0.00028	**0.001**
Housing Type & Transportation	0.00042	0.063	0.00005	0.675	-0.00007	0.461
Unemployed	0.00125	0.062	0.00062	0.087	0.00002	0.950
Food Insecurity	-0.00097	**0.039**	0.00012	0.641	-0.00017	0.397
Broadband Access	0.00093	0.230	0.00045	0.288	0.00072	**0.032**
Diabetes	0.00025	0.713	0.00057	0.135	-0.00039	0.192
Obesity	0.00059	0.335	-0.00044	0.184	-0.00053	**0.042**
Population Density	-0.00009	0.085	0.00007	**0.008**	0.00003	0.141
Associations	0.00261	**<0.001**	-0.00049	0.159	0.00211	**<0.001**
Age over 65	-0.00000	0.960	-0.00000	0.177	-0.00000	0.872
Democratic Voting Pct	0.00054	0.324	-0.00077	**0.010**	-0.00041	0.083
Vaccination Rate	-0.00058	0.317	-0.00096	**0.003**	-0.00009	0.723
Minority Status and Language	-0.00049	0.117	-0.00006	0.705	-0.00032	**0.018**
Uninsured Adults	0.00237	**<0.001**	0.00031	0.117	-0.00014	0.358
Observations	428		428		428	
R^2 / R^2 adjusted	0.358 / 0.334		0.196 / 0.167		0.322 / 0.298	

Part 3: Data Analysis and Regression: Region 7 (Middle West)

Figure S13: Population Adjusted Cumulative Deaths vs Ideology over time

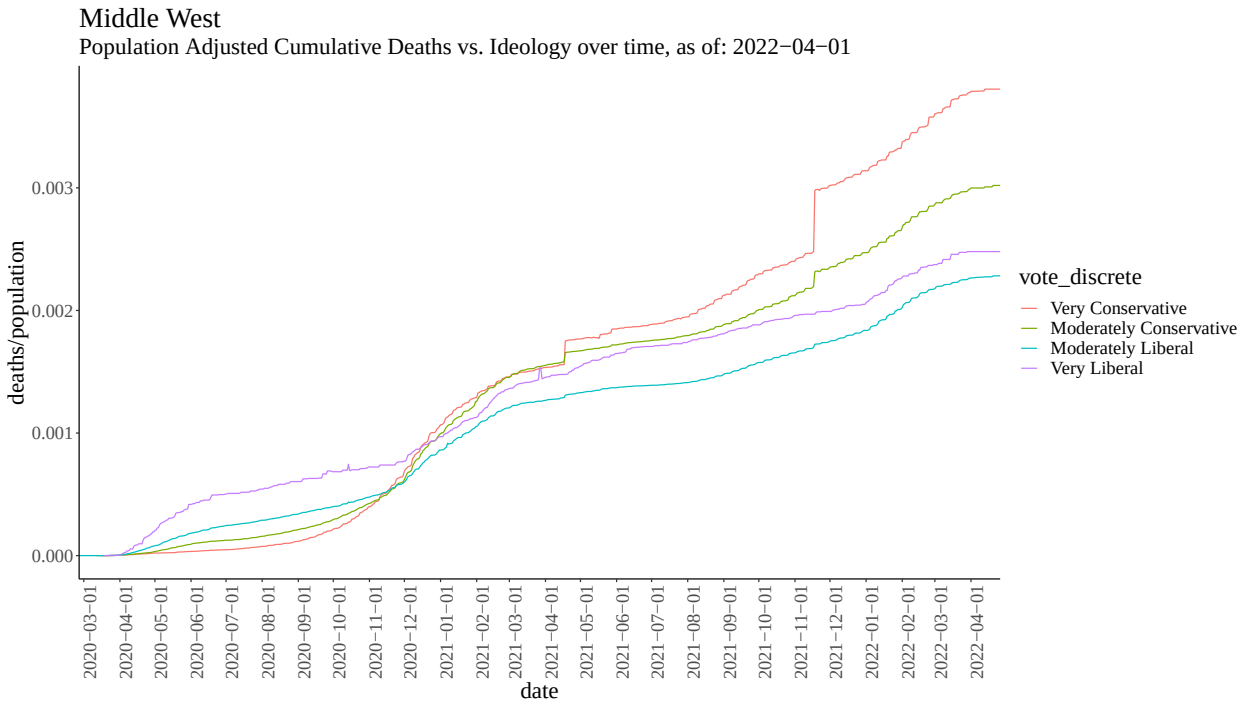


Table T8: Region 7 (Middle West): Regression Model Results

	Alpha Wave Deaths		**Delta Wave Deaths**		**Omicron Wave Deaths**	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
Intercept	0.00107	0.095	-0.00008	0.799	0.00015	0.556
Socioeconomic	0.00108	**0.017**	0.00061	**0.007**	0.00087	**<0.001**
Household Composition & Disability	0.00034	0.162	-0.00010	0.399	0.00010	0.299
Housing Type & Transportation	0.00041	0.155	0.00002	0.906	0.00001	0.960
Unemployed	-0.00068	0.678	0.00336	**<0.001**	0.00117	0.068
Food Insecurity	-0.00249	**0.016**	-0.00087	0.089	-0.00097	**0.016**
Broadband Access	0.00021	0.854	0.00133	**0.022**	0.00028	0.534
Diabetes	0.00098	0.158	0.00201	**<0.001**	0.00098	**<0.001**
Obesity	-0.00022	0.764	-0.00150	**<0.001**	-0.00041	0.146
Population Density	-0.00004	0.606	0.00013	**0.002**	0.00002	0.537
Associations	0.00259	**<0.001**	0.00030	0.223	0.00056	**0.004**
Age over 65	0.00000	0.589	-0.00000	0.460	0.00000	0.368
Democratic Voting Pct	-0.00225	**0.023**	-0.00098	**0.045**	0.00010	0.795
Vaccination Rate	0.00269	**0.001**	0.00025	0.554	0.00038	0.247
Minority Status and Language	0.00030	0.310	-0.00046	**0.002**	-0.00048	**<0.001**
Uninsured Adults	-0.00313	**<0.001**	0.00064	0.083	-0.00083	**0.005**
Observations	409		409		409	
R^2 / R^2 adjusted	0.250 / 0.222		0.530 / 0.512		0.322 / 0.296	

Part 3: Data Analysis and Regression: Region 8 (Midnorth)

Figure S14: Population Adjusted Cumulative Deaths vs Ideology over time

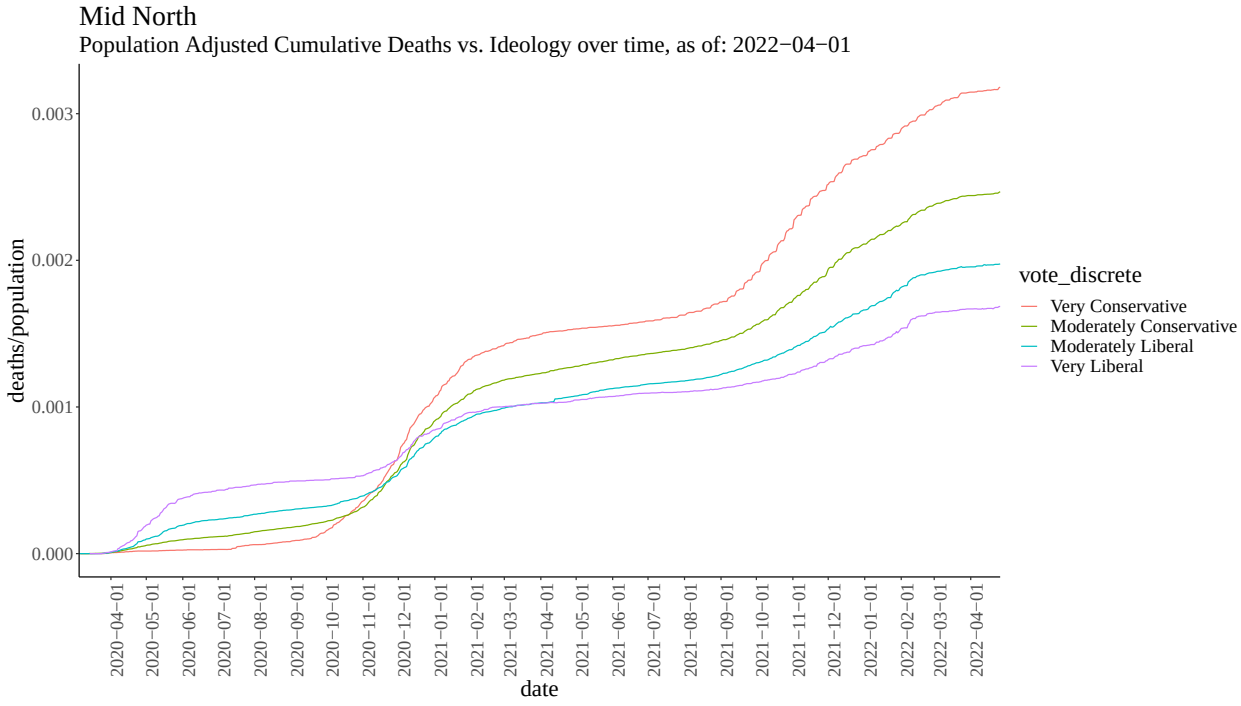


Table T9: Region 8 (Midnorth): Regression Model Results

	Alpha Wave Deaths		**Delta Wave Deaths**		**Omicron Wave Deaths**	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
Intercept	-0.00122	**0.022**	0.00198	**<0.001**	0.00011	0.571
Socioeconomic	0.00037	0.513	0.00081	**0.004**	0.00004	0.861
Household Composition & Disability	0.00044	0.256	0.00023	0.220	0.00020	0.162
Housing Type & Transportation	-0.00008	0.821	0.00030	0.090	0.00001	0.939
Unemployed	-0.00116	0.378	0.00203	**0.002**	0.00004	0.937
Food Insecurity	-0.00204	0.125	-0.00073	0.264	0.00007	0.886
Broadband Access	0.00472	**0.002**	0.00055	0.460	0.00148	**0.008**
Diabetes	0.00102	0.445	-0.00021	0.749	0.00060	0.218
Obesity	0.00268	**0.002**	-0.00145	**0.001**	-0.00046	0.155
Population Density	0.00014	0.135	-0.00003	0.483	0.00010	**0.004**
Associations	0.00123	0.085	0.00006	0.858	0.00053	**0.044**
Age over 65	-0.00000	0.923	0.00000	0.339	-0.00000	0.505
Democratic Voting Pct	-0.00106	0.196	-0.00060	0.138	-0.00063	**0.038**
Vaccination Rate	0.00180	**0.038**	-0.00126	**0.003**	-0.00034	0.287
Minority Status and Language	-0.00053	0.239	-0.00029	0.195	0.00006	0.710
Uninsured Adults	0.00089	0.464	-0.00038	0.529	0.00057	0.207
Observations	292		292		292	
R^2 / R^2 adjusted	0.343 / 0.307		0.274 / 0.234		0.182 / 0.137	

Part 3: Data Analysis and Regression: Region 9 (West)

Figure S15: Population Adjusted Cumulative Deaths vs Ideology over time

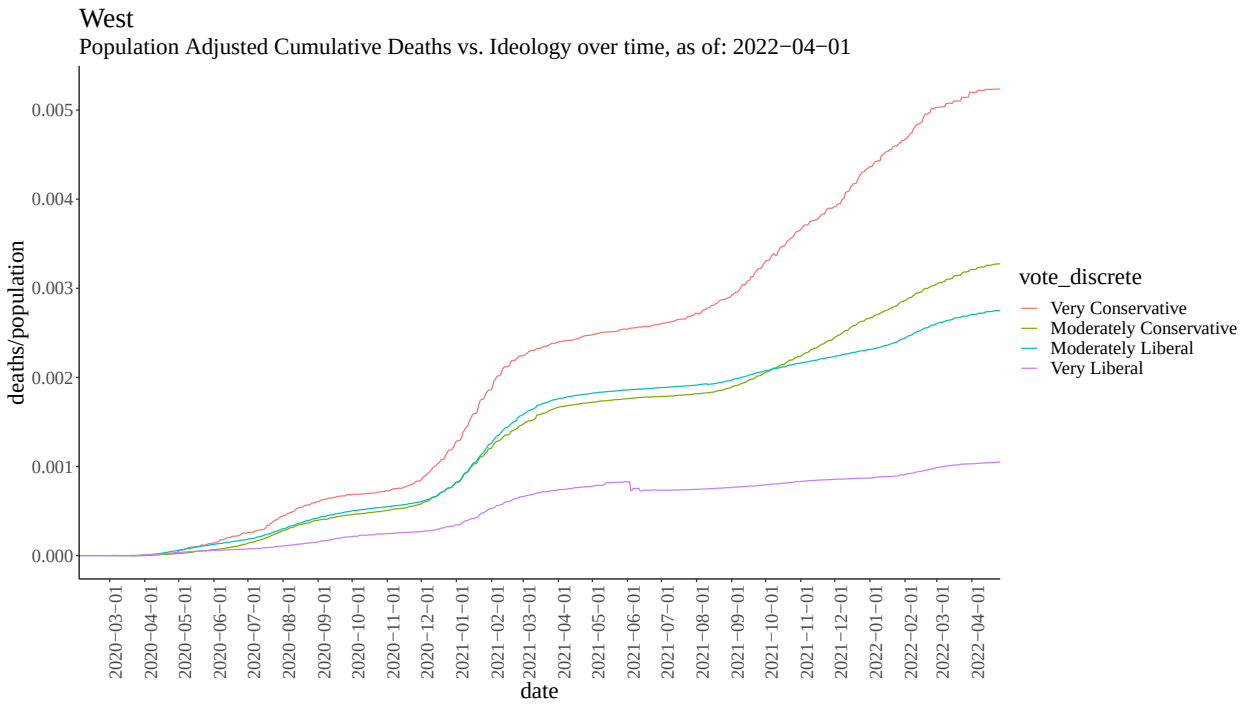


Table T10: Region 9 (West): Regression Model Results

	Alpha Wave Deaths		Delta Wave Deaths		Omicron Wave Deaths	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
Intercept	-0.00359	**<0.001**	0.00047	**0.046**	-0.00050	0.087
Socioeconomic	0.00121	**0.031**	-0.00030	0.176	-0.00008	0.757
Household Composition & Disability	-0.00074	0.079	0.00063	**<0.001**	0.00019	0.366
Housing Type & Transportation	0.00024	0.557	0.00027	0.096	0.00014	0.503
Unemployed	0.00070	0.259	-0.00097	**<0.001**	-0.00020	0.514
Food Insecurity	0.00058	0.663	0.00107	**0.047**	0.00051	0.435
Broadband Access	-0.00212	0.280	0.00067	0.394	-0.00048	0.617
Diabetes	0.00511	**<0.001**	-0.00042	0.386	0.00212	**0.001**
Obesity	0.00018	0.868	0.00022	0.624	-0.00009	0.864
Population Density	0.00006	0.373	0.00000	0.961	0.00005	0.184
Associations	0.00067	0.755	-0.00020	0.820	0.00112	0.293
Age over 65	0.00000	0.332	-0.00000	0.765	0.00000	0.945
Democratic Voting Pct	-0.00197	**0.020**	-0.00151	**<0.001**	-0.00102	**0.014**
Vaccination Rate	0.00389	**<0.001**	-0.00006	0.886	0.00045	0.347
Minority Status and Language	-0.00008	0.918	0.00054	0.086	-0.00023	0.552
Uninsured Adults	0.00449	**0.001**	0.00053	0.298	0.00157	**0.013**
Observations	90		90		90	
R^2 / R^2 adjusted	0.745 / 0.693		0.747 / 0.695		0.618 / 0.541	

Part 3: Data Analysis and Regression: Region 10 (Pacific NW)

Figure S16: Population Adjusted Cumulative Deaths vs Ideology over time

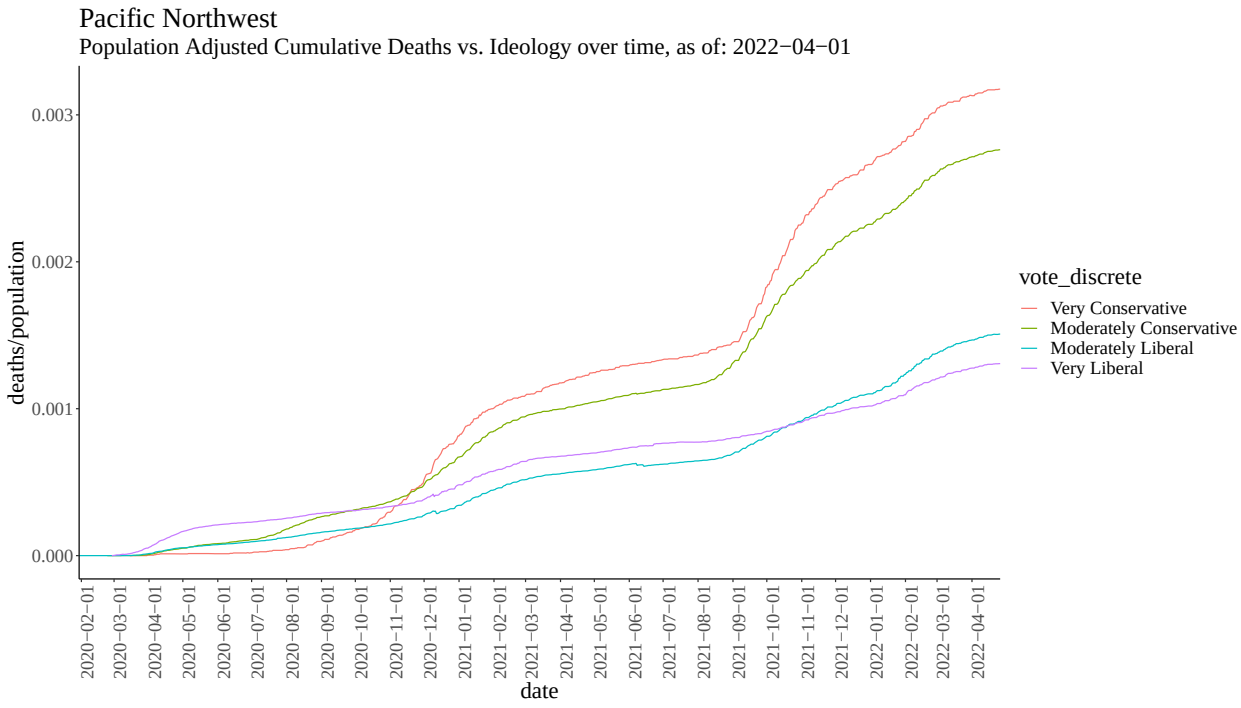


Table T11: Region 10 (Pacific Northwest): Regression Model Results

	Alpha Wave Deaths		Delta Wave Deaths		Omicron Wave Deaths	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
Intercept	0.00116	0.084	0.00083	0.210	-0.00094	**0.013**
Socioeconomic	-0.00012	0.761	-0.00029	0.475	-0.00053	**0.022**
Household Composition & Disability	0.00039	0.117	0.00076	**0.003**	0.00026	0.067
Housing Type & Transportation	0.00024	0.305	0.00031	0.192	0.00016	0.218
Unemployed	-0.00049	0.502	0.00219	**0.003**	0.00051	0.212
Food Insecurity	-0.00060	0.505	0.00166	0.065	0.00176	**0.001**
Broadband Access	0.00147	0.283	-0.00130	0.337	0.00211	**0.007**
Diabetes	0.00000	0.999	0.00044	0.549	0.00070	0.096
Obesity	-0.00023	0.718	-0.00097	0.132	-0.00007	0.842
Population Density	0.00008	0.082	0.00011	**0.016**	0.00002	0.502
Associations	0.00026	0.753	0.00178	**0.033**	-0.00016	0.739
Age over 65	0.00000	0.515	0.00000	0.839	0.00000	0.322
Democratic Voting Pct	-0.00114	0.067	-0.00184	**0.003**	-0.00093	**0.008**
Vaccination Rate	-0.00122	0.085	-0.00120	0.089	0.00064	0.108
Minority Status and Language	0.00045	0.163	-0.00045	0.165	0.00024	0.194
Uninsured Adults	0.00046	0.428	0.00159	**0.007**	0.00079	**0.017**
Observations	130		130		130	
R^2 / R^2 adjusted	0.469 / 0.400		0.640 / 0.593		0.540 / 0.479	

Part 3: Data Analysis and Regression Modeling Summarized Model Results

Table T12: Model Results: Alpha Wave (December 2019 - May 2021)

	NE	ME	SE	MW	MS	MDW	MN	W	PNW	US
Predictors	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*
Intercept	0.243	0.202	0.131	**0.009**	0.424	0.095	**0.022**	**<0.001**	0.084	**<0.001**
Socioeconomic	0.112	**0.046**	0.202	0.178	0.334	**0.017**	0.513	**0.031**	0.761	0.984
Household Composition & Disability	0.051	0.283	0.888	**0.015**	**0.004**	0.162	0.256	0.079	0.117	**0.002**
Housing Type & Transportation	**0.029**	**0.041**	**0.001**	0.925	0.063	0.155	0.821	0.557	0.305	0.185
Unemployed	0.393	0.891	**0.041**	0.530	0.062	0.678	0.378	0.259	0.502	0.074
Food Insecurity	**0.033**	0.946	0.053	0.577	**0.039**	**0.016**	0.125	0.663	0.505	0.064
Broadband Access	0.187	0.766	**0.017**	0.201	0.230	0.854	**0.002**	0.280	0.283	**<0.001**
Diabetes	0.414	**<0.001**	**<0.001**	0.136	0.713	0.158	0.445	**<0.001**	0.999	**0.016**
Obesity	0.733	0.773	0.257	0.125	0.335	0.764	**0.002**	0.868	0.718	**<0.001**
Population Density	**<0.001**	0.050	0.730	0.232	0.085	0.606	0.135	0.373	0.082	**0.003**
Associations	0.477	**0.014**	0.539	**0.001**	**<0.001**	**<0.001**	0.085	0.755	0.753	**<0.001**
Age over 65	0.312	0.418	0.050	0.073	0.960	0.589	0.923	0.332	0.515	**0.001**
Democratic Voting Pct	0.372	**0.022**	**0.038**	**<0.001**	0.324	**0.023**	0.196	**0.020**	0.067	**<0.001**
Vaccination Rate	0.480	0.639	**<0.001**	0.195	0.317	**0.001**	**0.038**	**<0.001**	0.085	0.104
Minority Status and Language	**0.006**	0.129	0.763	0.669	0.117	0.310	0.239	0.918	0.163	**<0.001**
Uninsured Adults	0.443	0.756	0.506	0.295	**<0.001**	**<0.001**	0.464	**0.001**	0.428	**<0.001**
Observations	145	82	383	523	428	409	292	90	130	3093
R^2 / R^2 adjusted	0.769 / 0.742	0.500 / 0.386	0.408 / 0.384	0.204 / 0.181	0.358 / 0.334	0.250 / 0.222	0.343 / 0.307	0.745 / 0.693	0.469 / 0.400	0.256 / 0.253

Table T13: Model Results: Delta Wave (May 2021 - December 2021)

	NE	ME	SE	MW	MS	MDW	MN	W	PNW	US
Predictors	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*
Intercept	0.253	**0.022**	0.163	**0.001**	**<0.001**	0.799	**<0.001**	**0.046**	0.210	**<0.001**
Socioeconomic	0.512	0.520	0.802	0.057	0.708	**0.007**	**0.004**	0.176	0.475	**0.010**
Household Composition & Disability	**0.001**	0.195	0.960	0.099	**0.003**	0.399	0.220	**<0.001**	**0.003**	**<0.001**
Housing Type & Transportation	0.104	0.639	**0.009**	0.656	0.675	0.906	0.090	0.096	0.192	**<0.001**
Unemployed	0.662	0.536	0.318	**<0.001**	0.087	**<0.001**	**0.002**	**<0.001**	**0.003**	**<0.001**
Food Insecurity	0.323	0.310	**0.021**	0.197	0.641	0.089	0.264	**0.047**	0.065	**<0.001**
Broadband Access	0.565	**0.045**	0.231	0.665	0.288	**0.022**	0.460	0.394	0.337	0.061
Diabetes	0.961	0.915	**<0.001**	**<0.001**	0.135	**<0.001**	0.749	0.386	0.549	**<0.001**
Obesity	0.146	0.581	0.720	0.765	0.184	**<0.001**	**0.001**	0.624	0.132	**<0.001**
Population Density	0.283	**0.011**	**0.018**	0.266	**0.008**	**0.002**	0.483	0.961	**0.016**	0.292
Associations	0.724	0.351	0.216	0.333	0.159	0.223	0.858	0.820	**0.033**	**<0.001**
Age over 65	0.588	0.128	**0.004**	0.750	0.177	0.460	0.339	0.765	0.839	0.580
Democratic Voting Pct	0.076	0.862	**<0.001**	0.408	**0.010**	**0.045**	0.138	**<0.001**	**0.003**	**<0.001**
Vaccination Rate	0.168	0.919	0.055	**0.009**	**0.003**	0.554	**0.003**	0.886	0.089	**<0.001**
Minority Status and Language	0.500	0.066	0.124	**0.002**	0.705	**0.002**	0.195	0.086	0.165	**<0.001**
Uninsured Adults	0.132	0.081	**0.037**	0.650	0.117	0.083	0.529	0.298	**0.007**	**<0.001**
Observations	145	82	383	523	428	409	292	90	130	3093
R^2 / R^2 adjusted	0.474 / 0.413	0.608 / 0.518	0.424 / 0.400	0.427 / 0.410	0.196 / 0.167	0.530 / 0.512	0.274 / 0.234	0.747 / 0.695	0.640 / 0.593	0.358 / 0.355

Table T14: Model Results: Omicron Wave (December 2021 - April 2022)

	NE	ME	SE	MW	MS	MDW	MN	W	PNW	US
Predictors	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*
Intercept	0.271	0.757	0.638	**0.031**	**0.001**	0.556	0.571	0.087	**0.013**	**<0.001**
Socioeconomic	0.076	0.267	0.083	0.128	**0.009**	**<0.001**	0.861	0.757	**0.022**	**<0.001**
Household Composition & Disability	**0.004**	0.233	0.645	0.079	**0.001**	0.299	0.162	0.366	0.067	**<0.001**
Housing Type & Transportation	0.454	0.486	0.425	0.338	0.461	0.960	0.939	0.503	0.218	0.304
Unemployed	**0.028**	0.798	0.519	**0.023**	0.950	0.068	0.937	0.514	0.212	0.109
Food Insecurity	**0.008**	0.328	0.430	0.889	0.397	**0.016**	0.886	0.435	**0.001**	**0.001**
Broadband Access	0.675	0.547	0.724	**<0.001**	**0.032**	0.534	**0.008**	0.617	**0.007**	**0.001**
Diabetes	0.080	0.412	**<0.001**	**<0.001**	0.192	**<0.001**	0.218	**0.001**	0.096	**<0.001**
Obesity	**0.020**	0.786	0.746	**0.034**	**0.042**	0.146	0.155	0.864	0.842	**<0.001**
Population Density	0.055	0.112	**0.002**	0.090	0.141	0.537	**0.004**	0.184	0.502	**<0.001**
Associations	0.751	0.863	0.106	0.915	**<0.001**	**0.004**	**0.044**	0.293	0.739	**<0.001**
Age over 65	0.532	0.867	0.142	0.967	0.872	0.368	0.505	0.945	0.322	0.542
Democratic Voting Pct	**<0.001**	0.055	**<0.001**	0.296	0.083	0.795	**0.038**	**0.014**	**0.008**	**<0.001**
Vaccination Rate	0.224	0.900	0.168	0.079	0.723	0.247	0.287	0.347	0.108	0.106
Minority Status and Language	0.260	0.800	0.085	**0.028**	**0.018**	**<0.001**	0.710	0.552	0.194	**<0.001**
Uninsured Adults	**<0.001**	0.959	0.507	0.454	0.358	**0.005**	0.207	**0.013**	**0.017**	0.124
Observations	145	82	383	523	428	409	292	90	130	3093
R^2 / R^2 adjusted	0.540 / 0.486	0.466 / 0.344	0.288 / 0.259	0.421 / 0.404	0.322 / 0.298	0.322 / 0.296	0.182 / 0.137	0.618 / 0.541	0.540 / 0.479	0.282 / 0.278

Figure S17: Model Results: Regression R2 Plot

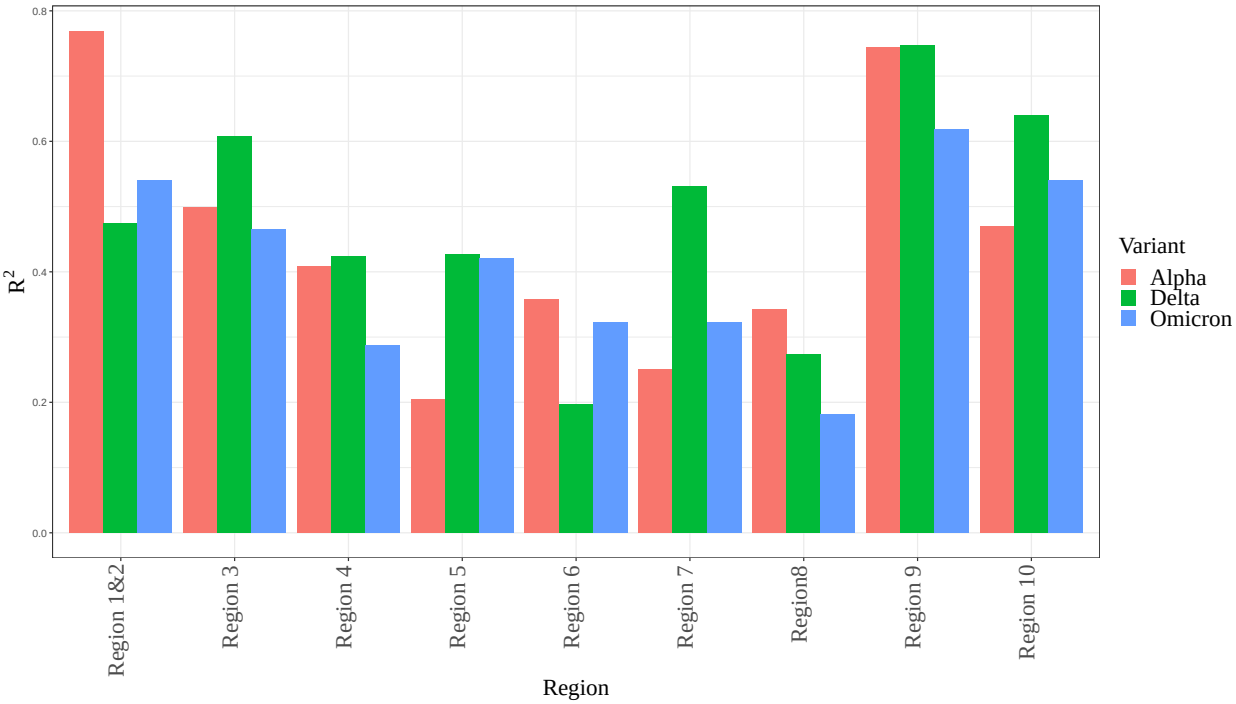
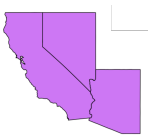
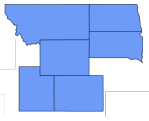
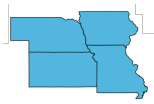
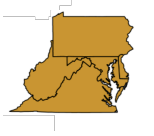


Table T15: Regionalized Regression Model Results: Significance Table

	Significant Independent Variables			
Regions	Alpha	Delta	Omicron	Map
Regions 1-2	Housing Type and Transportation, Food Insecurity, Population Density, Minority Status and Language	Household Composition and Disability	Household Composition and Disability, Unemployment, Food Insecurity, Obesity, Democratic Voting Pct	
Region 3	Socioeconomic Status, Diabetes, Democratic Voting Pct, Vaccination Rate	Household Composition and Disability, Unemployment, Food Insecurity, Democratic Voting Pct	Diabetes, Democratic Voting Pct	
Region 4	Lack of Broadband Access, Obesity, Vaccination Rate	Socioeconomic Status, Unemployment, Obesity, Vaccination Rate	Lack of Broadband Access, Population Density, Social Associations, Democratic Voting Pct	
Region 5	Socioeconomic Status, Food Insecurity, Social Associations, Democratic Voting Pct, Vaccination Rate	Socioeconomic Status, Unemployment, Lack of Broadband Access, Diabetes, Obesity, Population Density, Democratic Voting Pct, Minority Status and Language	Socioeconomic Status, Food Insecurity, Diabetes, Social Associations, Minority Status and Language	
Region 6	Household Composition and Disability, Food Insecurity, Social Associations	Household Composition and Disability, Population Density, Democratic Voting Pct, Vaccination Rate	Socioeconomic Status, Household Composition and Disability, Lack of Broadband Access, Obesity, Social Associations, Minority Status and Language	
Region 7	Household Composition and Disability, Social Associations, Democratic Voting Pct	Unemployment, Diabetes, Vaccination Rate, Minority Status and Language	Unemployment, Lack of Broadband Access, Diabetes, Obesity, Minority Status and Language	
Region 8	Housing Type and Transportation, Unemployment, Lack of Broadband Access, Diabetes, Democratic Voting Pct, Vaccination Rate	Housing Type and Transportation, Food Insecurity, Diabetes, Population Density, Age over 65+, Democratic Voting Pct	Diabetes, Population Density, Democratic Voting Pct	
Region 9	Socioeconomic Status, Housing Type and Transportation, Diabetes, Social Associations, Democratic Voting Pct	Lack of Broadband Access, Population Density		
Region 10		Household Composition and Disability, Unemployment, Population Density, Social Associations, Democratic Voting Pct	Socioeconomic Status, Food Insecurity, Lack of Broadband Access, Democratic Voting Pct	

Part 4: Spatial Autocorrelation

Morans I is a test of spatial autocorrelation.

$$I = \frac{n}{S_0} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} \left(x_i - \overline{x}\right) \left(x_j - \overline{x}\right)}{\sum_{i=1}^{n} \left(x_i - \overline{x}\right)^2}$$

- N: The number of spatial units indexed by i and j
- W: The sum of all wij
- x: The variable of interest (in this instance, cumulative COVID cases, adjusted for population)
- x: The mean of x
- wij: A matrix of spatial weights

Figure S18: Morans I results: United States - Alpha Wave, Dependent Variable

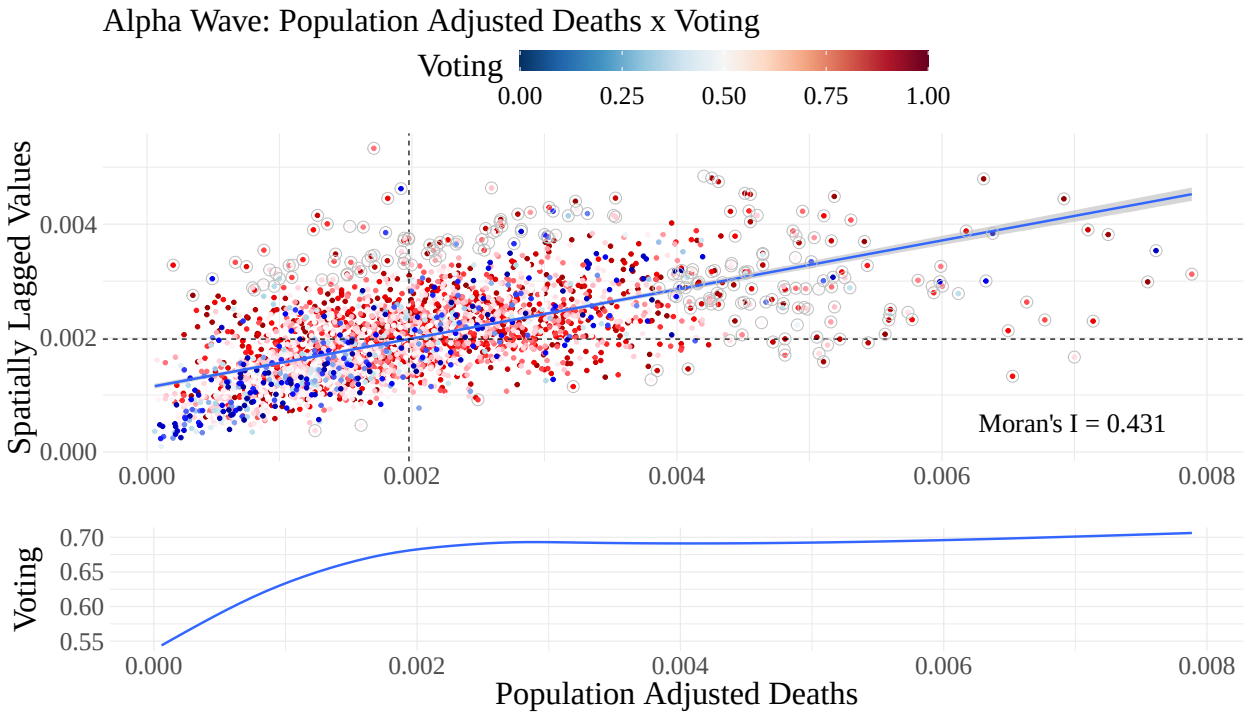
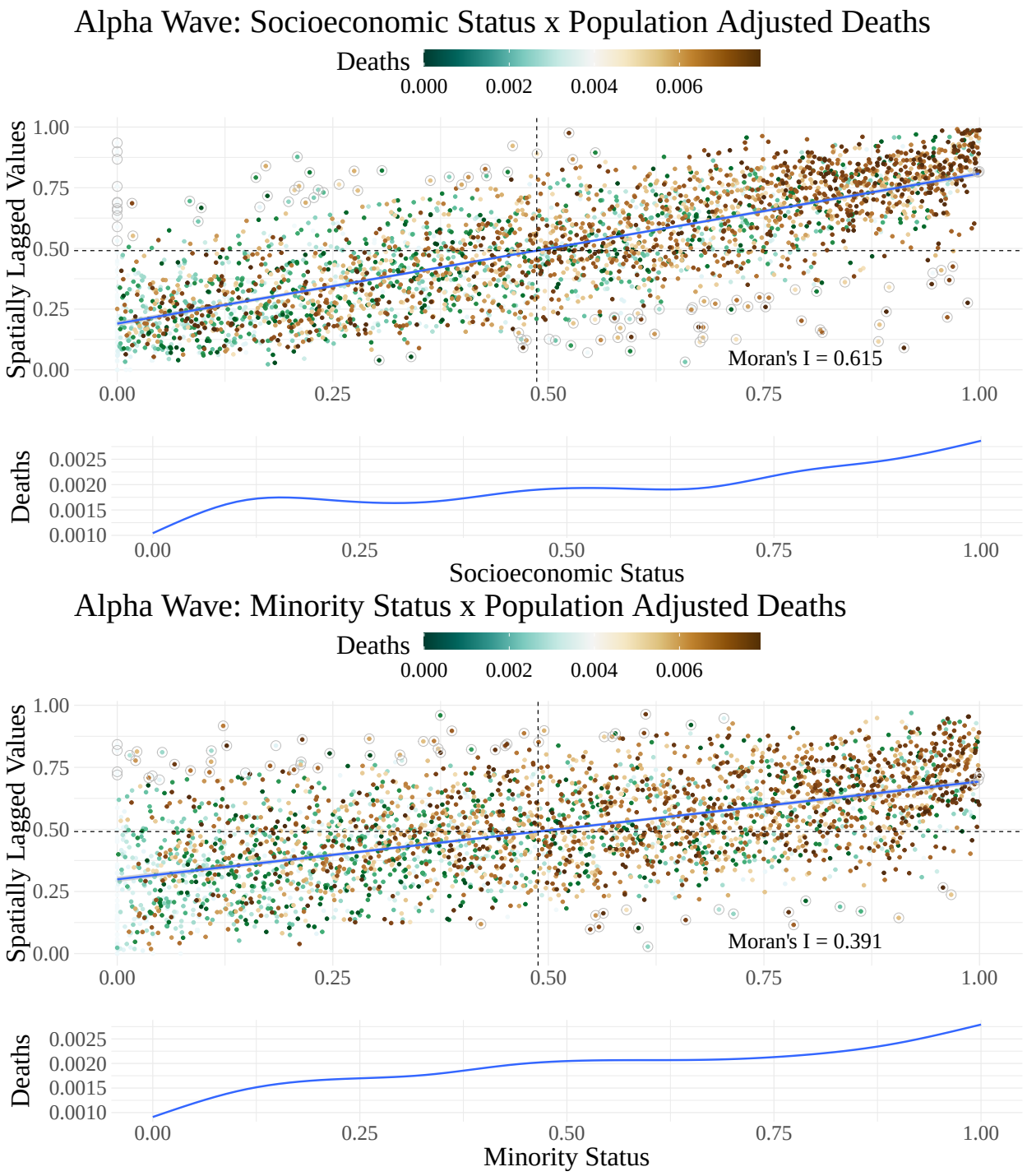
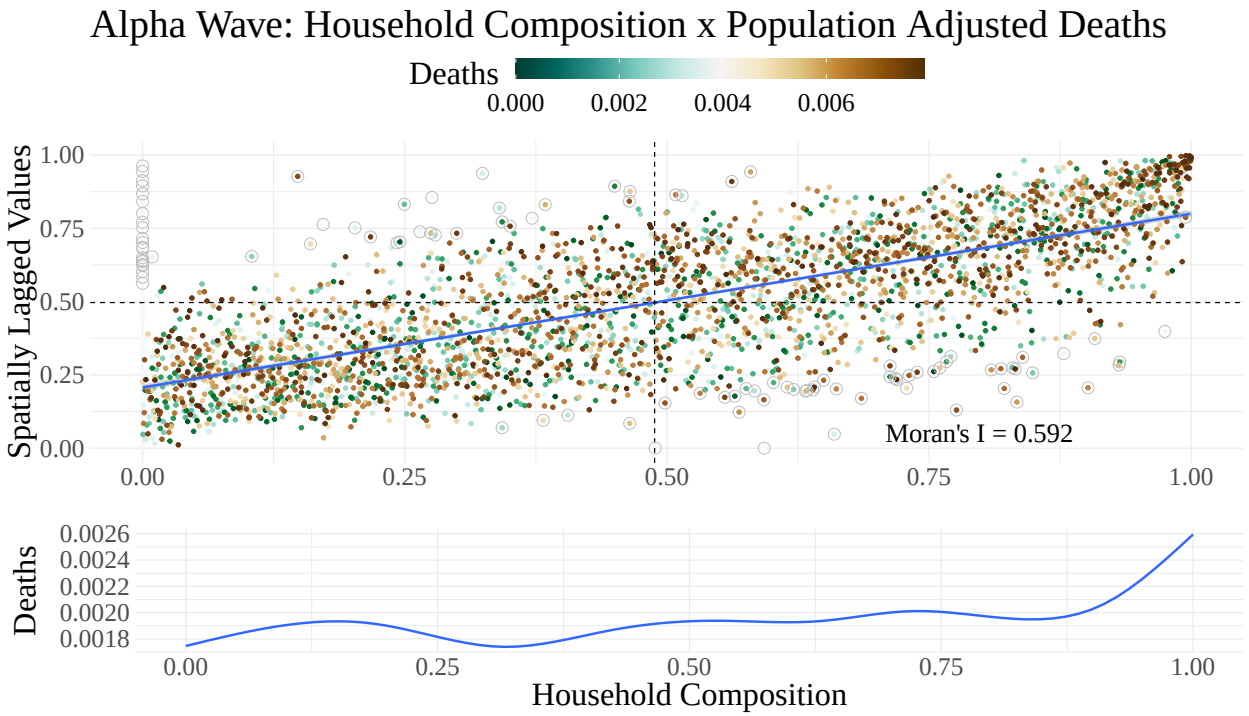
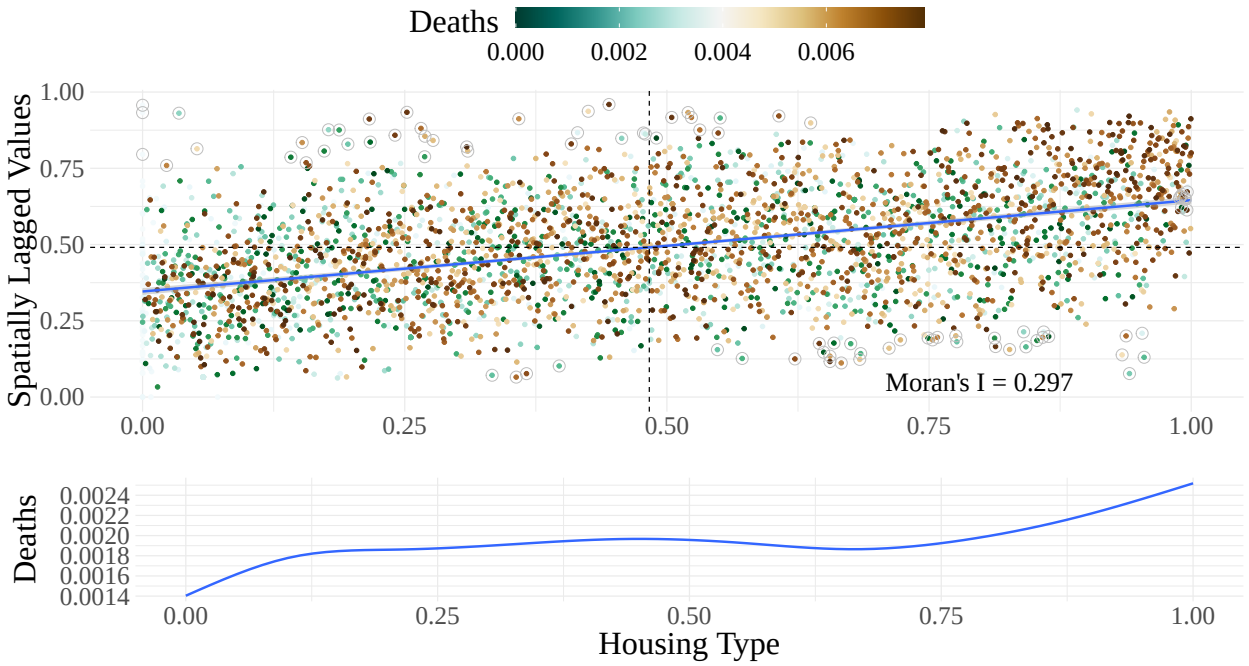
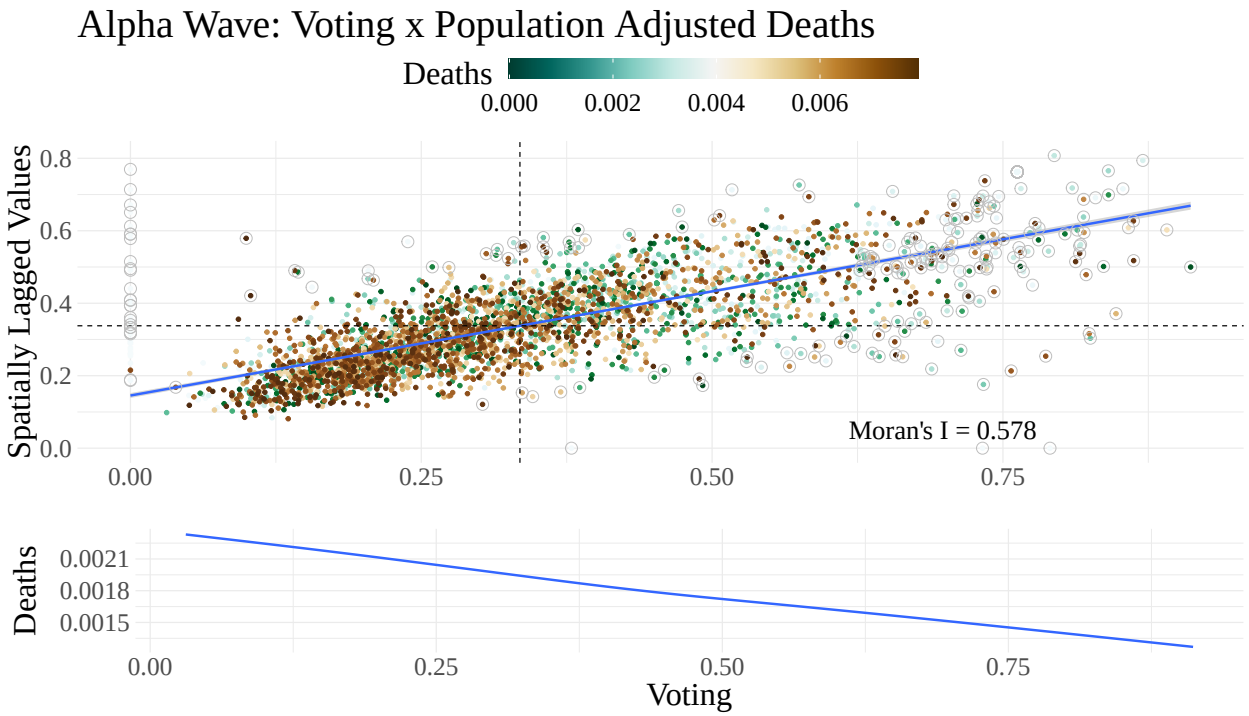


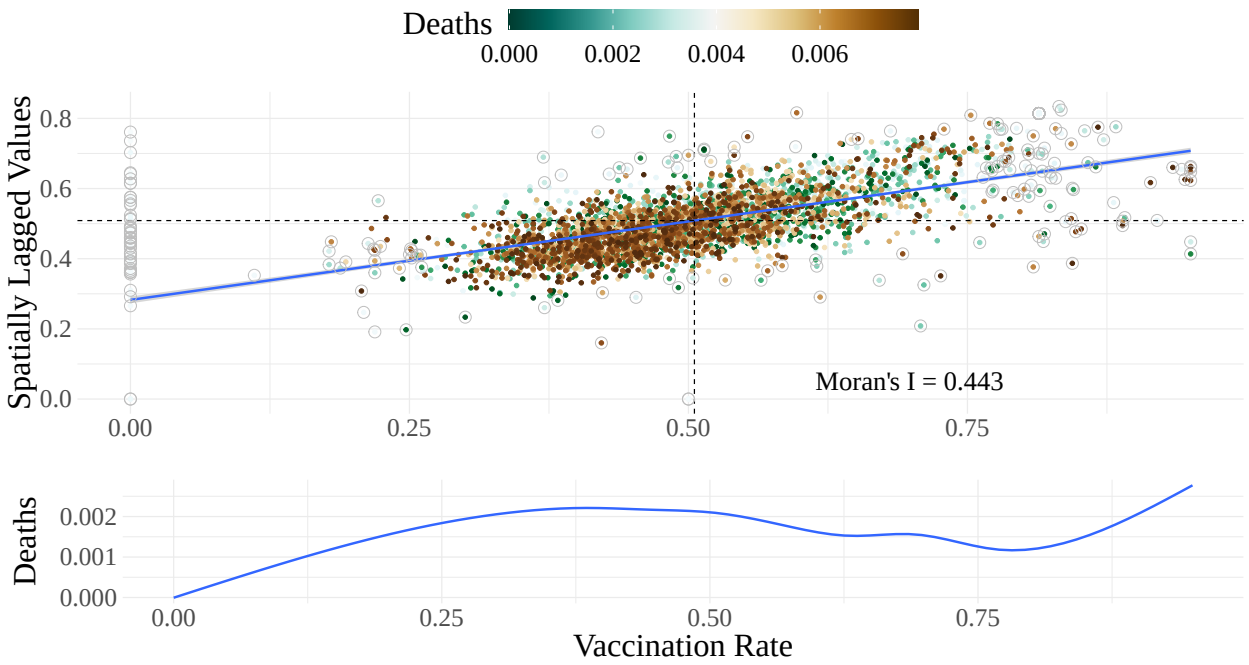
Figure S19: Morans I results: United States - Alpha Wave, Independent Variables

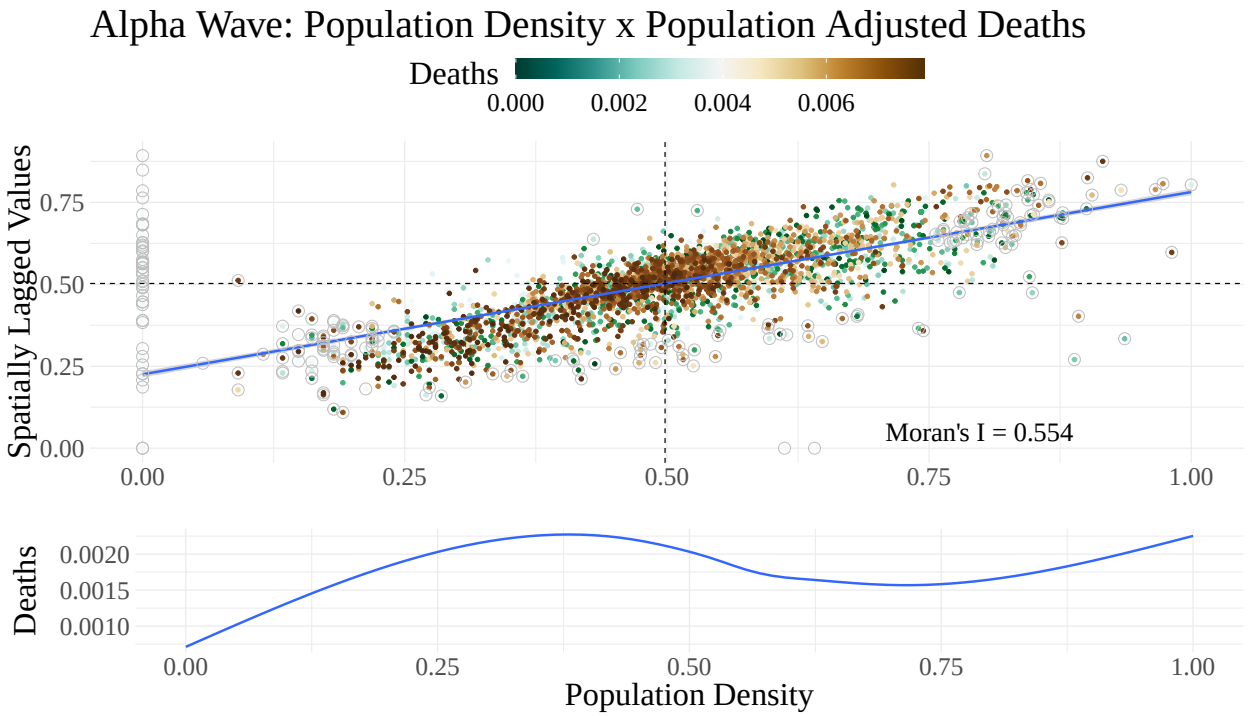


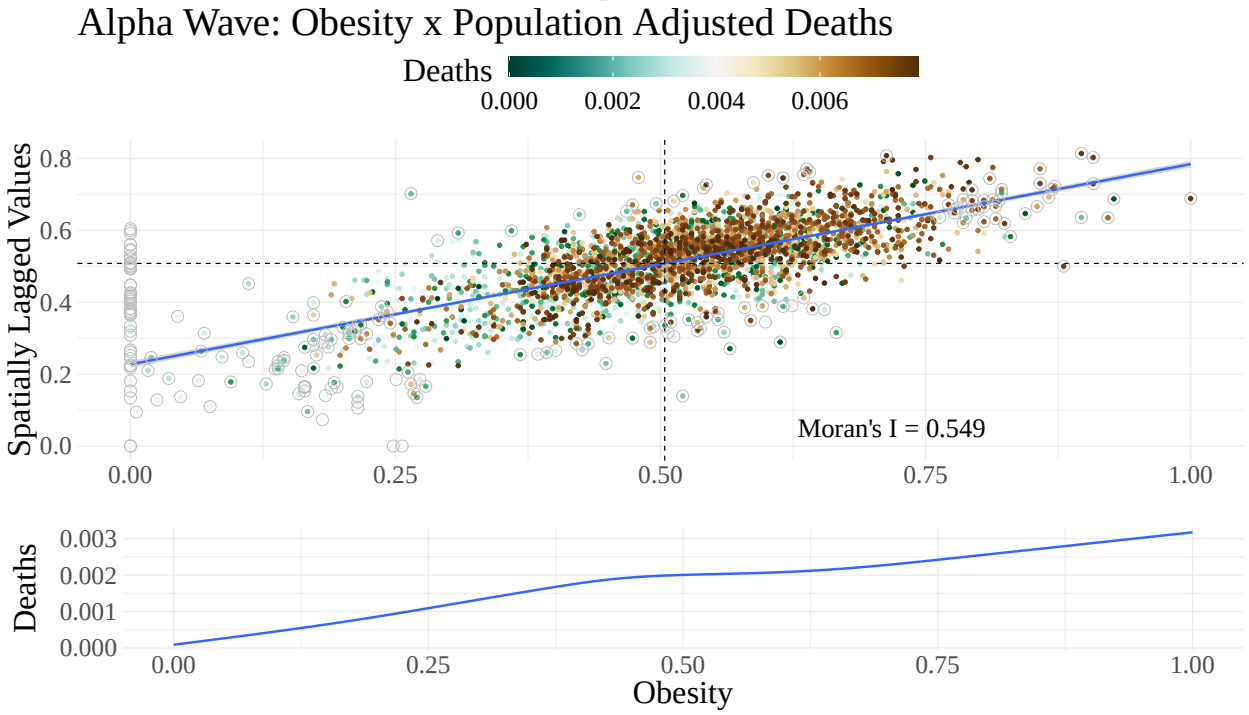

Alpha Wave: Household Composition x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
1.00
0.75
0.50
0.25
0.00
Moran's I = 0.592
0.00
0.25
0.50
0.75
1.00
Deaths
0.0026
0.0024
0.0022
0.0020
0.0018
Household Composition

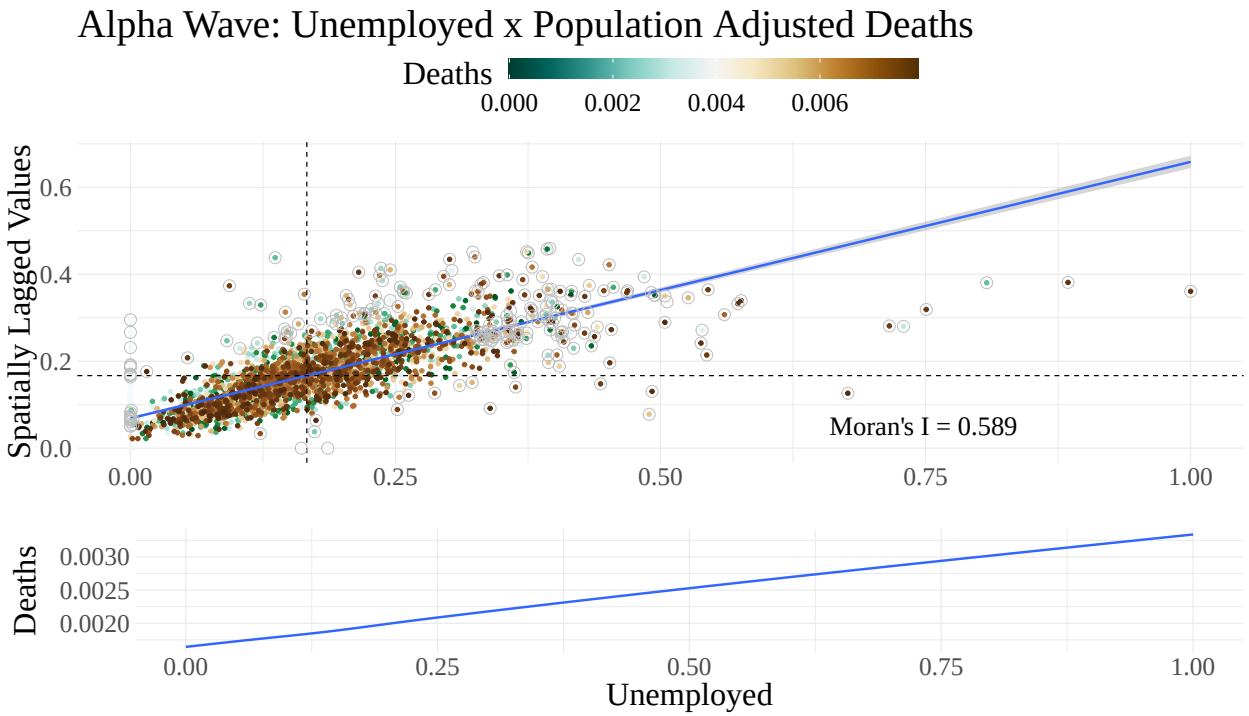

Alpha Wave: Housing Type x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
1.00
0.75
0.50
0.25
0.00
Moran's I = 0.297
0.00
0.25
0.50
0.75
1.00
Deaths
0.0024
0.0022
0.0020
0.0018
0.0016
0.0014
Housing Type

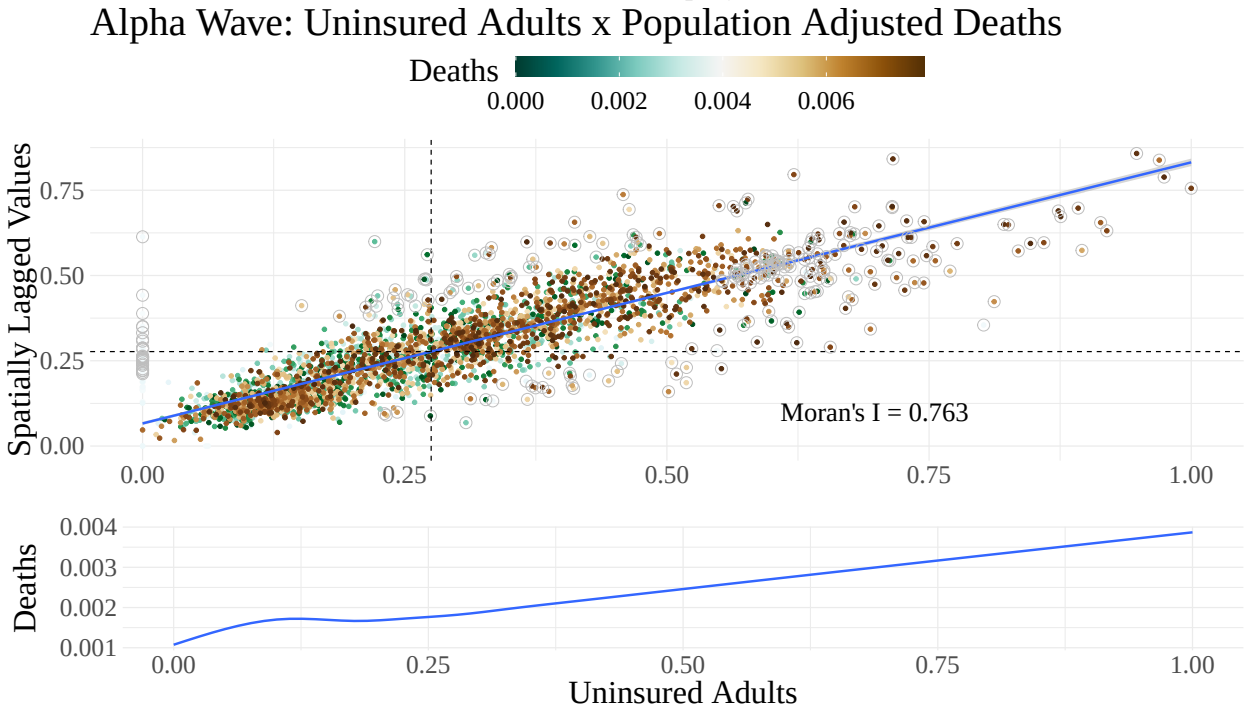

Alpha Wave: Voting x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
0.8
0.6
0.4
0.2
0.0
Moran's I = 0.578
0.00
0.25
0.50
0.75
Deaths
0.0021
0.0018
0.0015
0.00
0.25
0.50
0.75
Voting

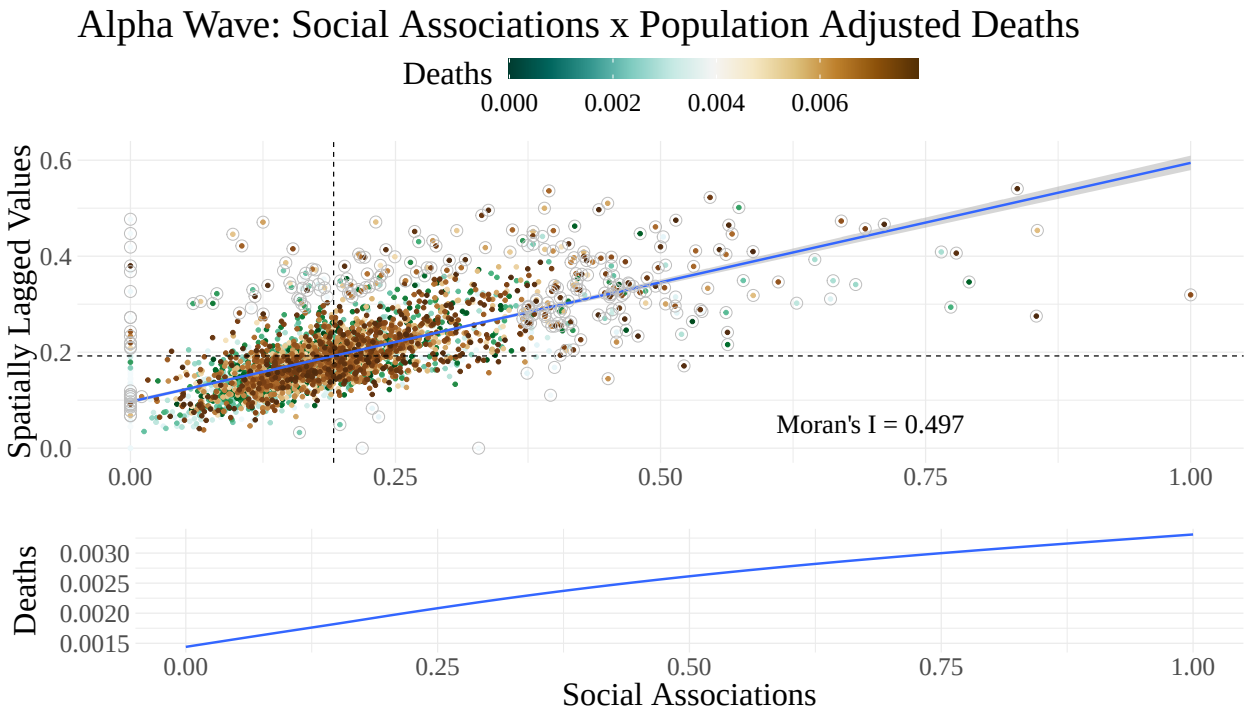

Alpha Wave: Vaccination Rate x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
0.8
0.6
0.4
0.2
0.0
Moran's I = 0.443
0.00
0.25
0.50
0.75
Deaths
0.002
0.001
0.000
0.00
0.25
0.50
0.75
Vaccination Rate

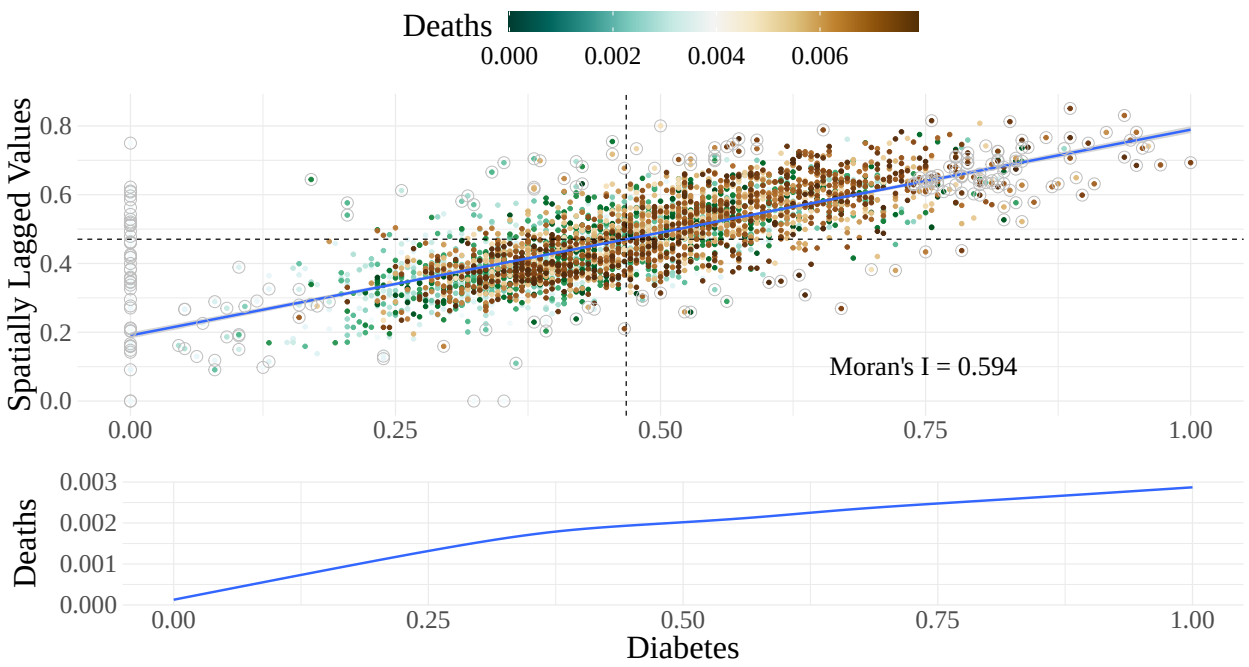

Alpha Wave: Population Density x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
0.00
0.25
0.50
0.75
Moran's I = 0.554
Deaths
0.0010
0.0015
0.0020
0.00
0.25
0.50
0.75
1.00
Population Density

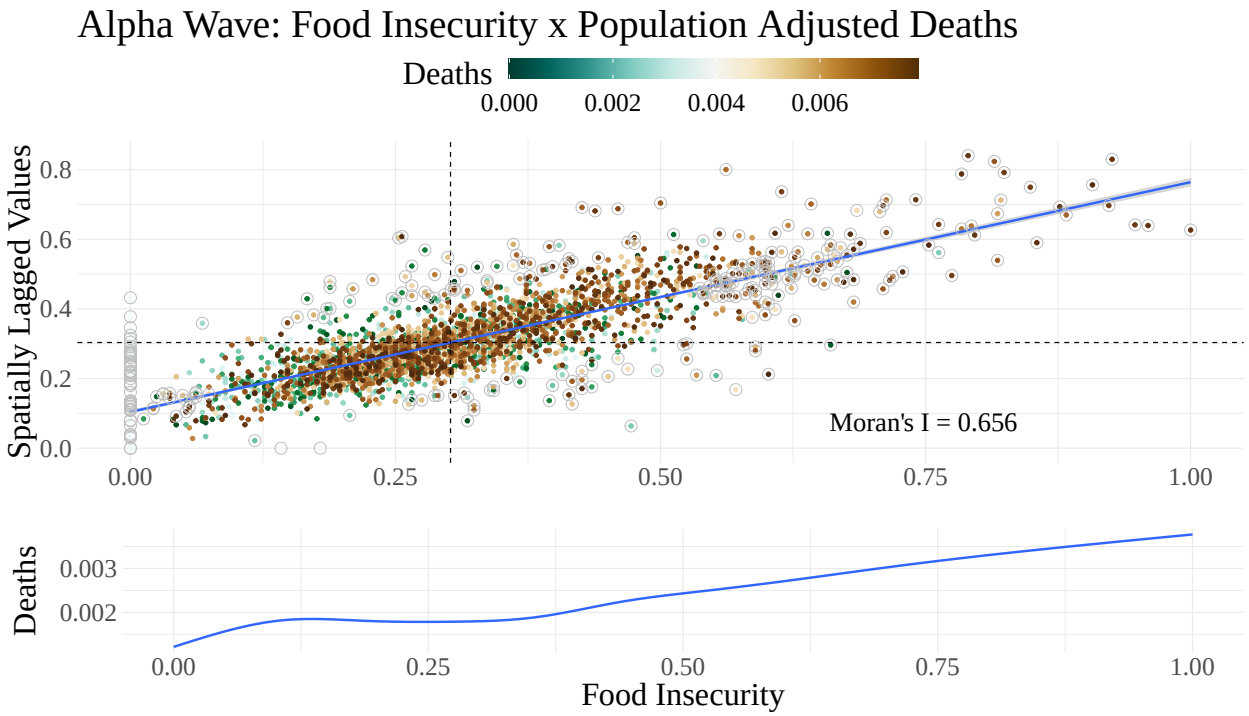

Alpha Wave: Obesity x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
0.0
0.2
0.4
0.6
0.8
Moran's I = 0.549
Deaths
0.000
0.001
0.002
0.003
0.00
0.25
0.50
0.75
1.00
Obesity

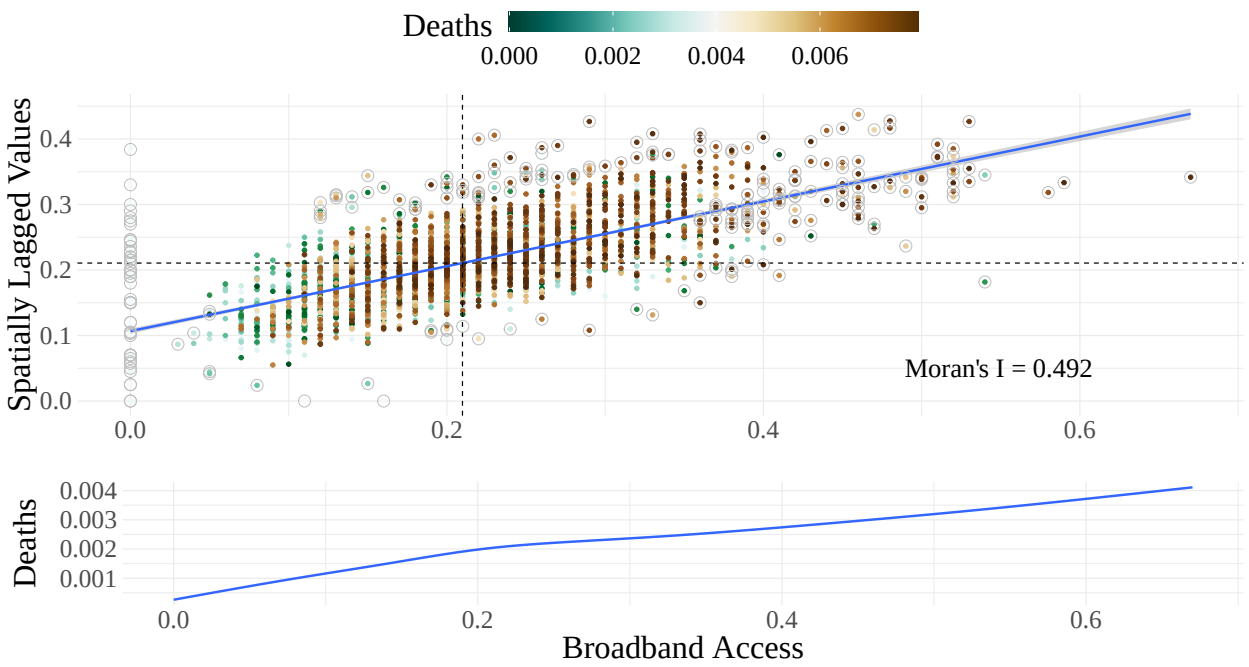

Alpha Wave: Unemployed x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
0.0
0.2
0.4
0.6
Moran's I = 0.589
0.00
0.25
0.50
0.75
1.00
Deaths
0.0020
0.0025
0.0030
Unemployed


Alpha Wave: Uninsured Adults x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
0.00
0.25
0.50
0.75
Moran's I = 0.763
0.00
0.25
0.50
0.75
1.00
Deaths
0.001
0.002
0.003
0.004
Uninsured Adults


Alpha Wave: Social Associations x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
0.6
0.4
0.2
0.0
Moran's I = 0.497
0.00
0.25
0.50
0.75
1.00
Deaths
0.0030
0.0025
0.0020
0.0015
Social Associations


Alpha Wave: Diabetes x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
0.8
0.6
0.4
0.2
0.0
Moran's I = 0.594
0.00
0.25
0.50
0.75
1.00
Deaths
0.003
0.002
0.001
0.000
Diabetes


Alpha Wave: Food Insecurity x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
0.0
0.2
0.4
0.6
0.8
Moran's I = 0.656
0.00
0.25
0.50
0.75
1.00
Deaths
0.002
0.003
Food Insecurity


Alpha Wave: Broadband Access x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
0.0
0.1
0.2
0.3
0.4
Moran's I = 0.492
0.0
0.2
0.4
0.6
Deaths
0.001
0.002
0.003
0.004
Broadband Access

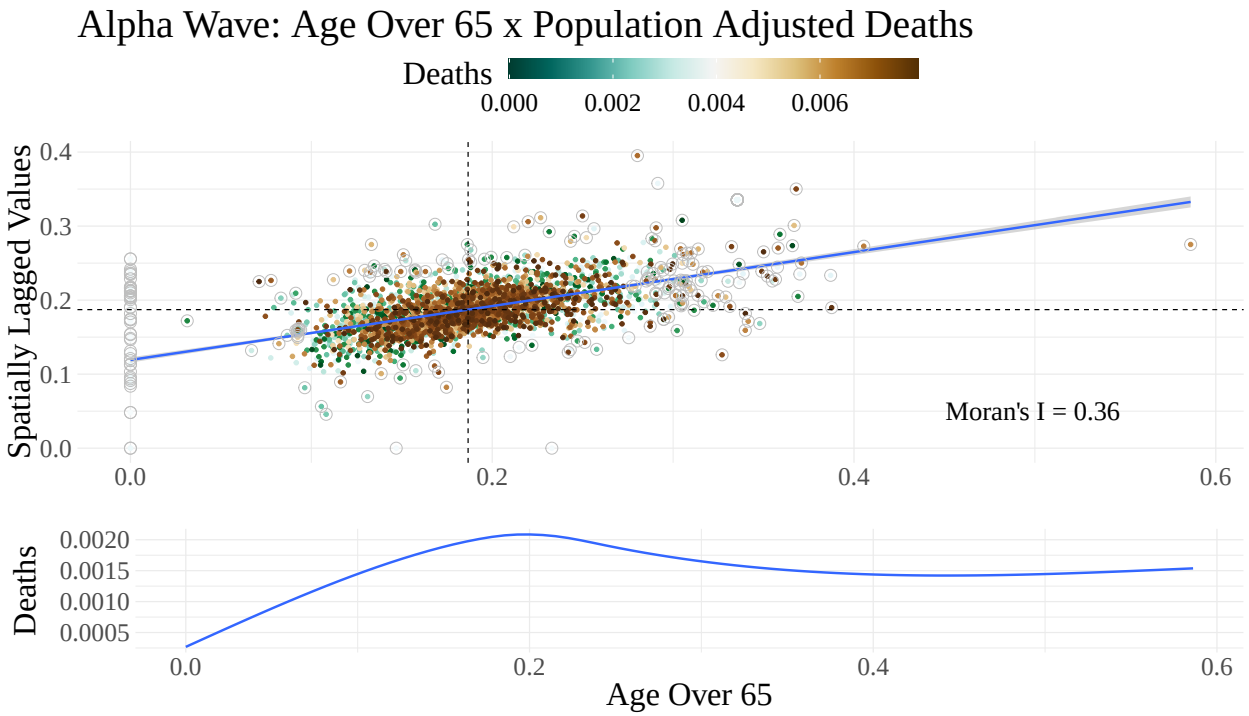

Alpha Wave: Age Over 65 x Population Adjusted Deaths
Deaths
0.000
0.002
0.004
0.006
Spatially Lagged Values
0.4
0.3
0.2
0.1
0.0
Moran's I = 0.36
0.0
0.2
0.4
0.6
Deaths
0.0020
0.0015
0.0010
0.0005
0.0
0.2
0.4
0.6
Age Over 65

Figure S20: Morans I results: United States - Delta Wave, Dependent Variable

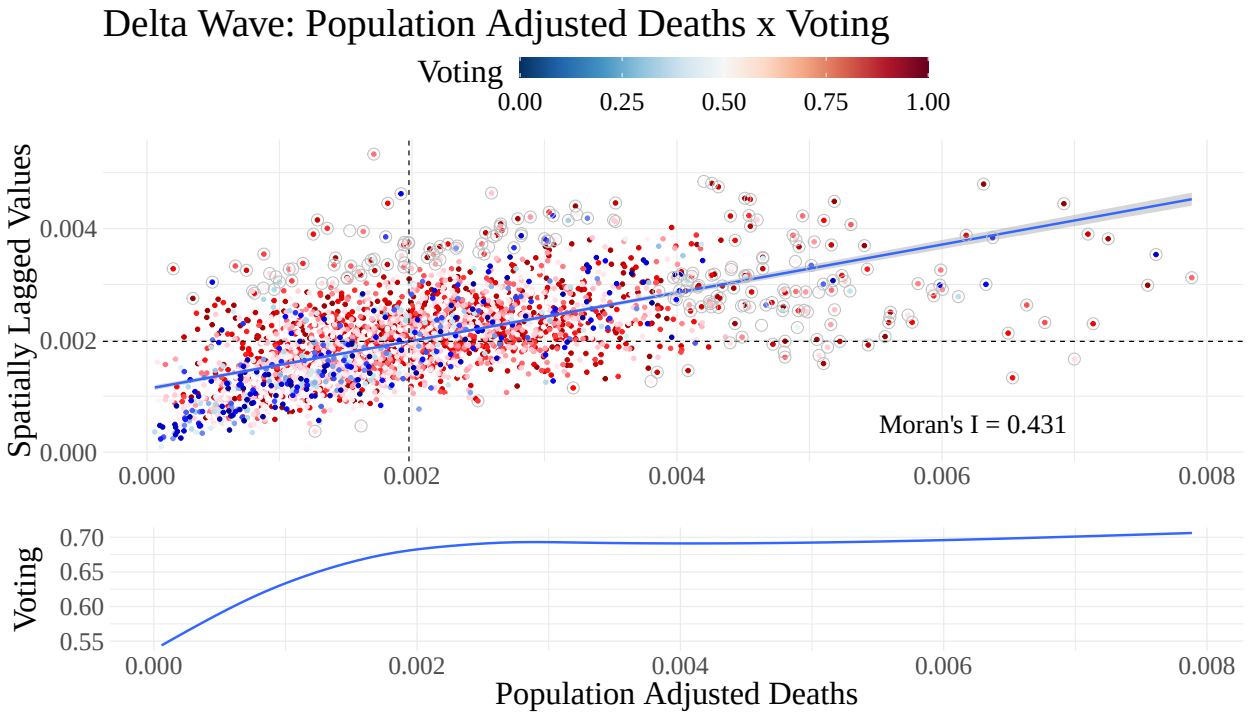
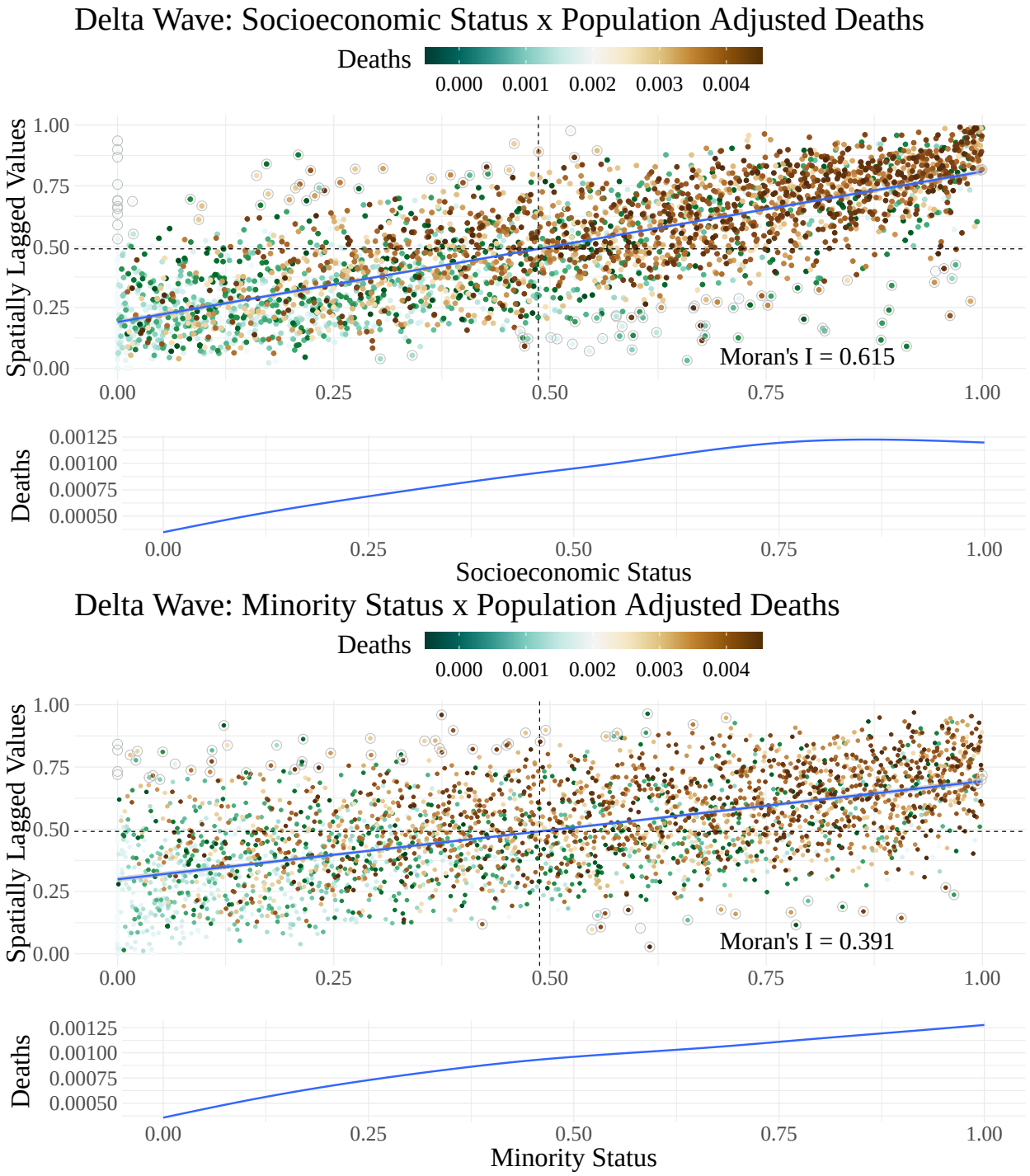
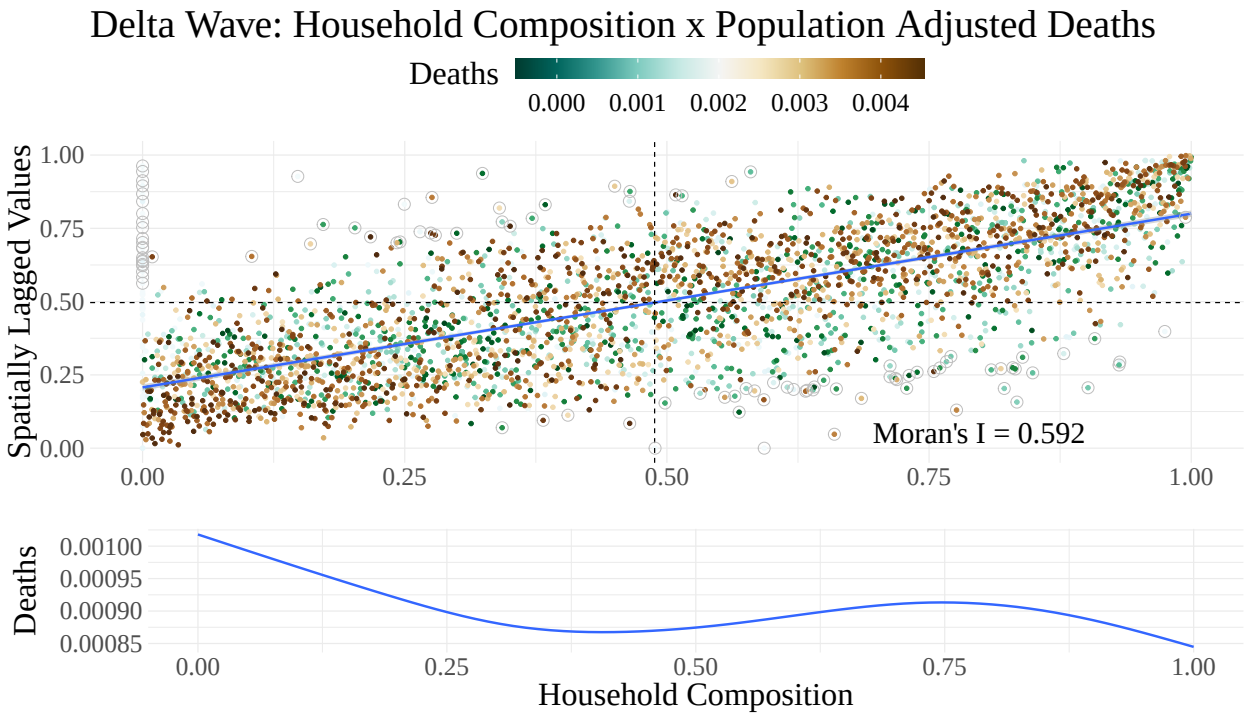
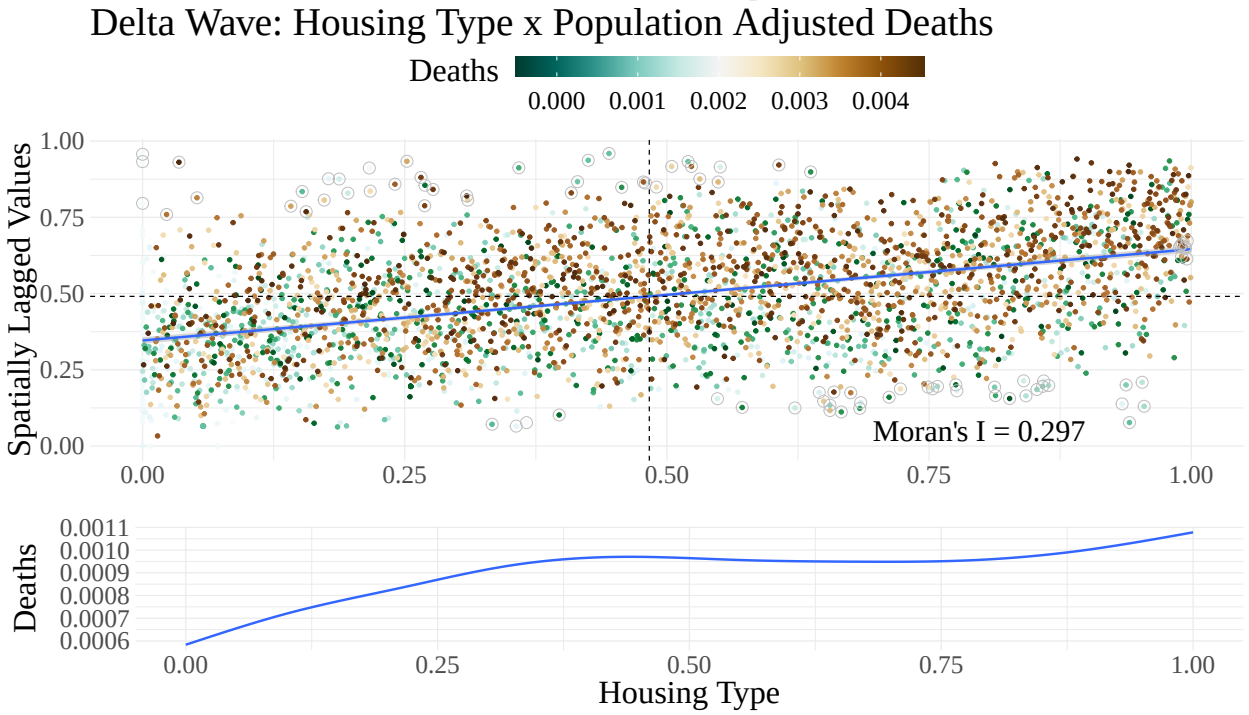
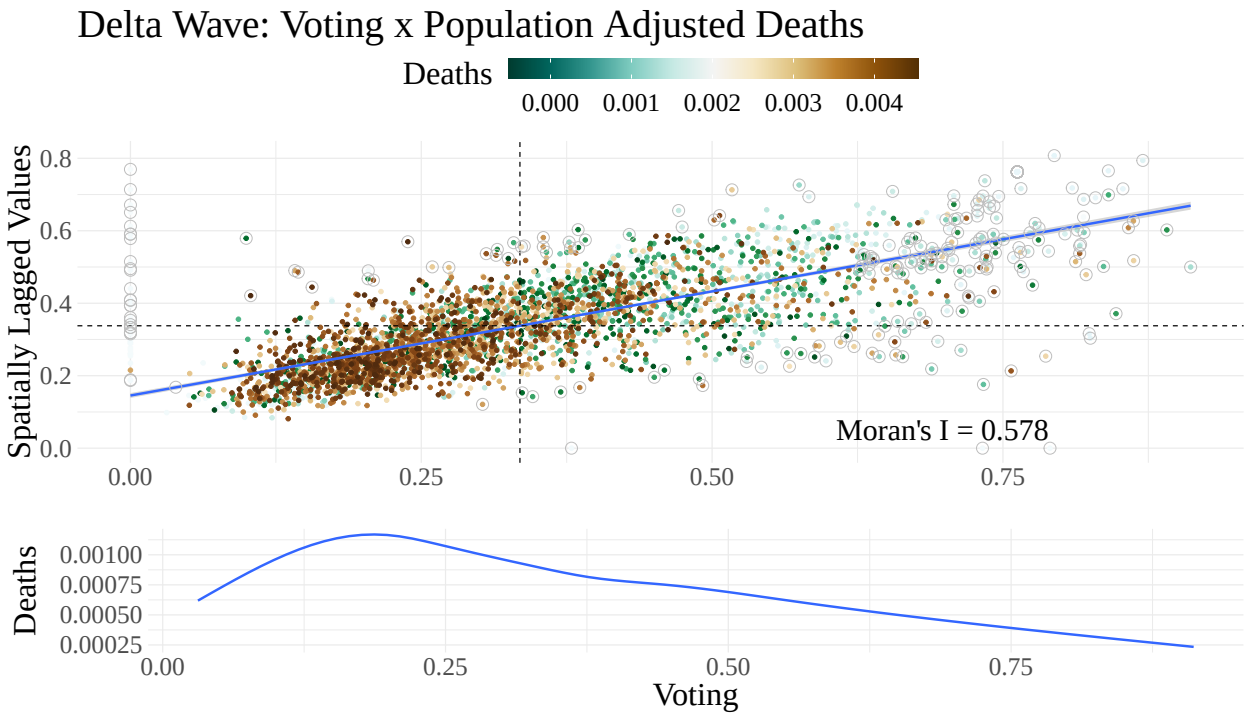


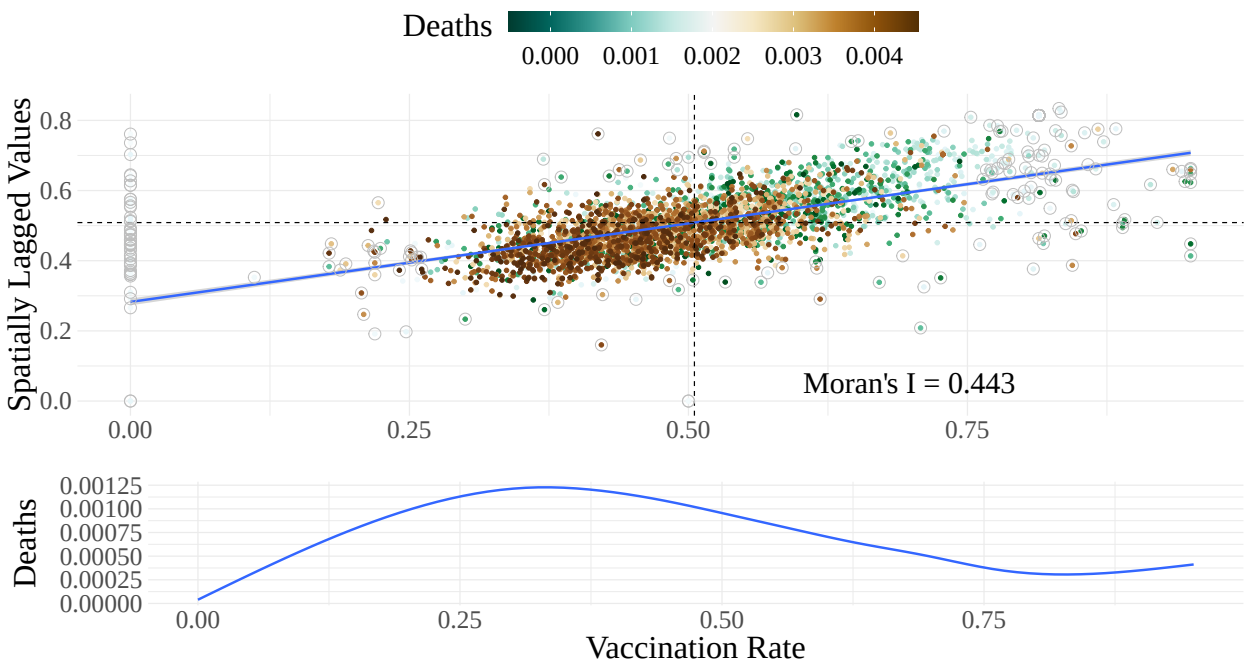
Figure S21: Morans I results: United States - Delta Wave, Independent Variables

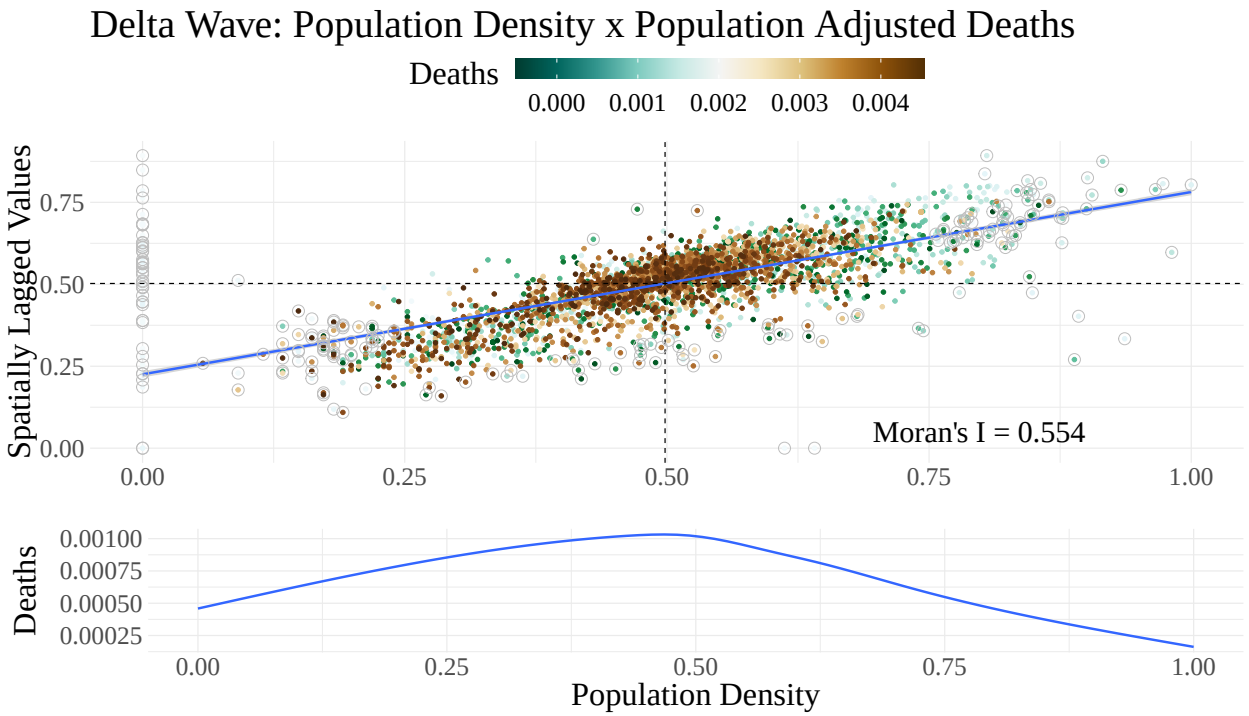


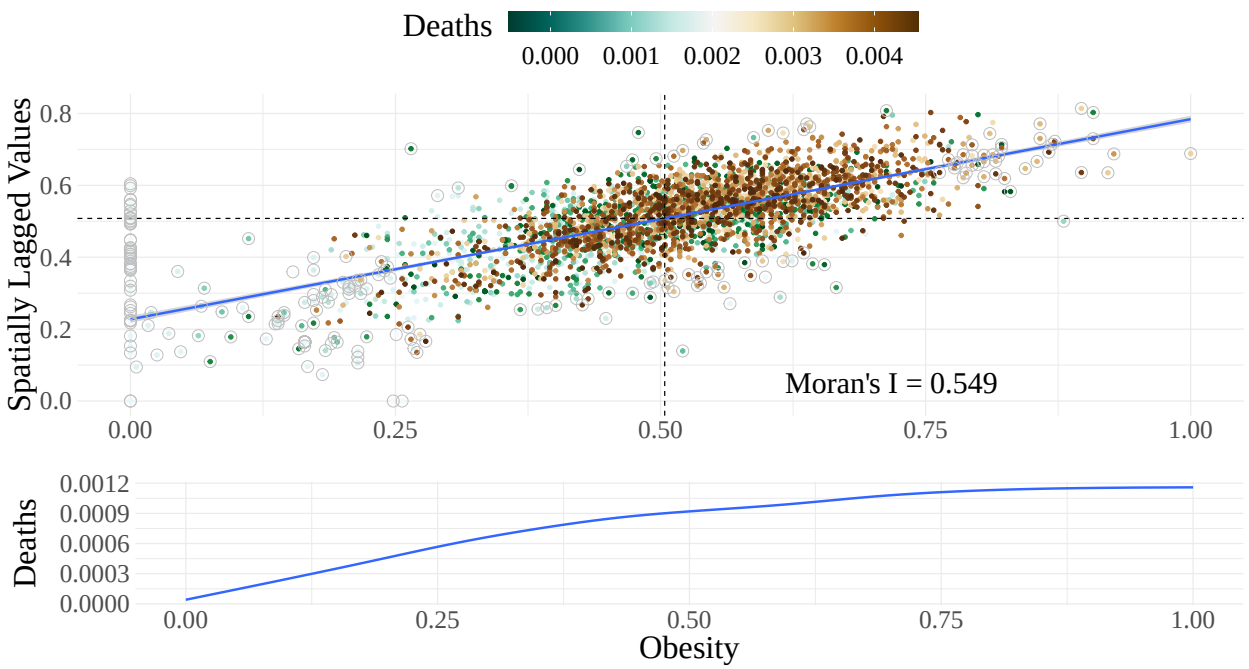

Delta Wave: Household Composition x Population Adjusted Deaths
Deaths
0.000 0.001 0.002 0.003 0.004
Spatially Lagged Values
1.00
0.75
0.50
0.25
0.00
Moran's I = 0.592
0.00 0.25 0.50 0.75 1.00
Deaths
0.00100
0.00095
0.00090
0.00085
0.00 0.25 0.50 0.75 1.00
Household Composition

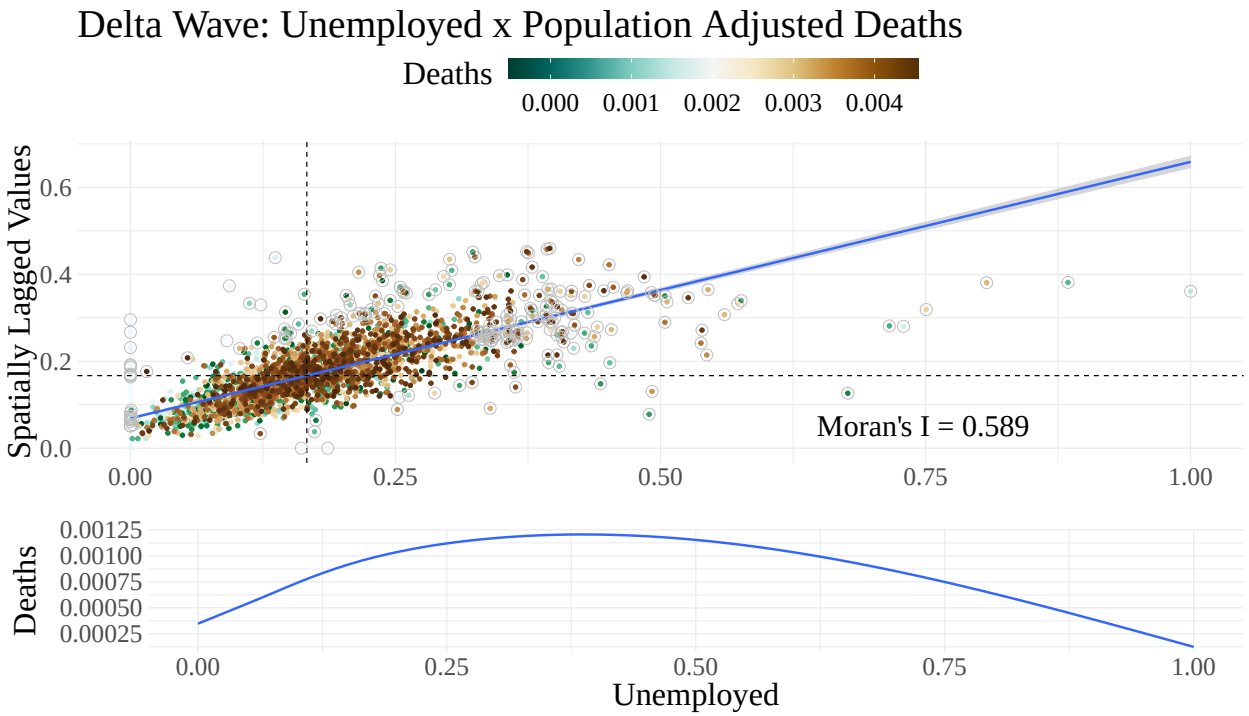

Delta Wave: Housing Type x Population Adjusted Deaths
Deaths
0.000 0.001 0.002 0.003 0.004
Spatially Lagged Values
1.00
0.75
0.50
0.25
0.00
Moran's I = 0.297
0.00 0.25 0.50 0.75 1.00
Deaths
0.0011
0.0010
0.0009
0.0008
0.0007
0.0006
0.00 0.25 0.50 0.75 1.00
Housing Type

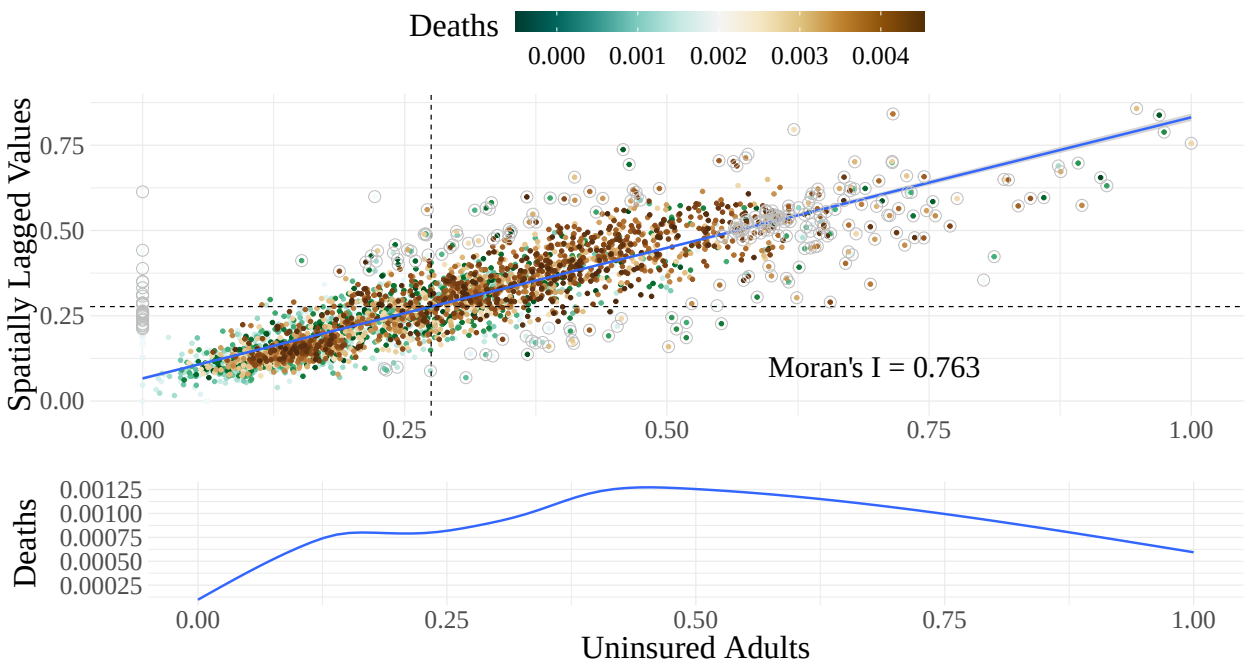

Delta Wave: Voting x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
0.004
Spatially Lagged Values
0.8
0.6
0.4
0.2
0.0
0.00
0.25
0.50
0.75
Moran's I = 0.578
Deaths
0.00100
0.00075
0.00050
0.00025
0.00
0.25
0.50
0.75
Voting

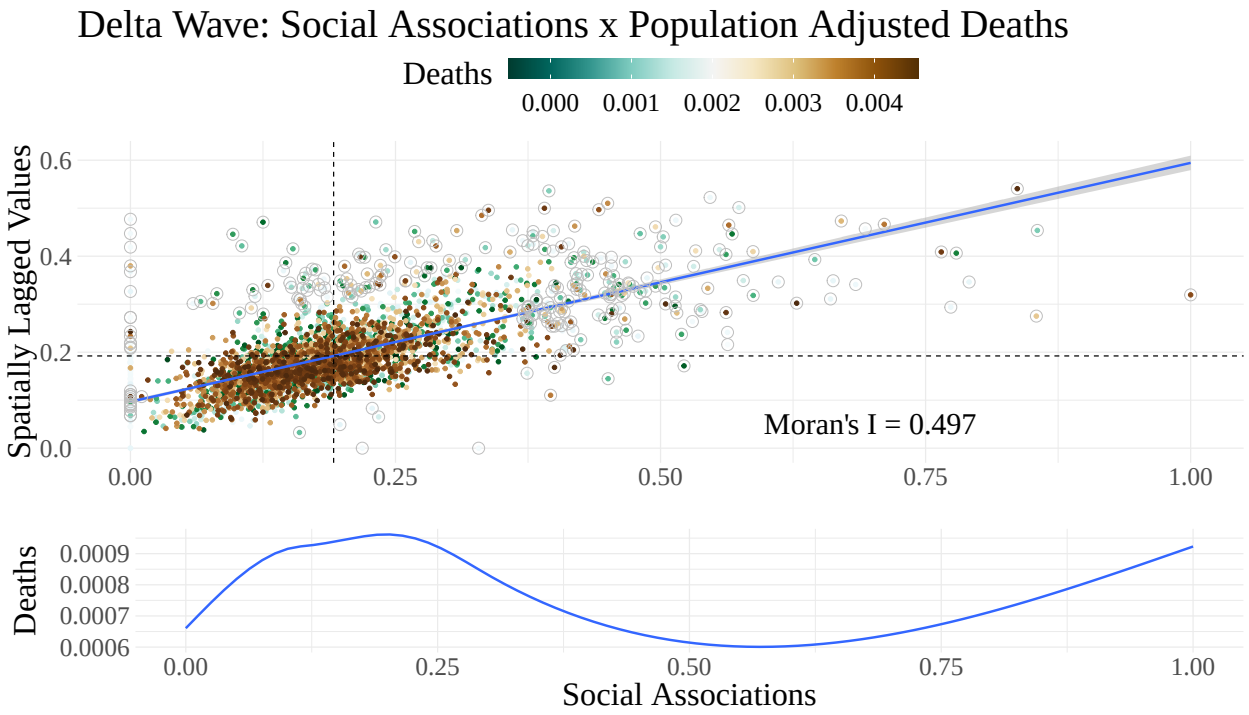

Delta Wave: Vaccination Rate x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
0.004
Spatially Lagged Values
0.8
0.6
0.4
0.2
0.0
0.00
0.25
0.50
0.75
Moran's I = 0.443
Deaths
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
0.00
0.25
0.50
0.75
Vaccination Rate

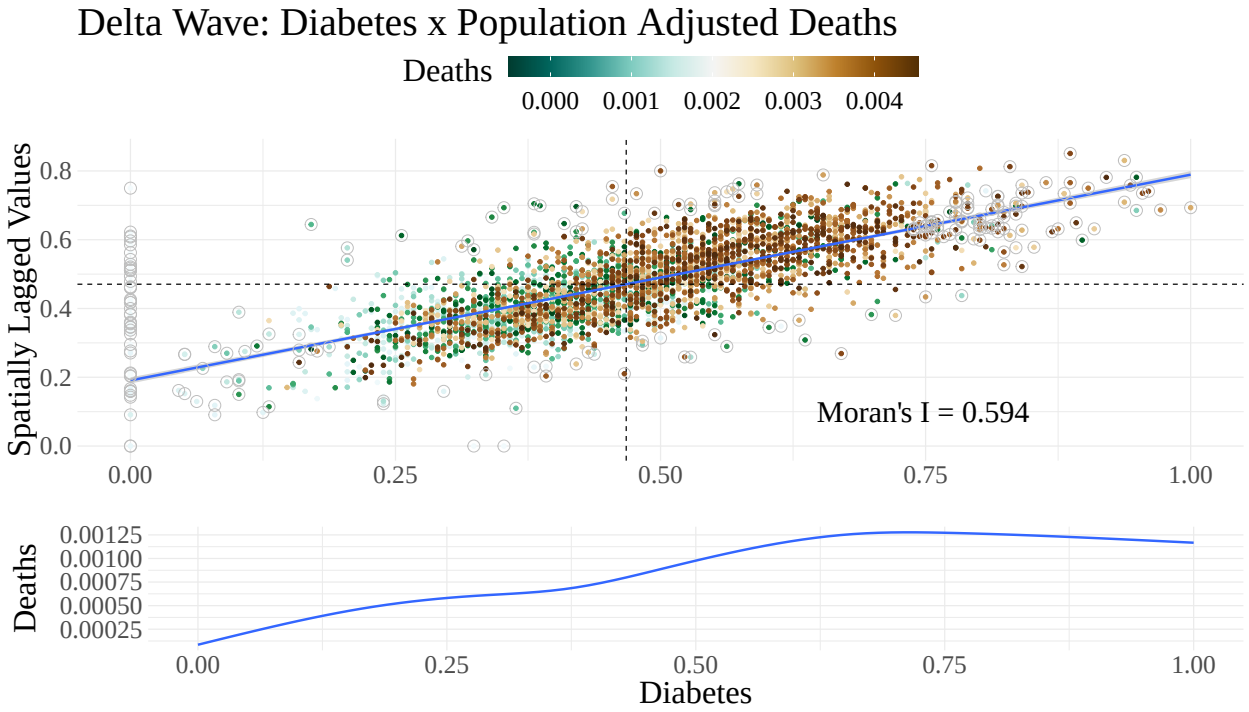

Delta Wave: Population Density x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
0.004
Spatially Lagged Values
0.00
0.25
0.50
0.75
Moran's I = 0.554
0.00
0.25
0.50
0.75
1.00
Deaths
0.00100
0.00075
0.00050
0.00025
0.00
0.25
0.50
0.75
1.00
Population Density

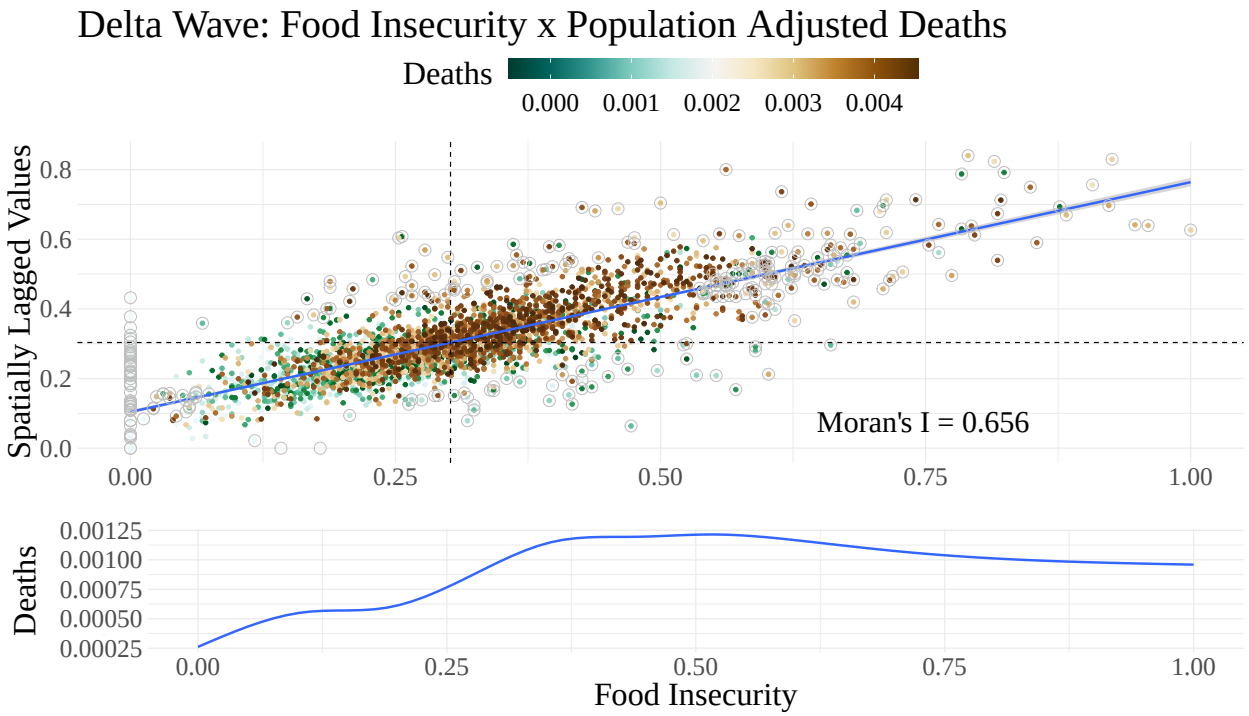

Delta Wave: Obesity x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
0.004
Spatially Lagged Values
0.0
0.2
0.4
0.6
0.8
Moran's I = 0.549
0.00
0.25
0.50
0.75
1.00
Deaths
0.0012
0.0009
0.0006
0.0003
0.0000
0.00
0.25
0.50
0.75
1.00
Obesity

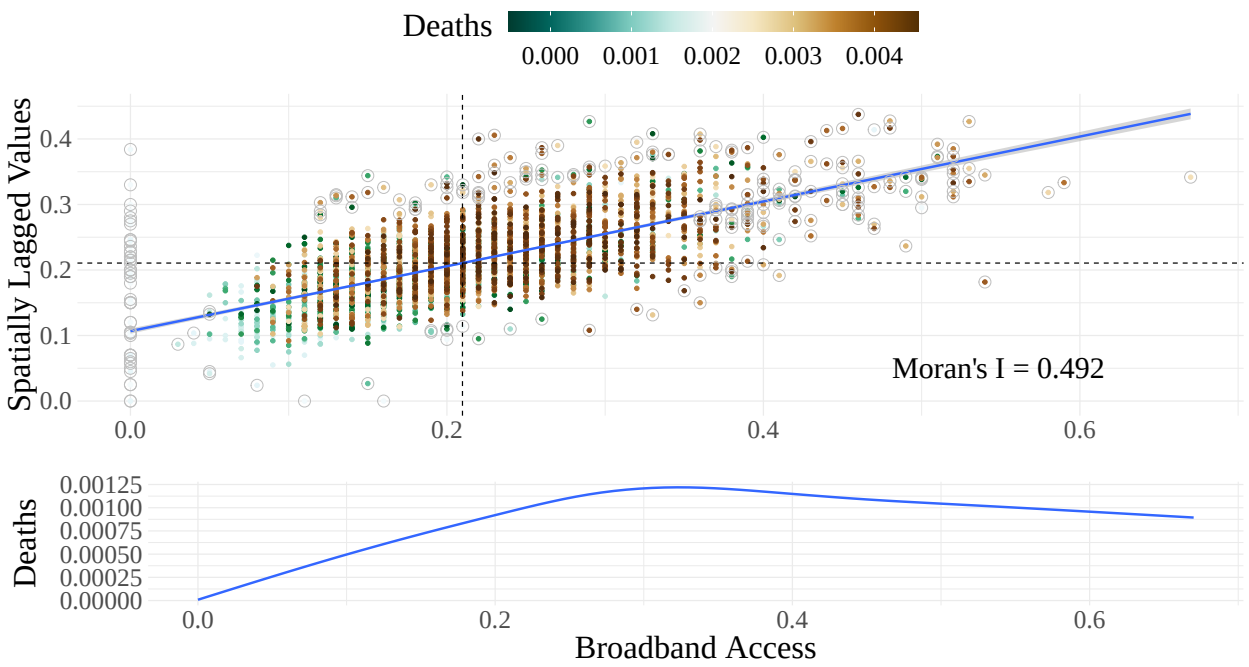

Delta Wave: Unemployed x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
0.004
Spatially Lagged Values
0.6
0.4
0.2
0.0
Moran's I = 0.589
0.00
0.25
0.50
0.75
1.00
Deaths
0.00125
0.00100
0.00075
0.00050
0.00025
Unemployed


Delta Wave: Uninsured Adults x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
0.004
Spatially Lagged Values
0.75
0.50
0.25
0.00
Moran's I = 0.763
0.00
0.25
0.50
0.75
1.00
Deaths
0.00125
0.00100
0.00075
0.00050
0.00025
Uninsured Adults


Delta Wave: Social Associations x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
0.004
Spatially Lagged Values
0.6
0.4
0.2
0.0
Moran's I = 0.497
0.00
0.25
0.50
0.75
1.00
Deaths
0.0009
0.0008
0.0007
0.0006
Social Associations


Delta Wave: Diabetes x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
0.004
Spatially Lagged Values
0.8
0.6
0.4
0.2
0.0
Moran's I = 0.594
0.00
0.25
0.50
0.75
1.00
Deaths
0.00125
0.00100
0.00075
0.00050
0.00025
Diabetes


Delta Wave: Food Insecurity x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
0.004
Spatially Lagged Values
0.0
0.2
0.4
0.6
0.8
Moran's I = 0.656
0.00
0.25
0.50
0.75
1.00
Deaths
0.00025
0.00050
0.00075
0.00100
0.00125
Food Insecurity


Delta Wave: Broadband Access x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
0.004
Spatially Lagged Values
0.0
0.1
0.2
0.3
0.4
Moran's I = 0.492
0.0
0.2
0.4
0.6
Deaths
0.00000
0.00025
0.00050
0.00075
0.00100
0.00125
Broadband Access

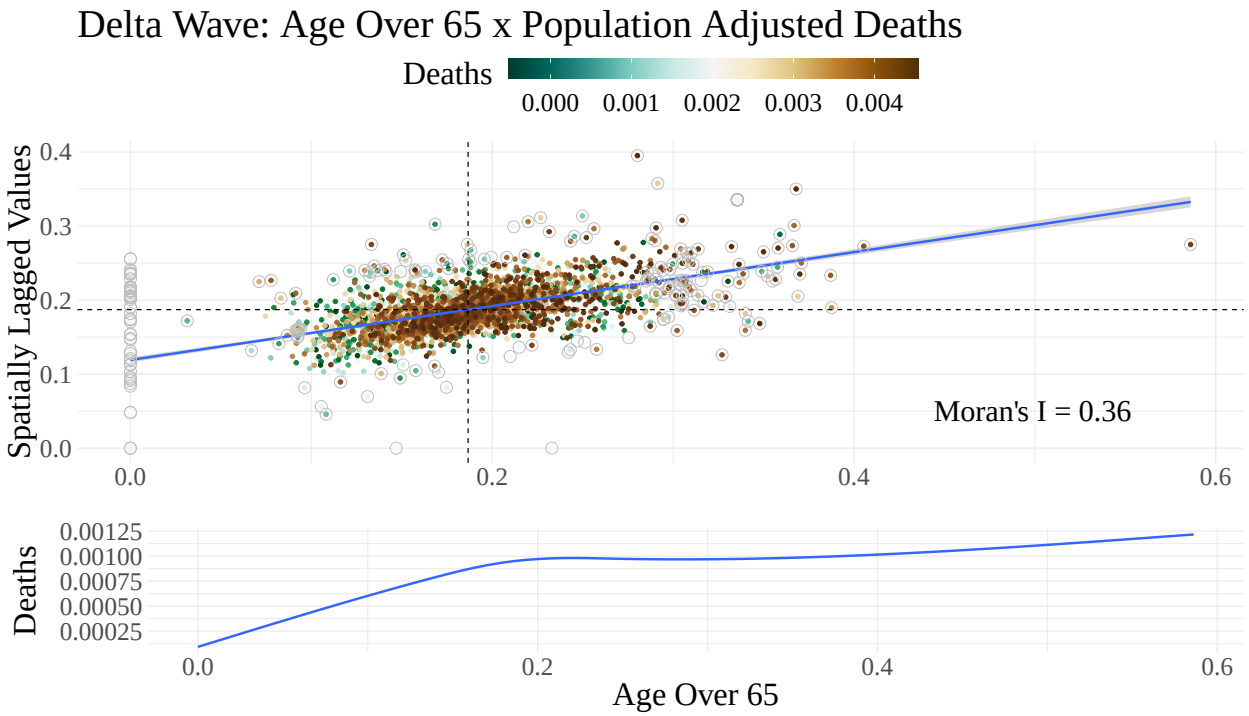

Delta Wave: Age Over 65 x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
0.004
Spatially Lagged Values
0.4
0.3
0.2
0.1
0.0
Moran's I = 0.36
0.0
0.2
0.4
0.6
Deaths
0.00125
0.00100
0.00075
0.00050
0.00025
0.0
0.2
0.4
0.6
Age Over 65

Figure S22: Morans I results: United States - Omicron Wave, Dependent Variable

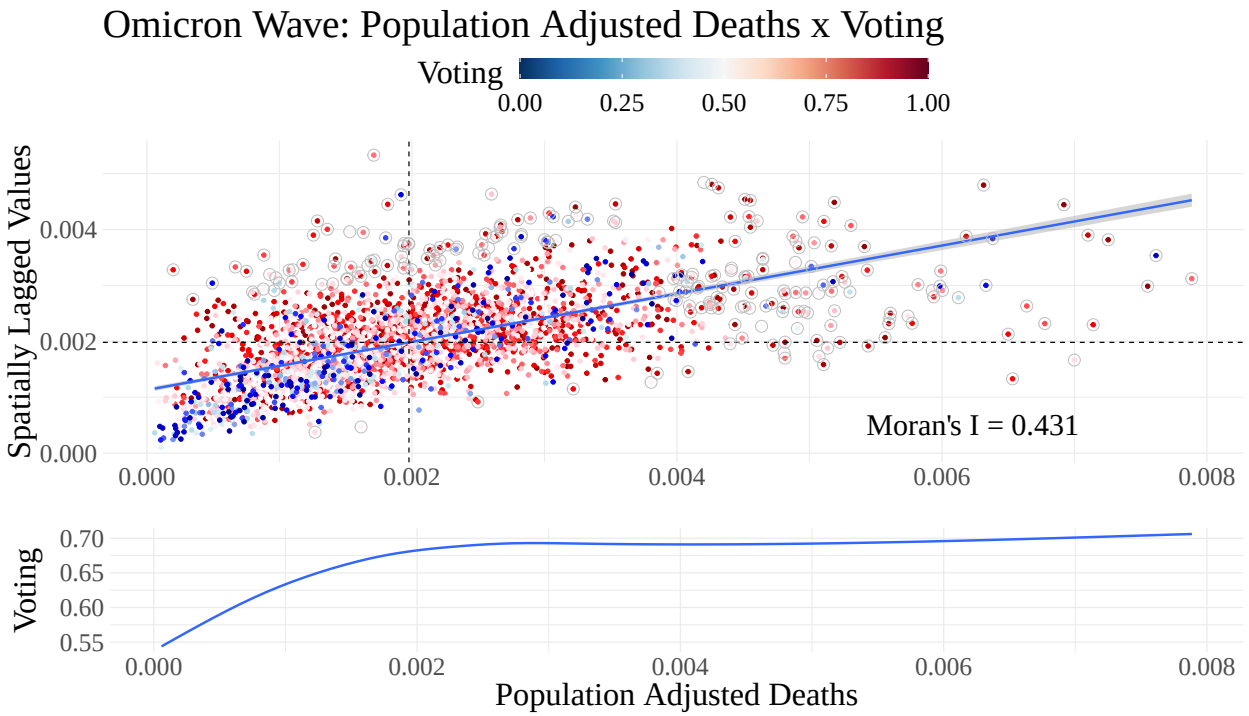
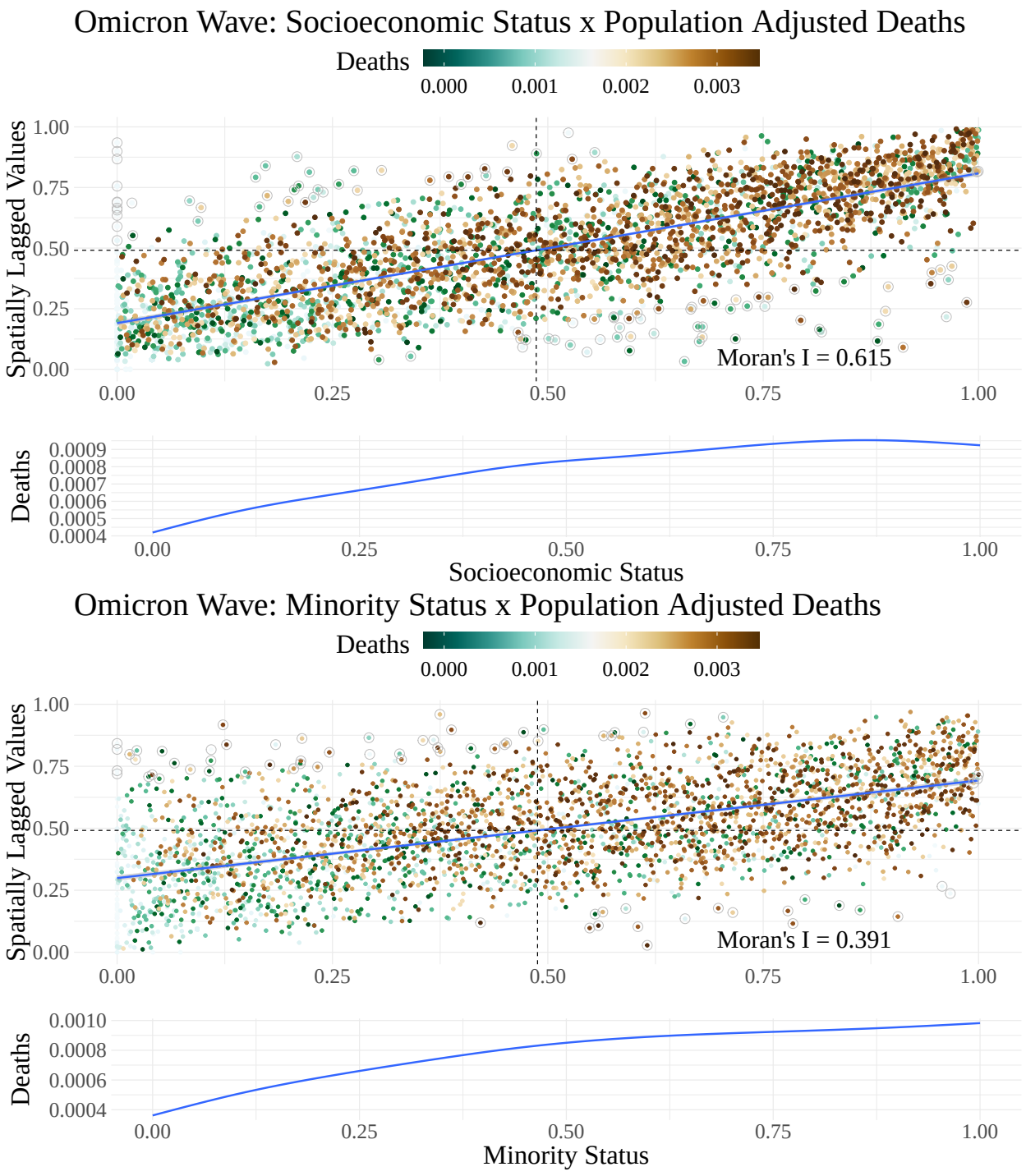
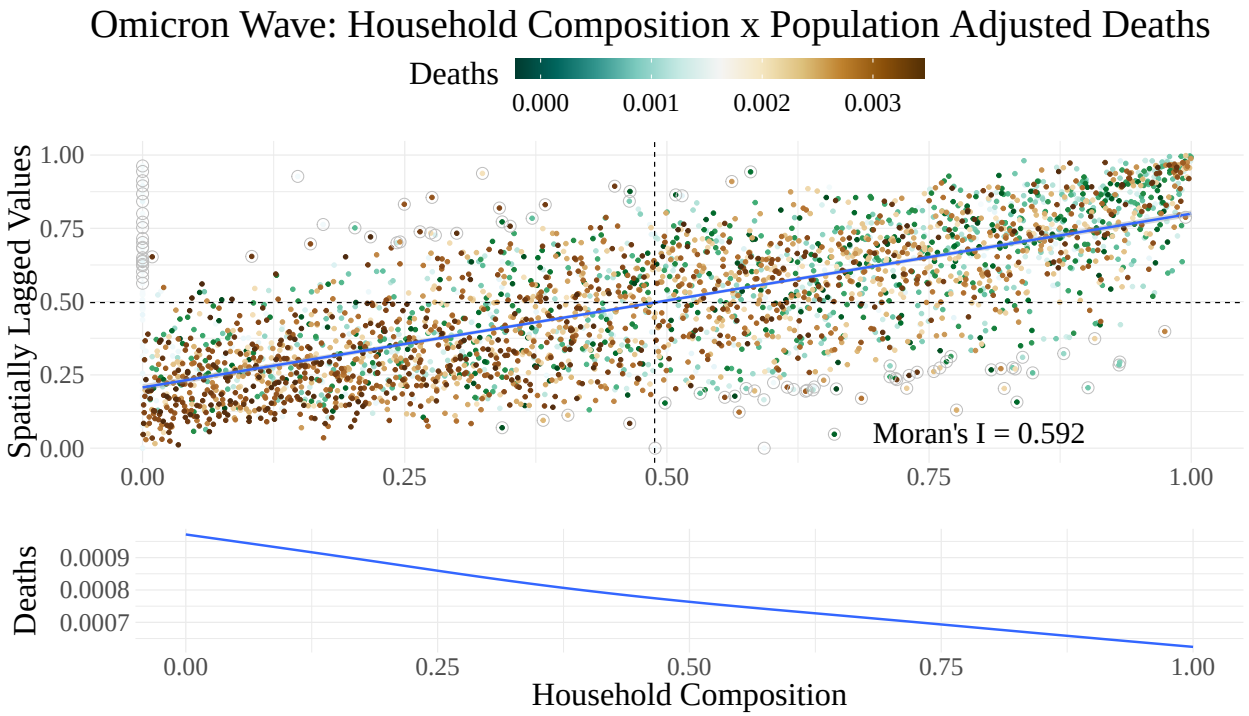
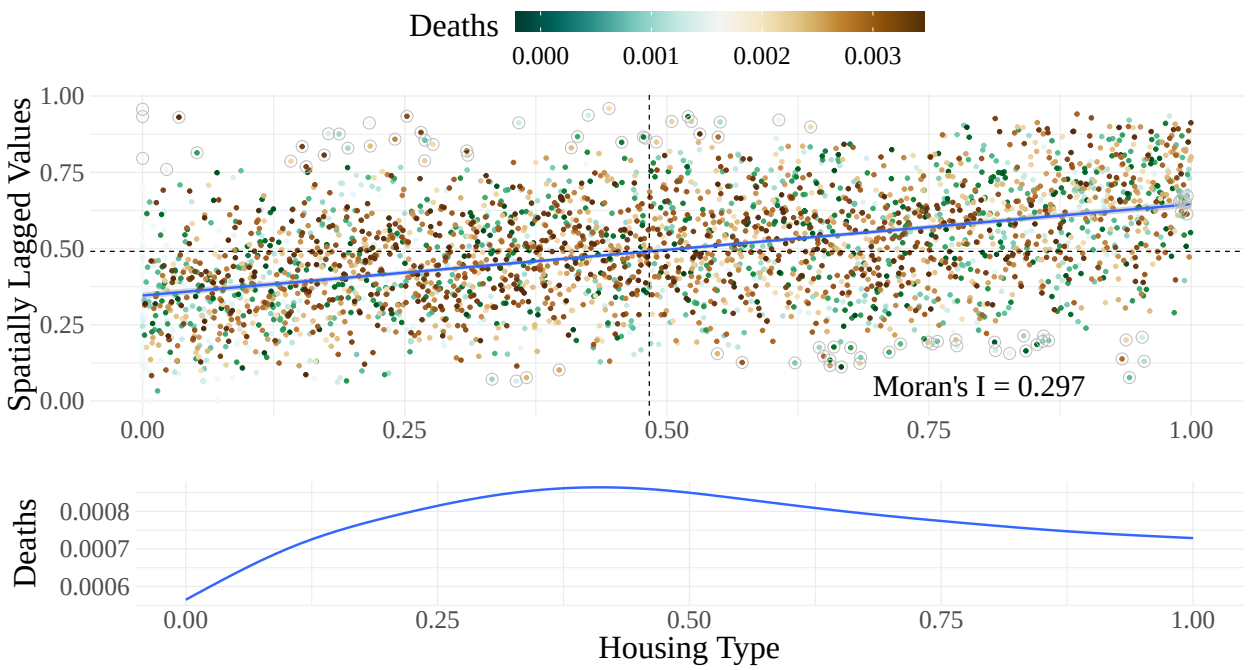
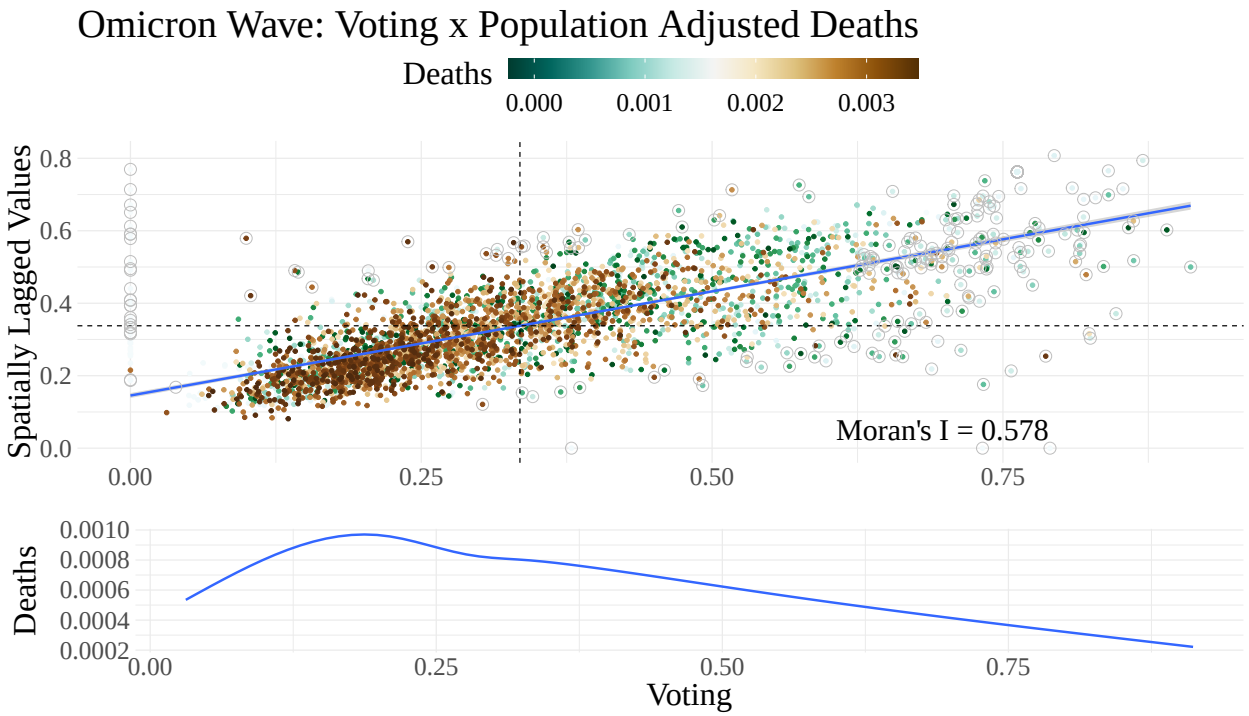


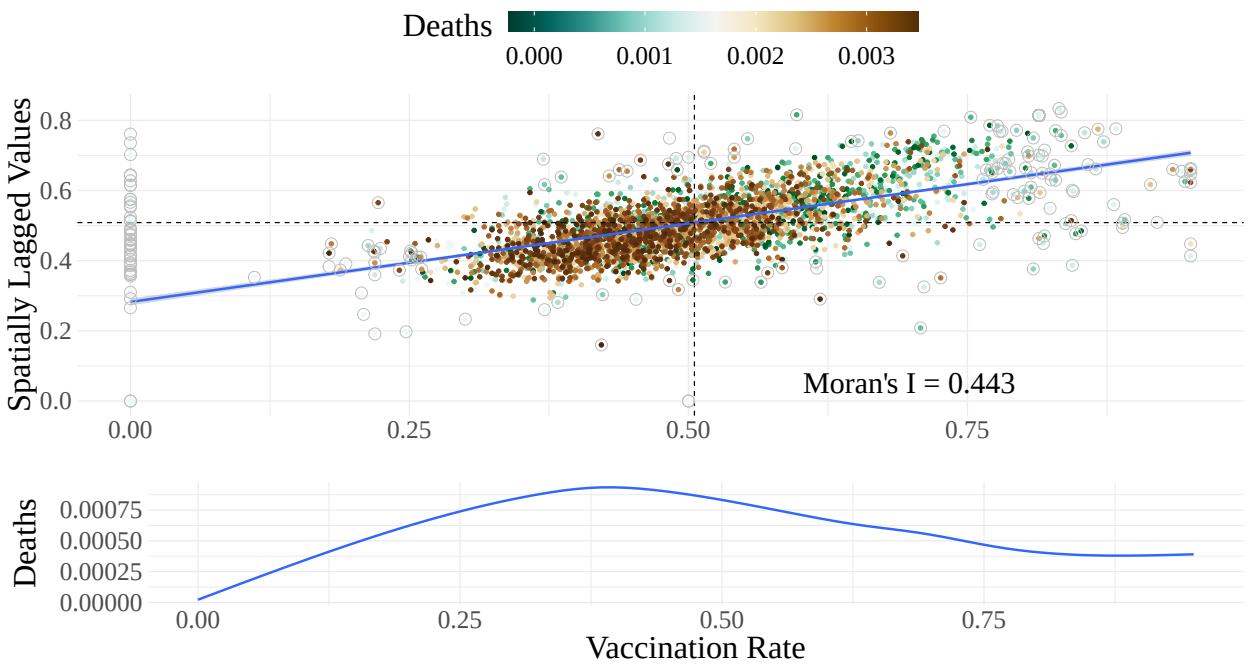
Figure S23: Morans I results: United States - Omicron Wave, Independent Variables

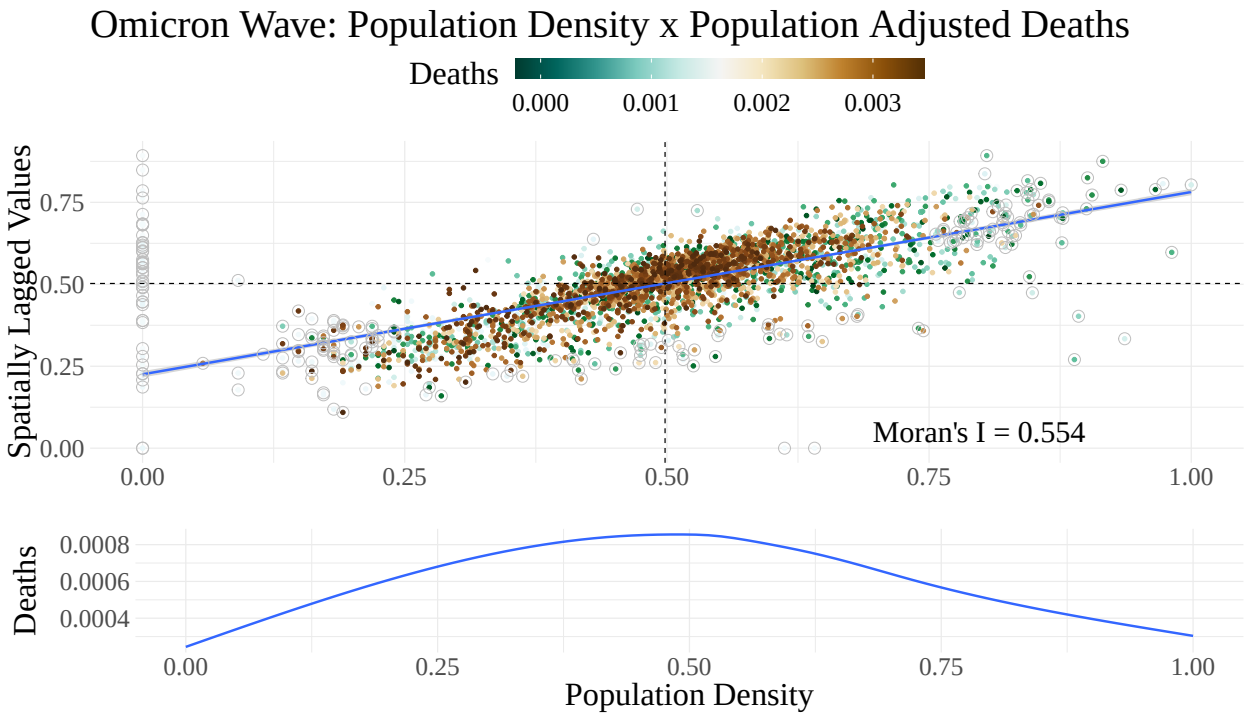


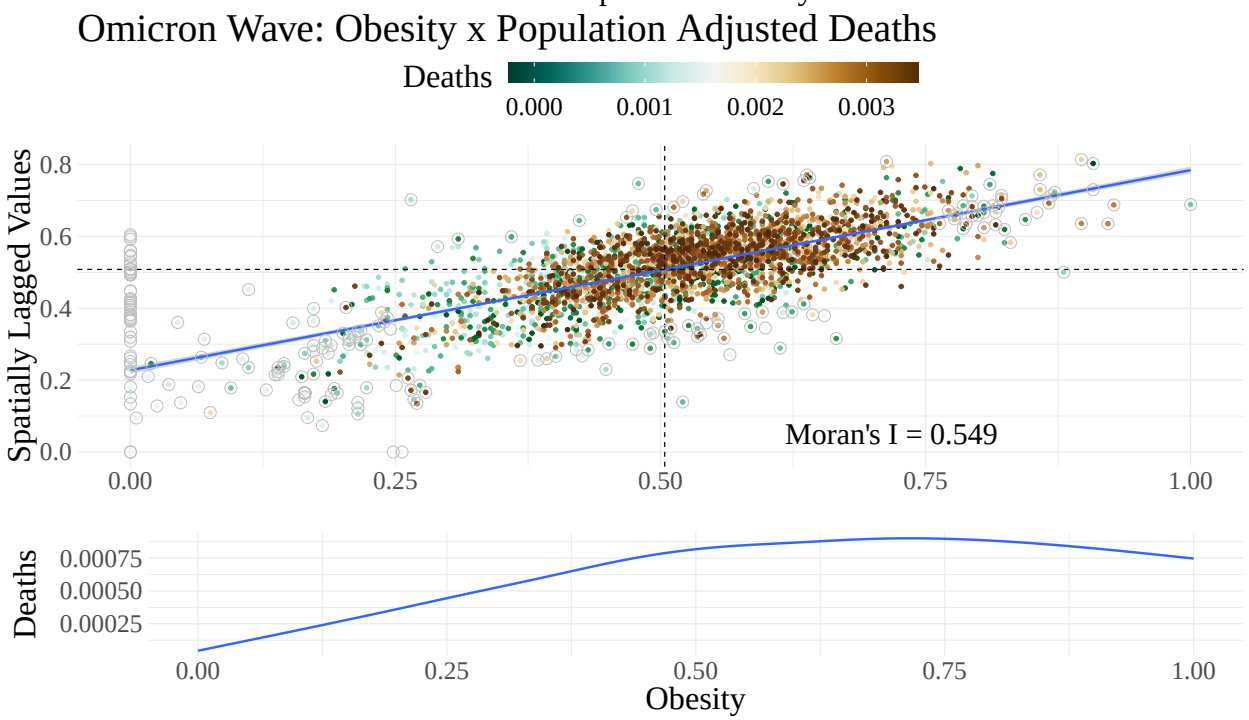

Omicron Wave: Household Composition x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
1.00
0.75
0.50
0.25
0.00
Moran's I = 0.592
0.00
0.25
0.50
0.75
1.00
Deaths
0.0009
0.0008
0.0007
Household Composition

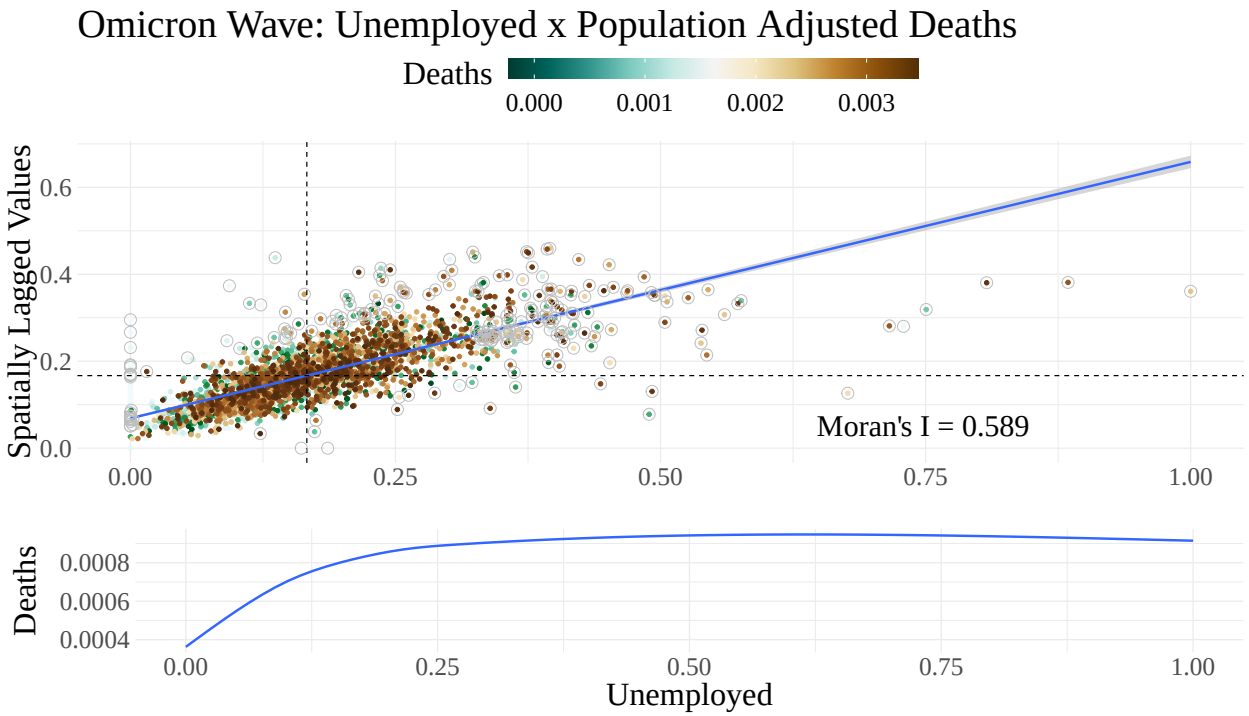

Omicron Wave: Housing Type x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
1.00
0.75
0.50
0.25
0.00
Moran's I = 0.297
0.00
0.25
0.50
0.75
1.00
Deaths
0.0008
0.0007
0.0006
Housing Type

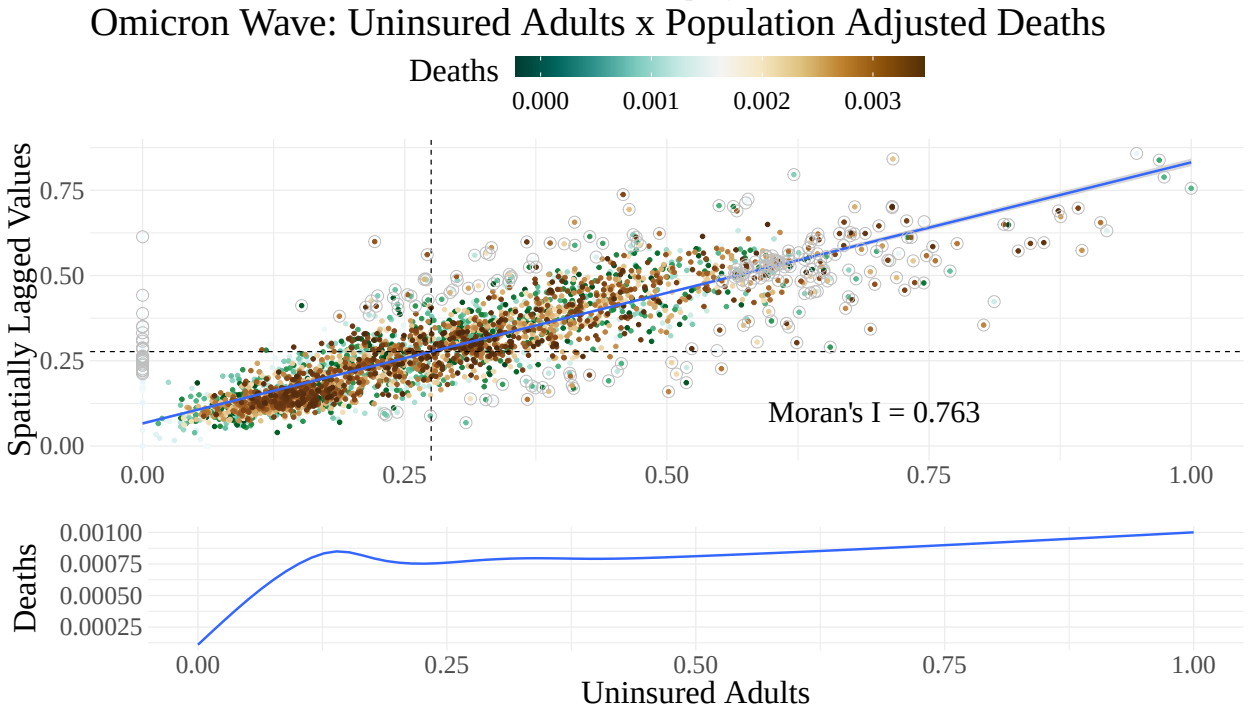

Omicron Wave: Voting x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
0.0
0.2
0.4
0.6
0.8
Moran's I = 0.578
0.00
0.25
0.50
0.75
Deaths
0.0002
0.0004
0.0006
0.0008
0.0010
Voting

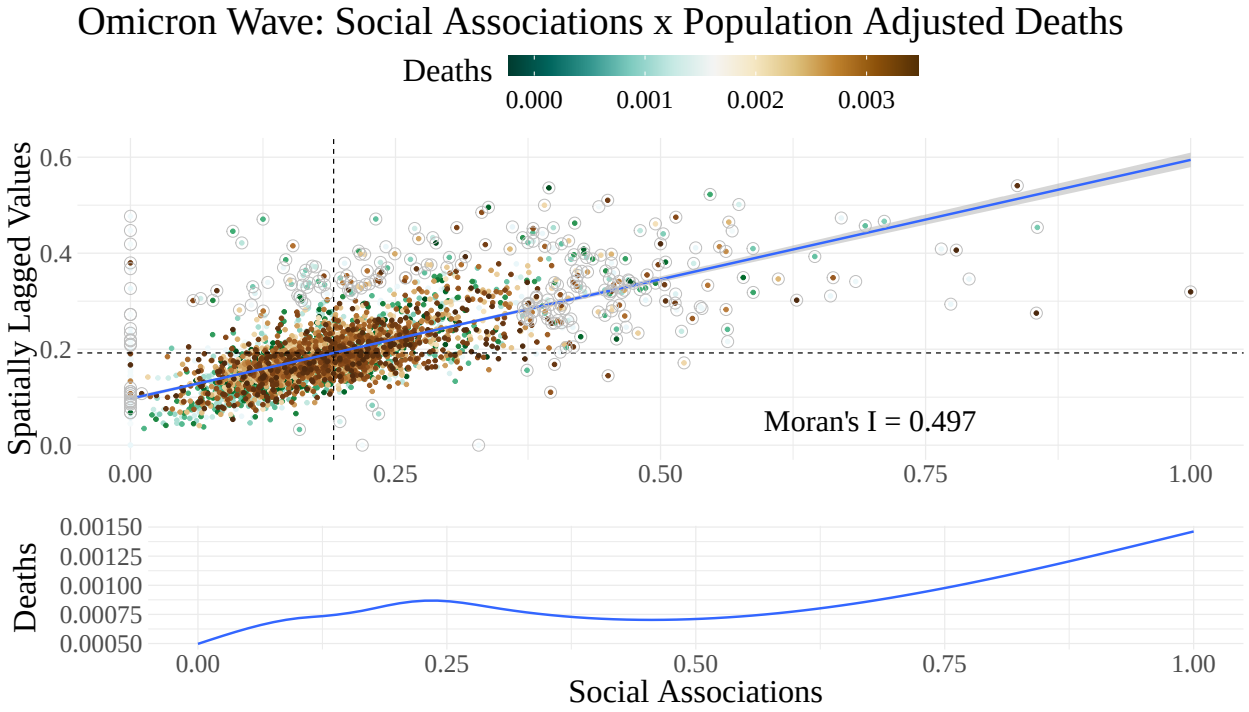

Omicron Wave: Vaccination Rate x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
0.0
0.2
0.4
0.6
0.8
Moran's I = 0.443
0.00
0.25
0.50
0.75
Deaths
0.00000
0.00025
0.00050
0.00075
Vaccination Rate

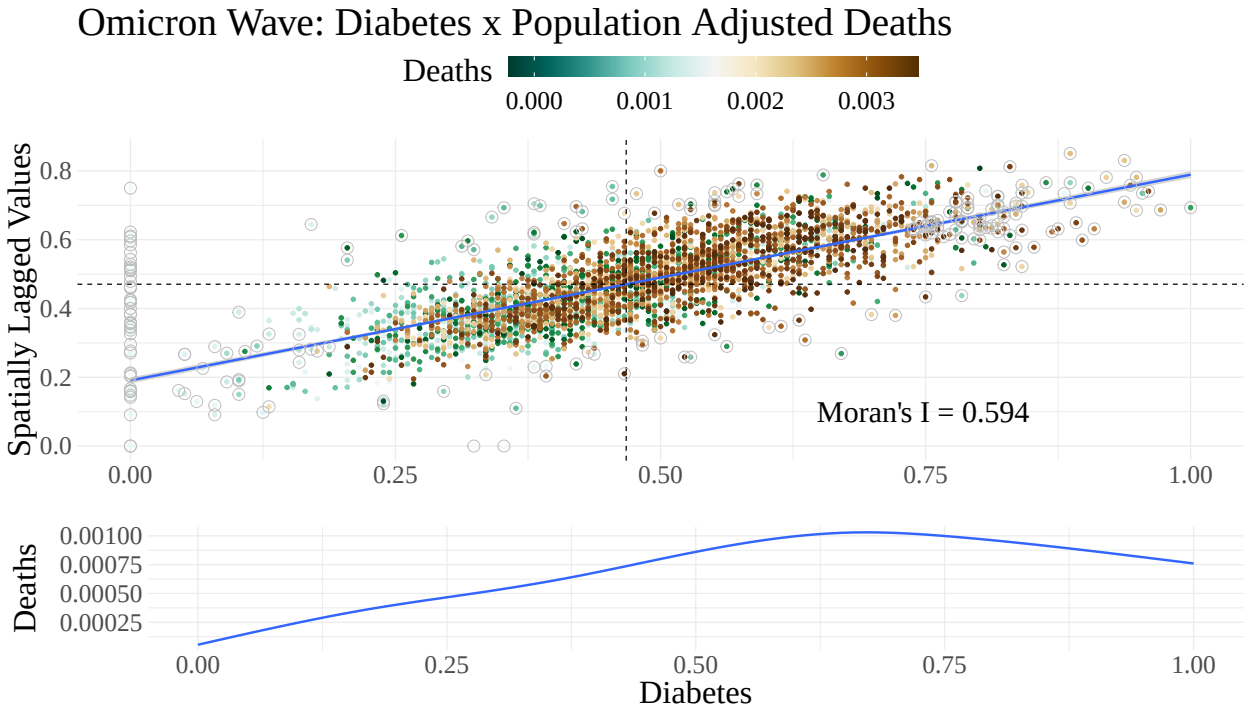

Omicron Wave: Population Density x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
0.75
0.50
0.25
0.00
Moran's I = 0.554
0.00
0.25
0.50
0.75
1.00
Deaths
0.0008
0.0006
0.0004
Population Density

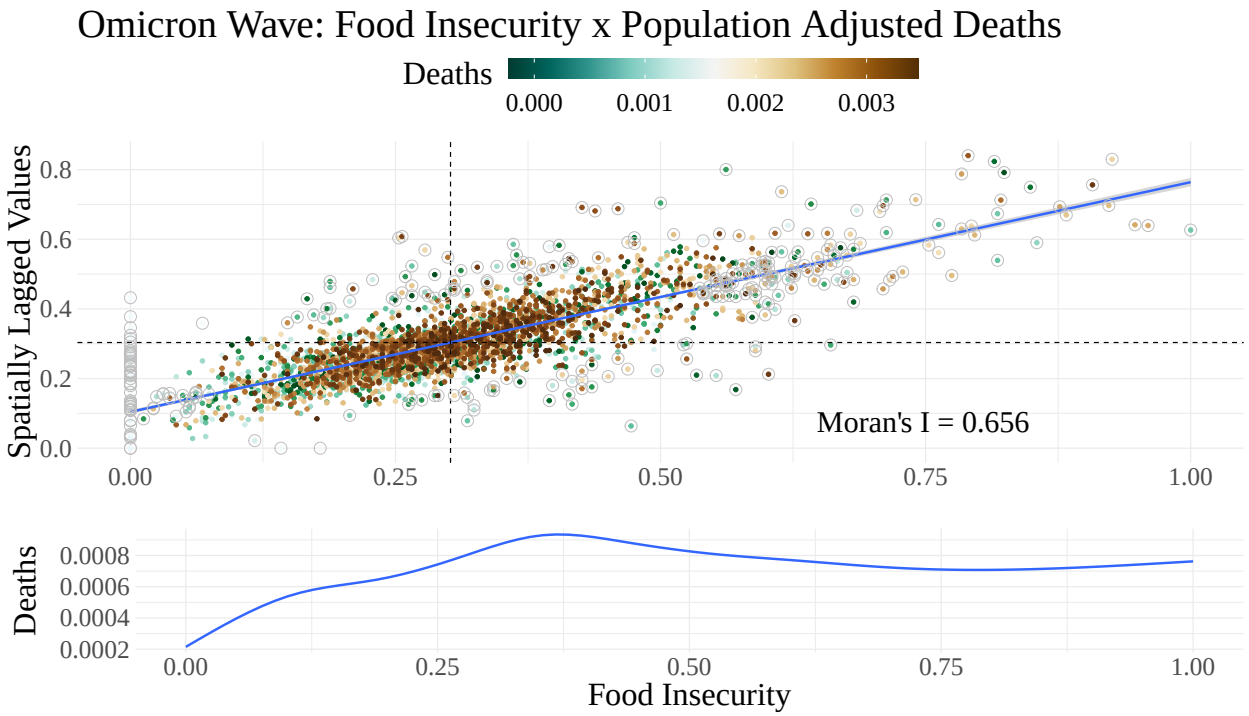

Omicron Wave: Obesity x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
0.8
0.6
0.4
0.2
0.0
Moran's I = 0.549
0.00
0.25
0.50
0.75
1.00
Deaths
0.00075
0.00050
0.00025
Obesity

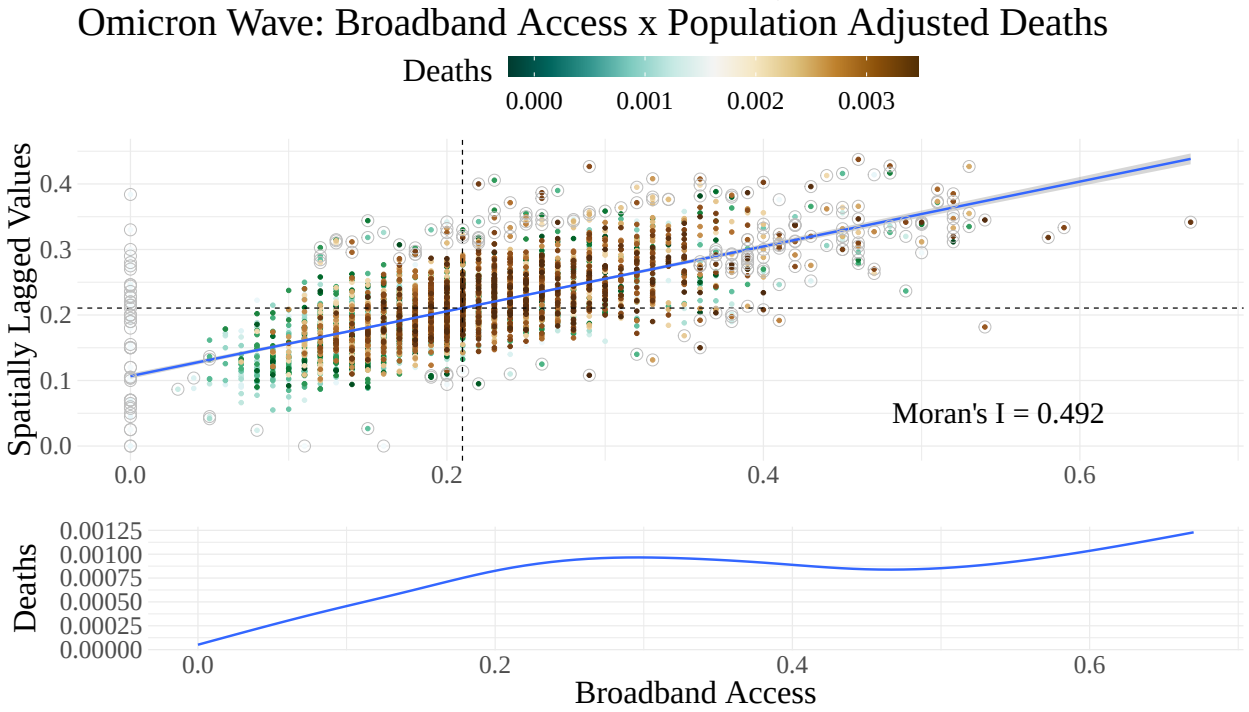

Omicron Wave: Unemployed x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
0.6
0.4
0.2
0.0
Moran's I = 0.589
0.00
0.25
0.50
0.75
1.00
Deaths
0.0008
0.0006
0.0004
Unemployed

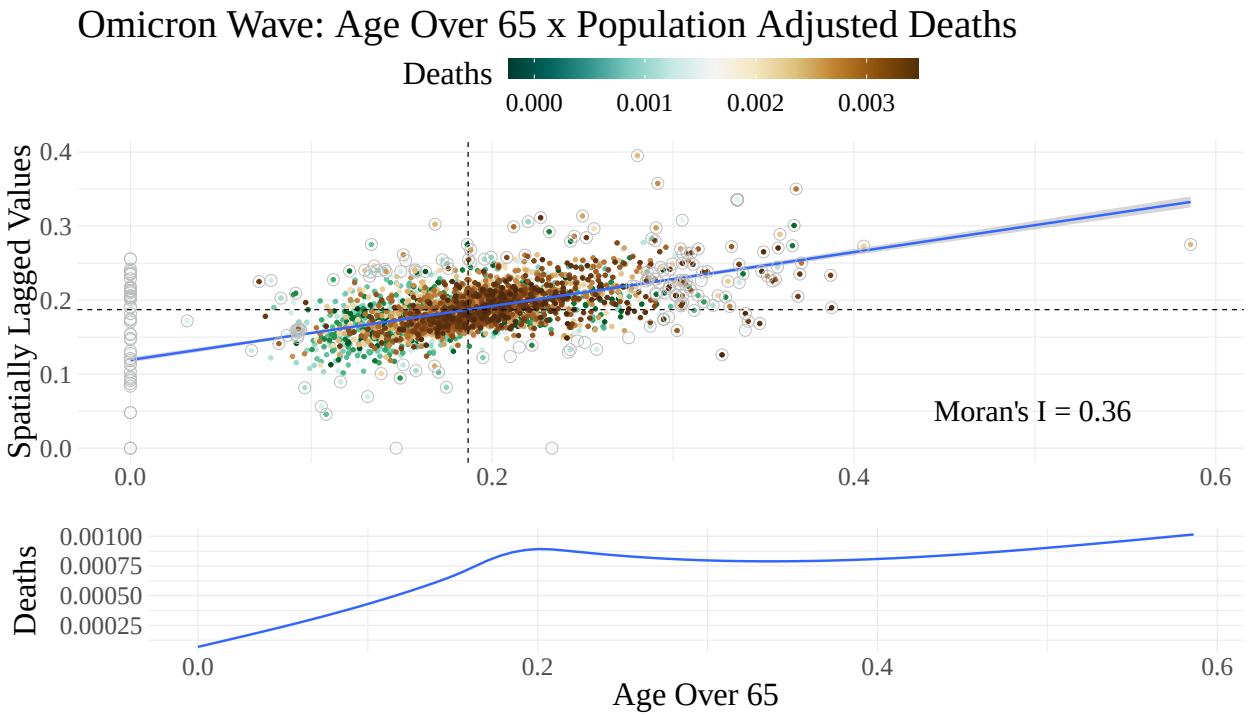

Omicron Wave: Uninsured Adults x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
0.75
0.50
0.25
0.00
Moran's I = 0.763
0.00
0.25
0.50
0.75
1.00
Deaths
0.00100
0.00075
0.00050
0.00025
Uninsured Adults


Omicron Wave: Social Associations x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
0.0
0.2
0.4
0.6
Moran's I = 0.497
0.00
0.25
0.50
0.75
1.00
Deaths
0.00050
0.00075
0.00100
0.00125
0.00150
Social Associations


Omicron Wave: Diabetes x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
0.0
0.2
0.4
0.6
0.8
Moran's I = 0.594
0.00
0.25
0.50
0.75
1.00
Deaths
0.00025
0.00050
0.00075
0.00100
Diabetes


Omicron Wave: Food Insecurity x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
0.0
0.2
0.4
0.6
0.8
Moran's I = 0.656
0.00
0.25
0.50
0.75
1.00
Deaths
0.0002
0.0004
0.0006
0.0008
Food Insecurity


Omicron Wave: Broadband Access x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
0.0
0.1
0.2
0.3
0.4
Moran's I = 0.492
0.0
0.2
0.4
0.6
Deaths
0.00000
0.00025
0.00050
0.00075
0.00100
0.00125
Broadband Access


Omicron Wave: Age Over 65 x Population Adjusted Deaths
Deaths
0.000
0.001
0.002
0.003
Spatially Lagged Values
0.4
0.3
0.2
0.1
0.0
Moran's I = 0.36
0.0
0.2
0.4
0.6
Deaths
0.00100
0.00075
0.00050
0.00025
0.0
0.2
0.4
0.6
Age Over 65

Part 5: Geographically Weighted Random Forest Modeling: Model Alpha Wave

Figure S24: GWRF Alpha Wave: Model Weighting

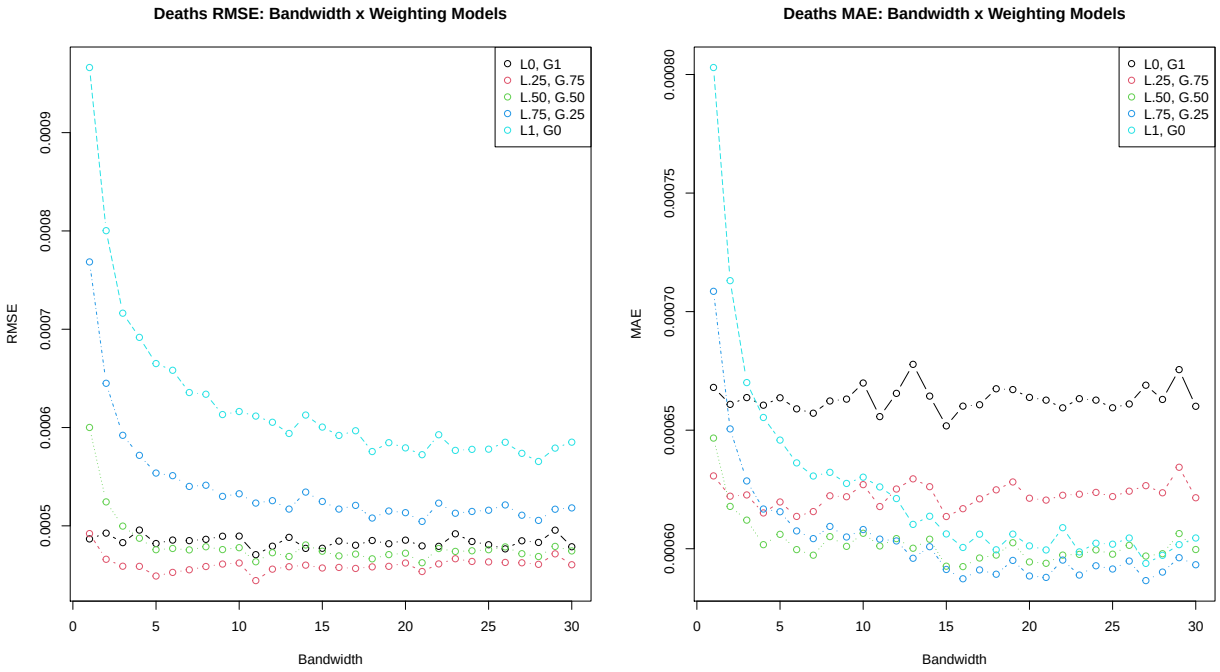
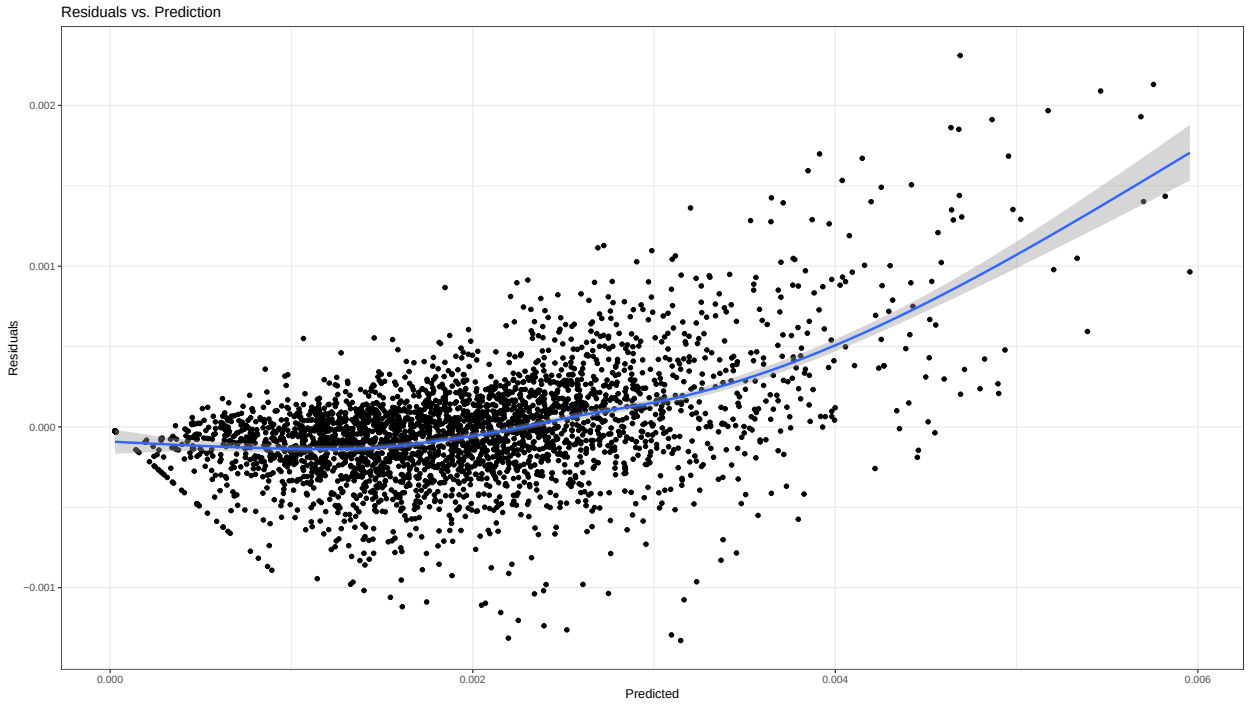


Figure S25: GWRF Alpha Wave: Residuals vs. Predicted




```
##
##  Pearson's product-moment correlation
##
## data:  risk_final5@data$deaths_adjusted and risk_final5@data$LM_ResPred
## t = 54.605, df = 3152, p-value < 0.00000000000000022
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.6788410 0.7147329
## sample estimates:
##       cor
## 0.6972236
```

Figure S26: GWRF Alpha Wave: Model Prediction Results

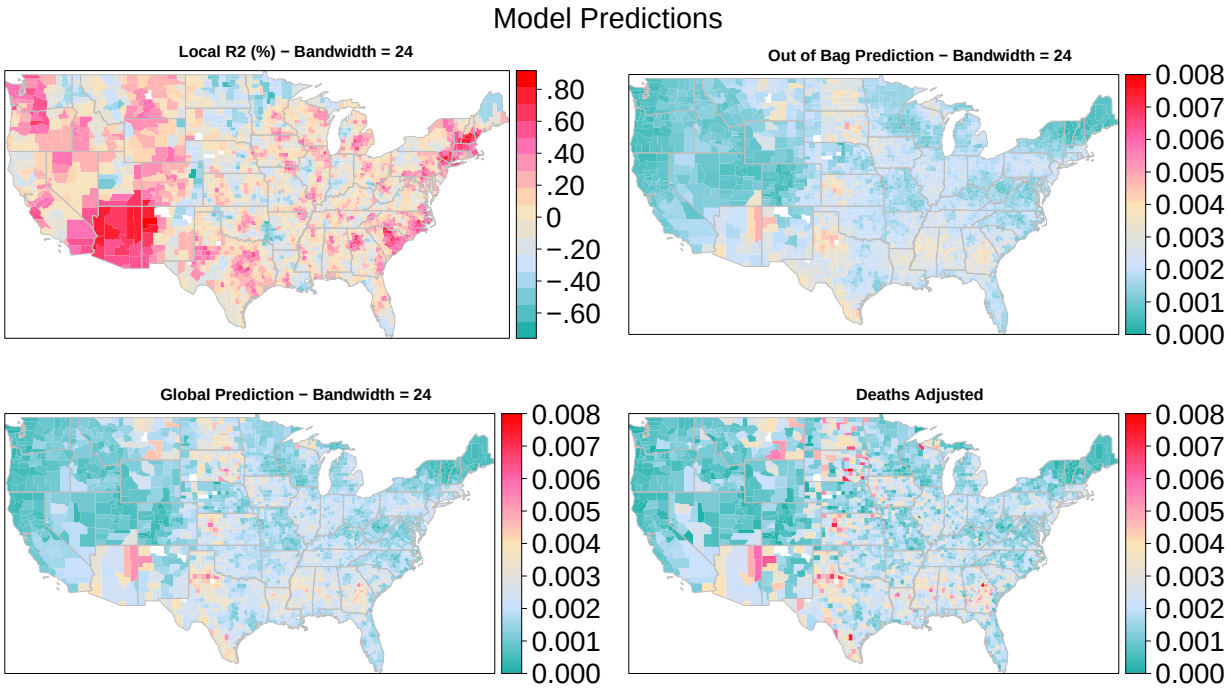
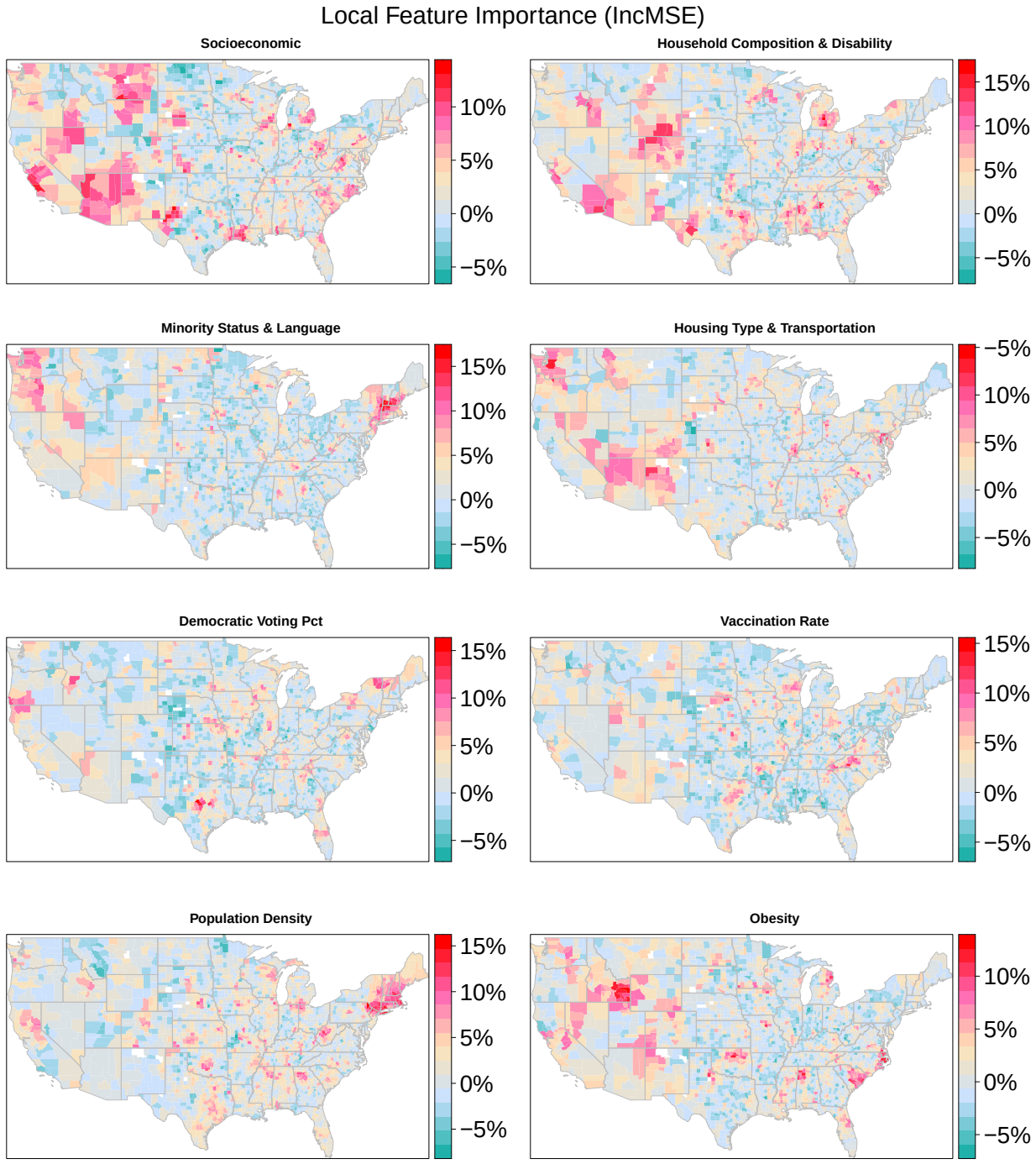


Figure S27: GWRF Alpha Wave: Feature Importance



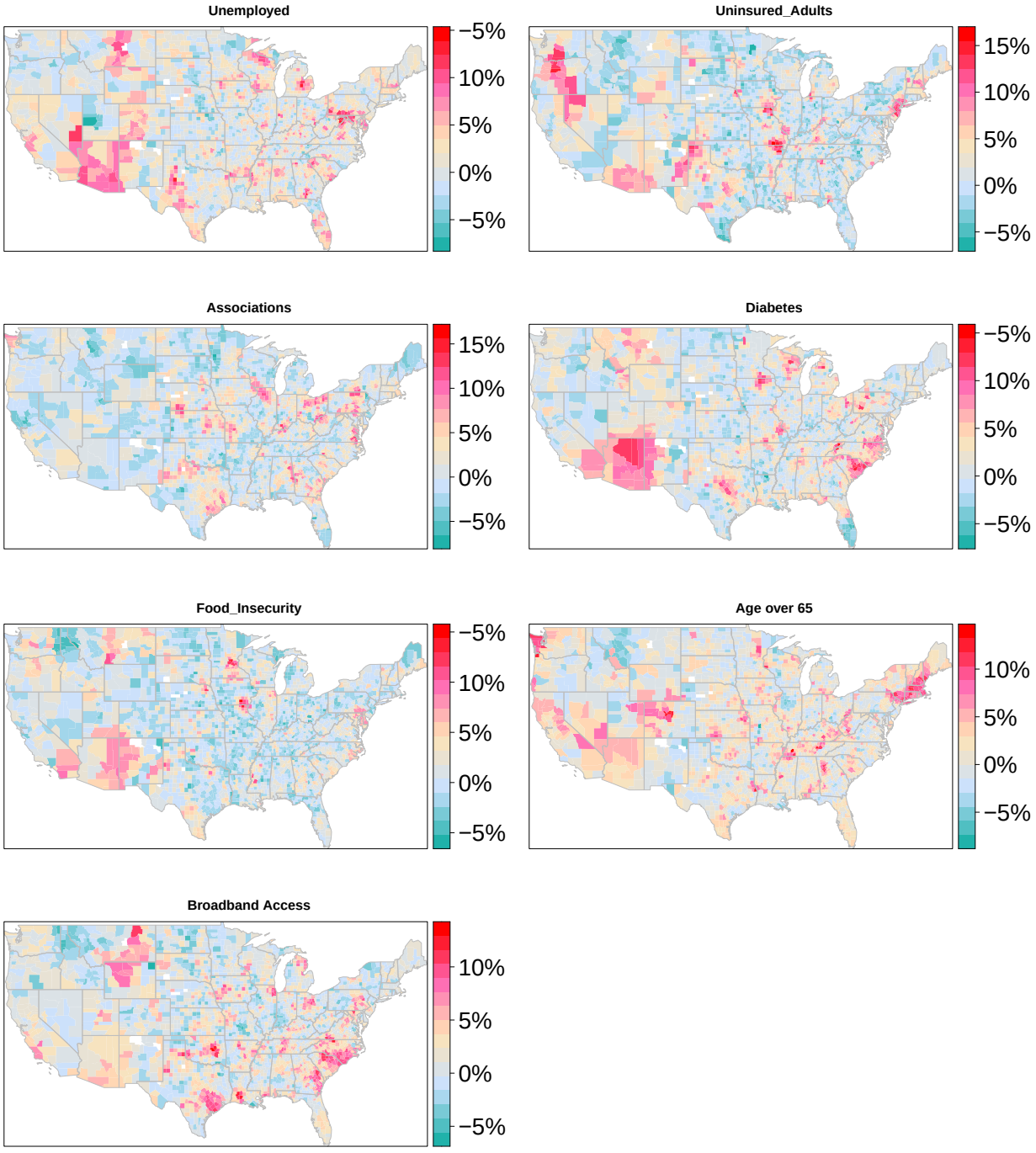


Table T16: GWRF Alpha Wave OOB vs. Global R2

Out of Bag R2	Global R2
0.4037901	0.8949985

Part 5: Geographically Weighted Random Forest Modeling: Delta Wave

Figure S28: GWRF Delta Wave: Model Weighting

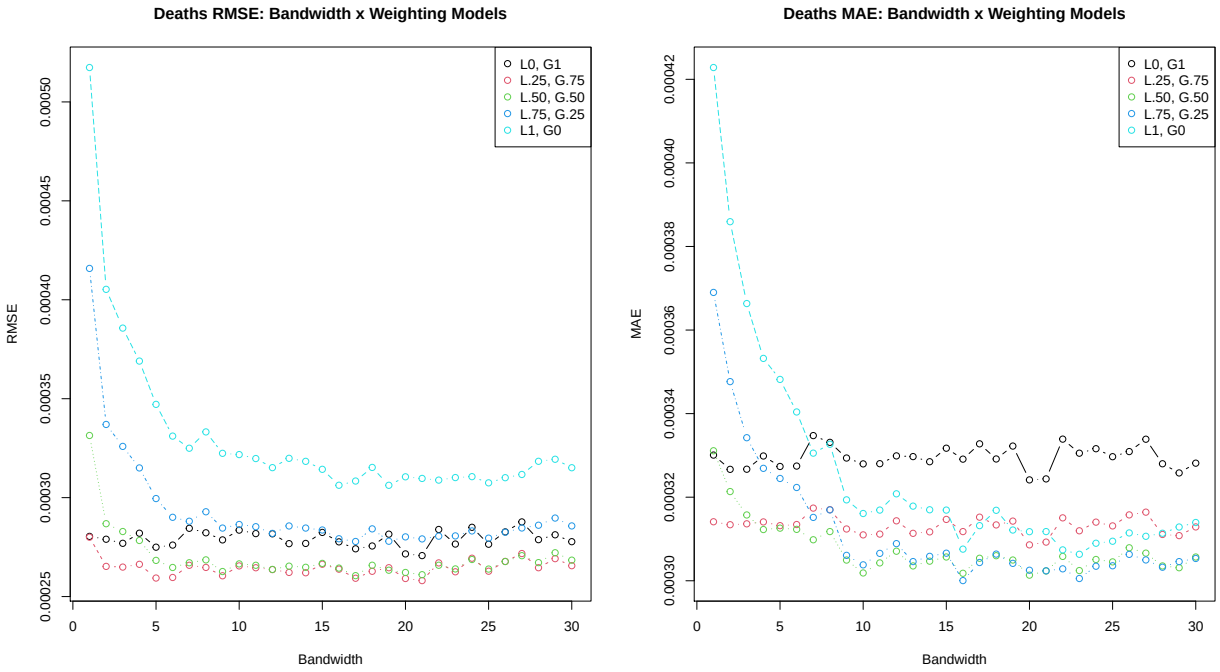
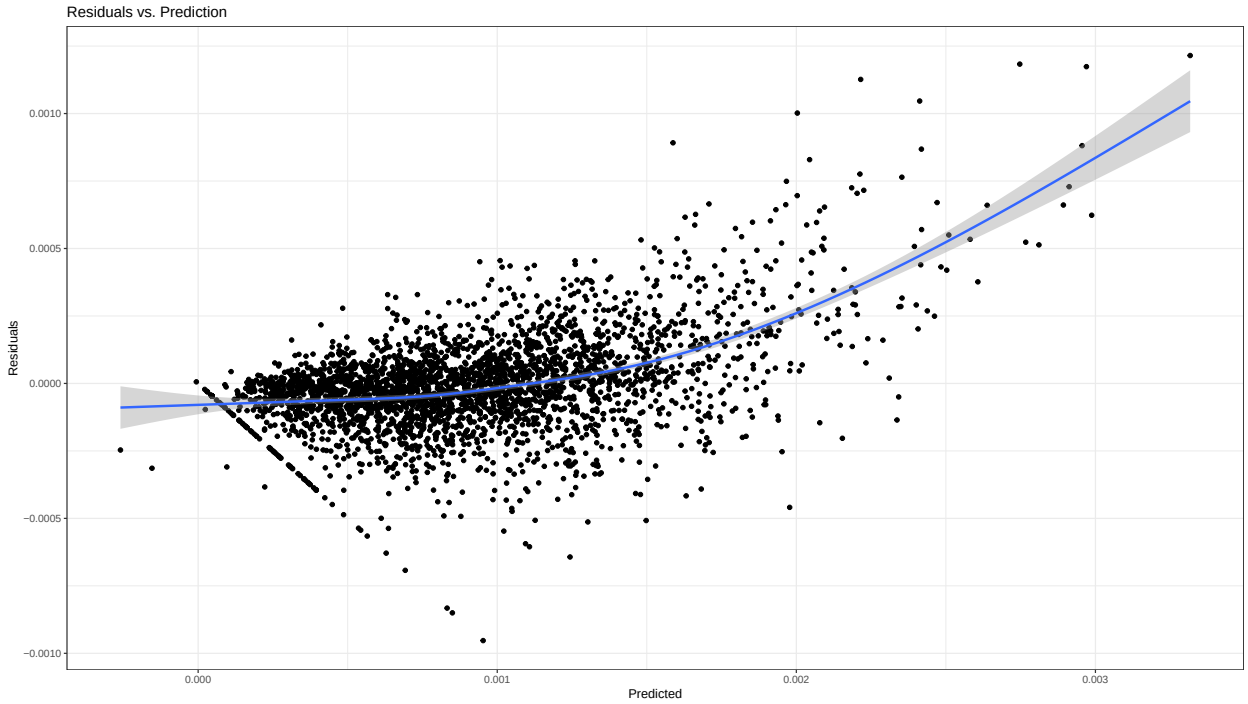


Figure S29: GWRF Delta Wave: Residuals vs. Predicted




```
##
##  Pearson's product-moment correlation
##
## data:  risk_final5@data$deaths_adjusted and risk_final5@data$LM_ResPred
## t = 53.402, df = 3152, p-value < 0.00000000000000022
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.6704279 0.7070959
## sample estimates:
##       cor
## 0.6892029
```

Figure S30: GWRF Delta Wave: Model Prediction Results

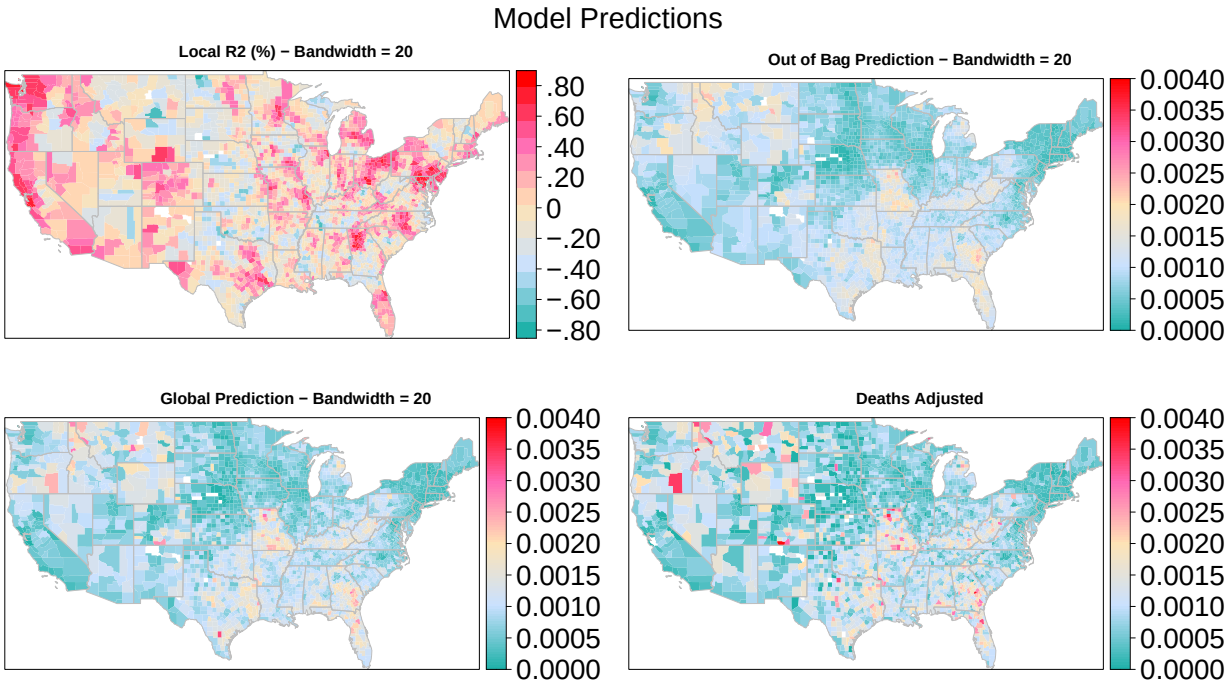
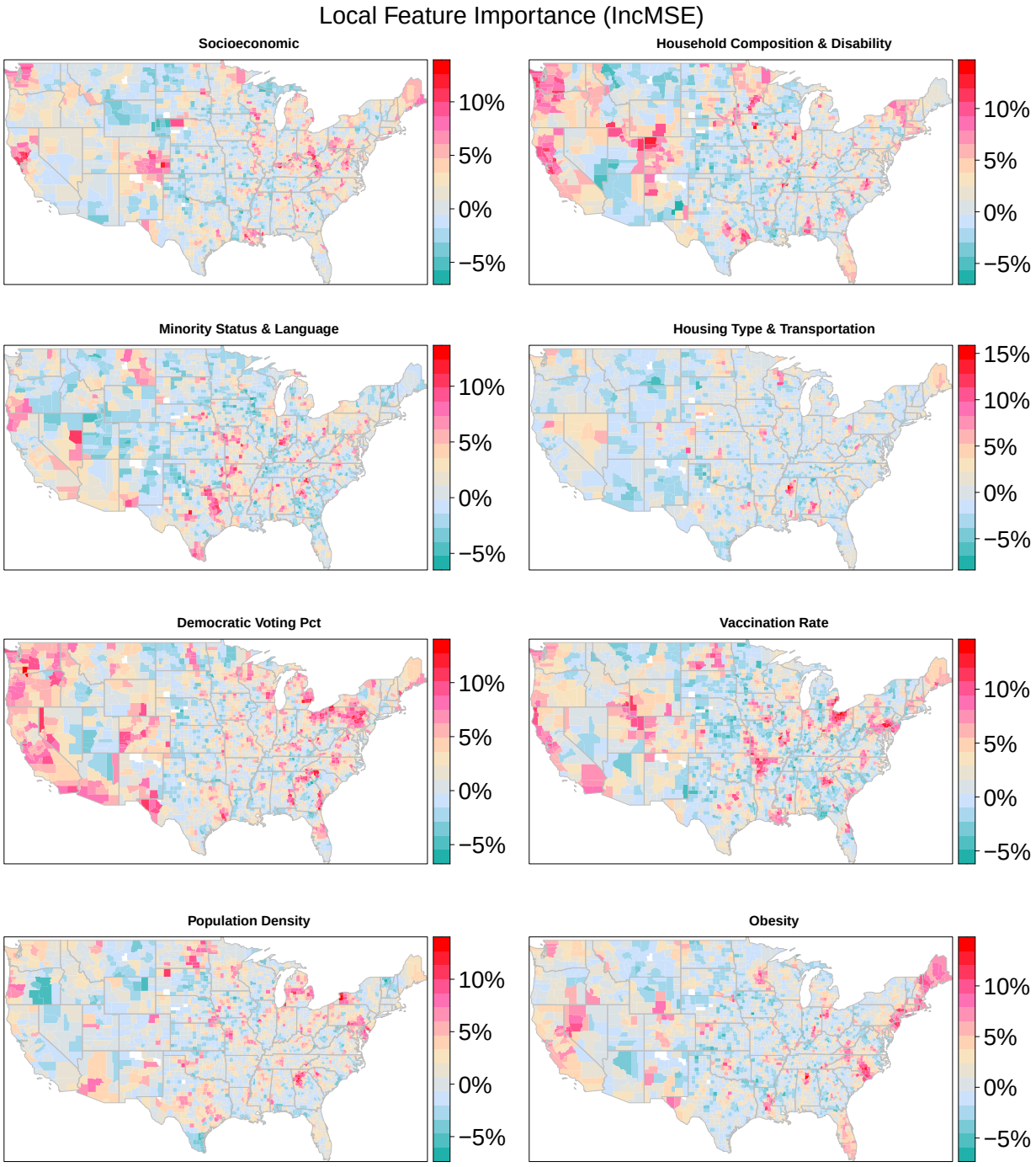


Figure S31: GWRF Delta Wave: Model Feature Importance



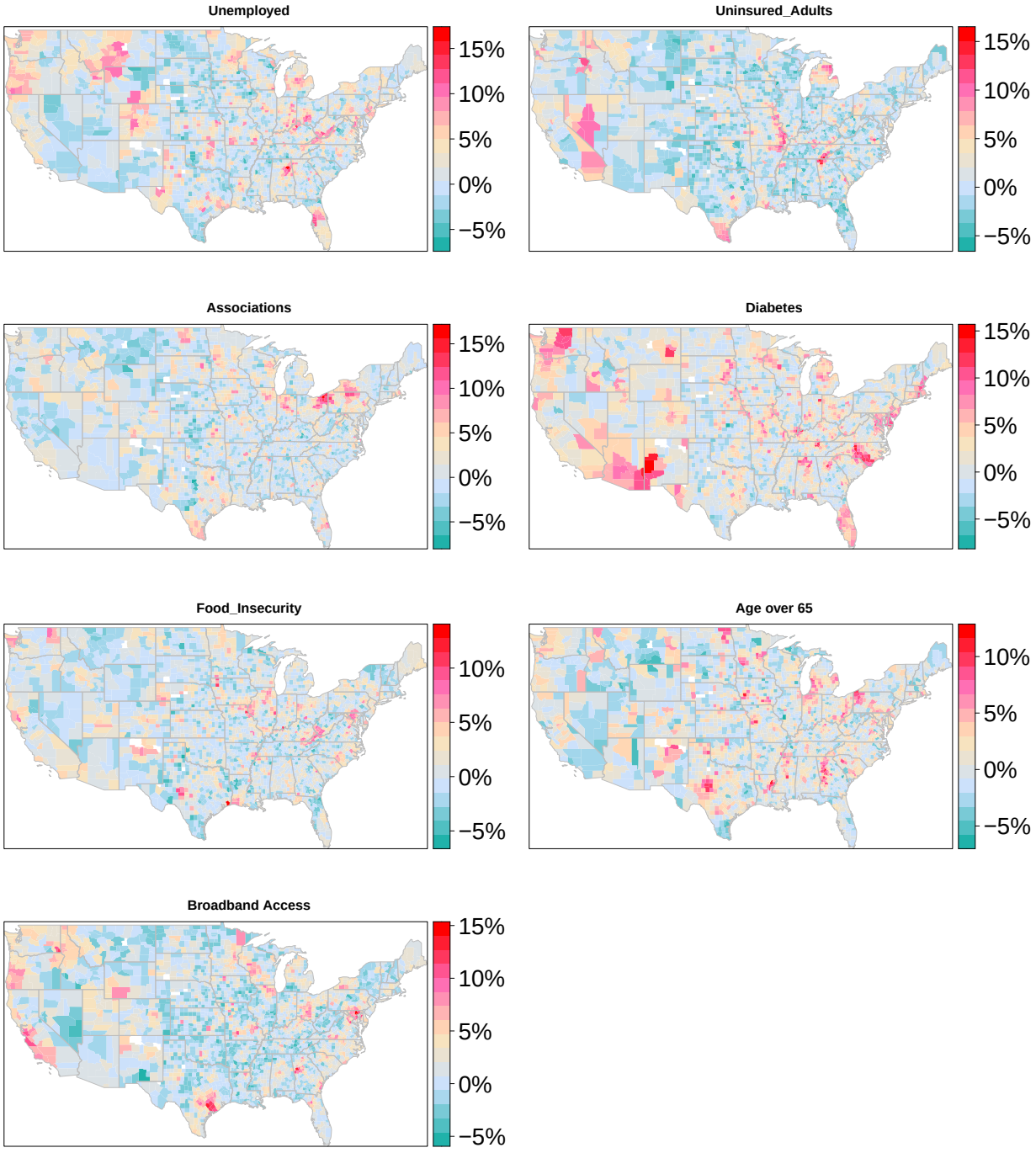


Table T17: GWRF Delta Wave: OOB vs Global R2

Out of Bag R2	Global R2
0.4452838	0.9023839

Part 5: Geographically Weighted Random Forest Modeling: Omicron Wave

Figure S32: GWRF Omicron Wave: Model Weighting

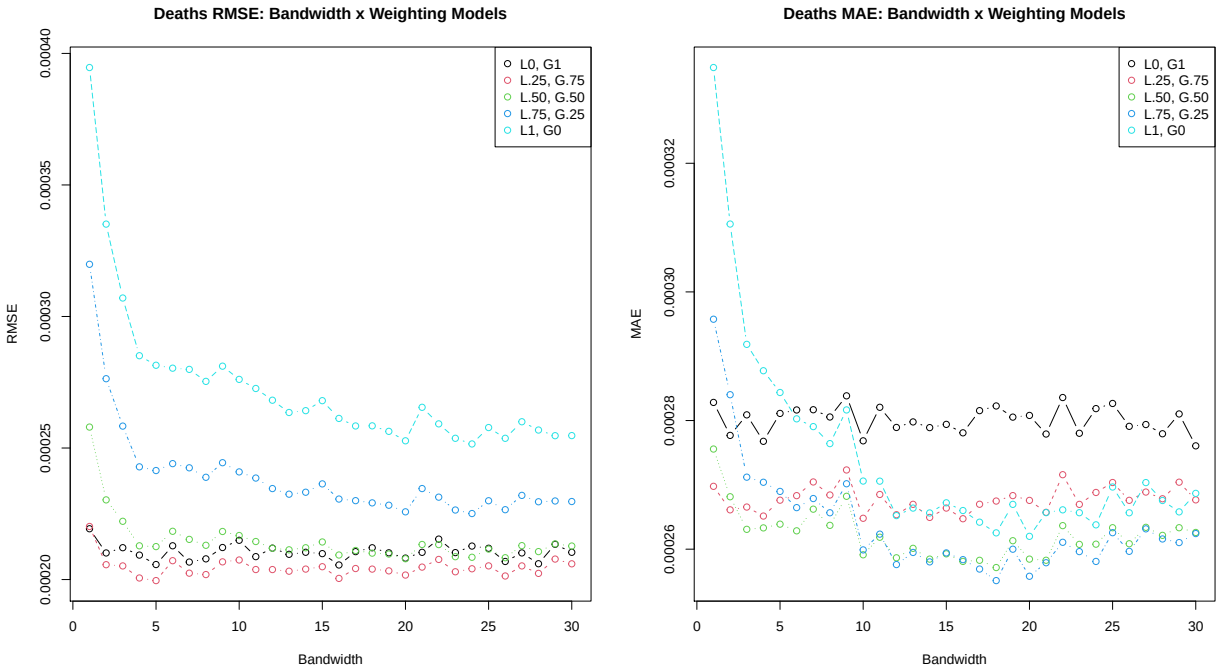
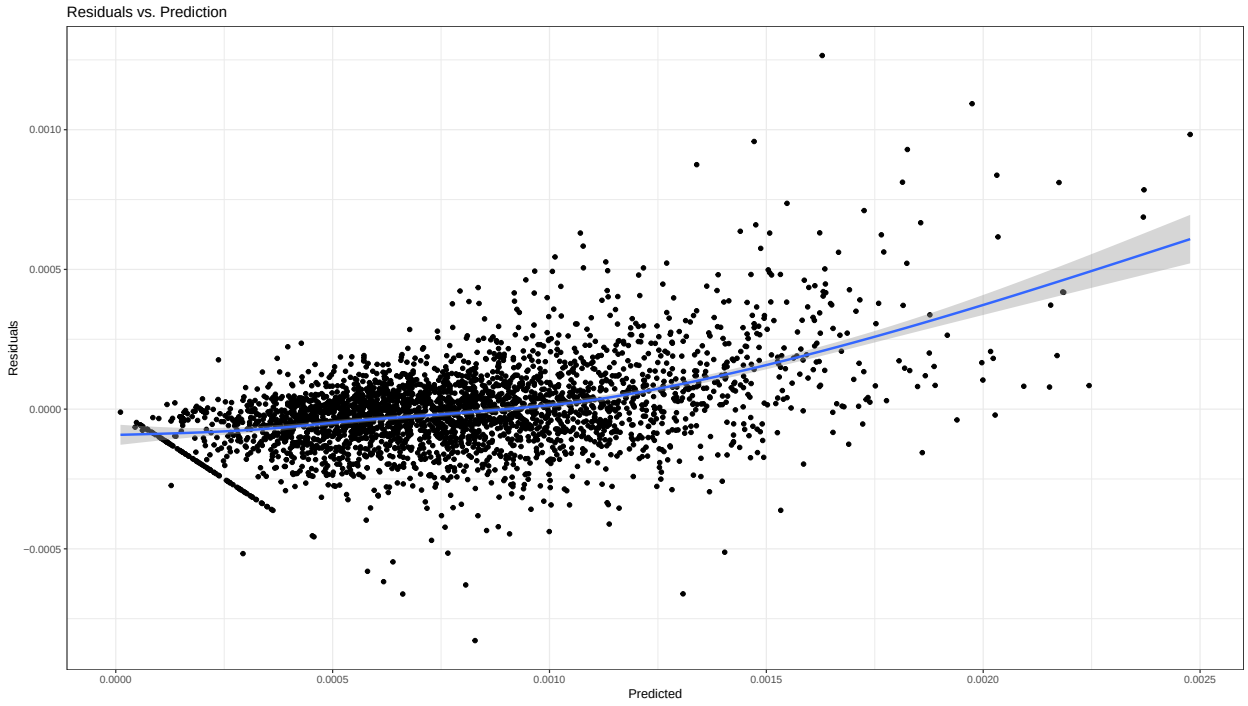


Figure S33: GWRF Omicron Wave: Residuals vs. Predicted




```
##
##  Pearson's product-moment correlation
##
## data:  risk_final5@data$deaths_adjusted and risk_final5@data$LM_ResPred
## t = 54.688, df = 3152, p-value < 0.00000000000000022
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.6794105 0.7152495
## sample estimates:
##       cor
## 0.6977664
```

Figure S34: GWRF Omicron Wave: Model Prediction Results

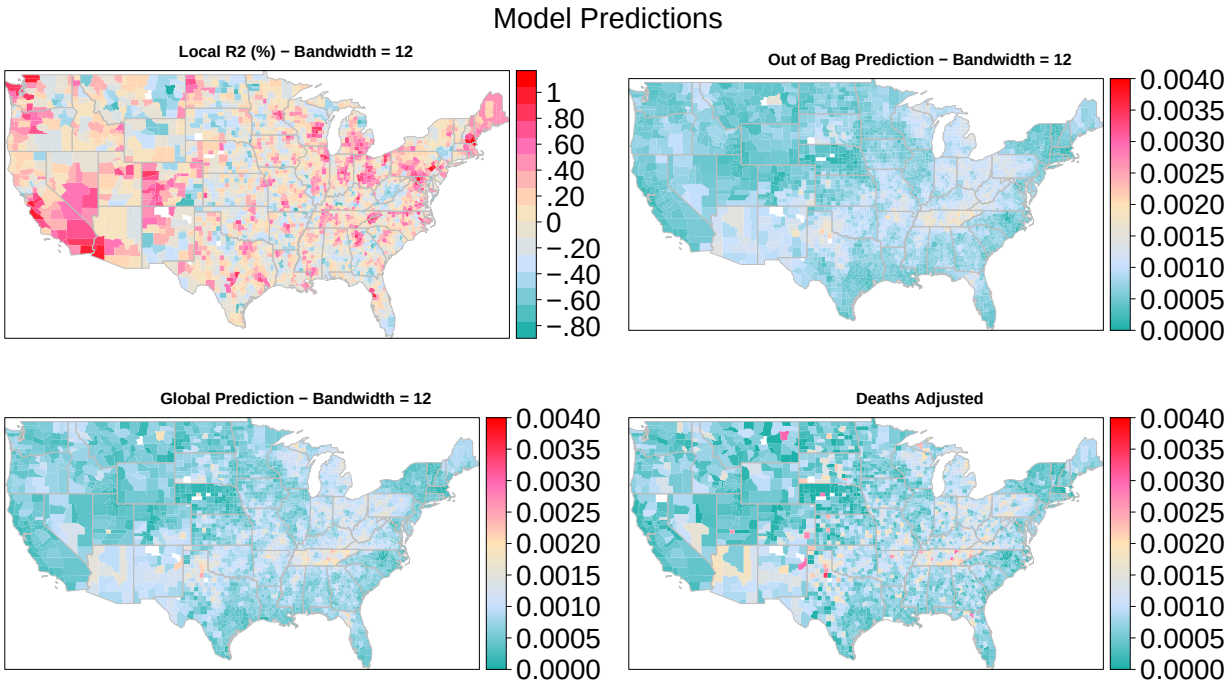
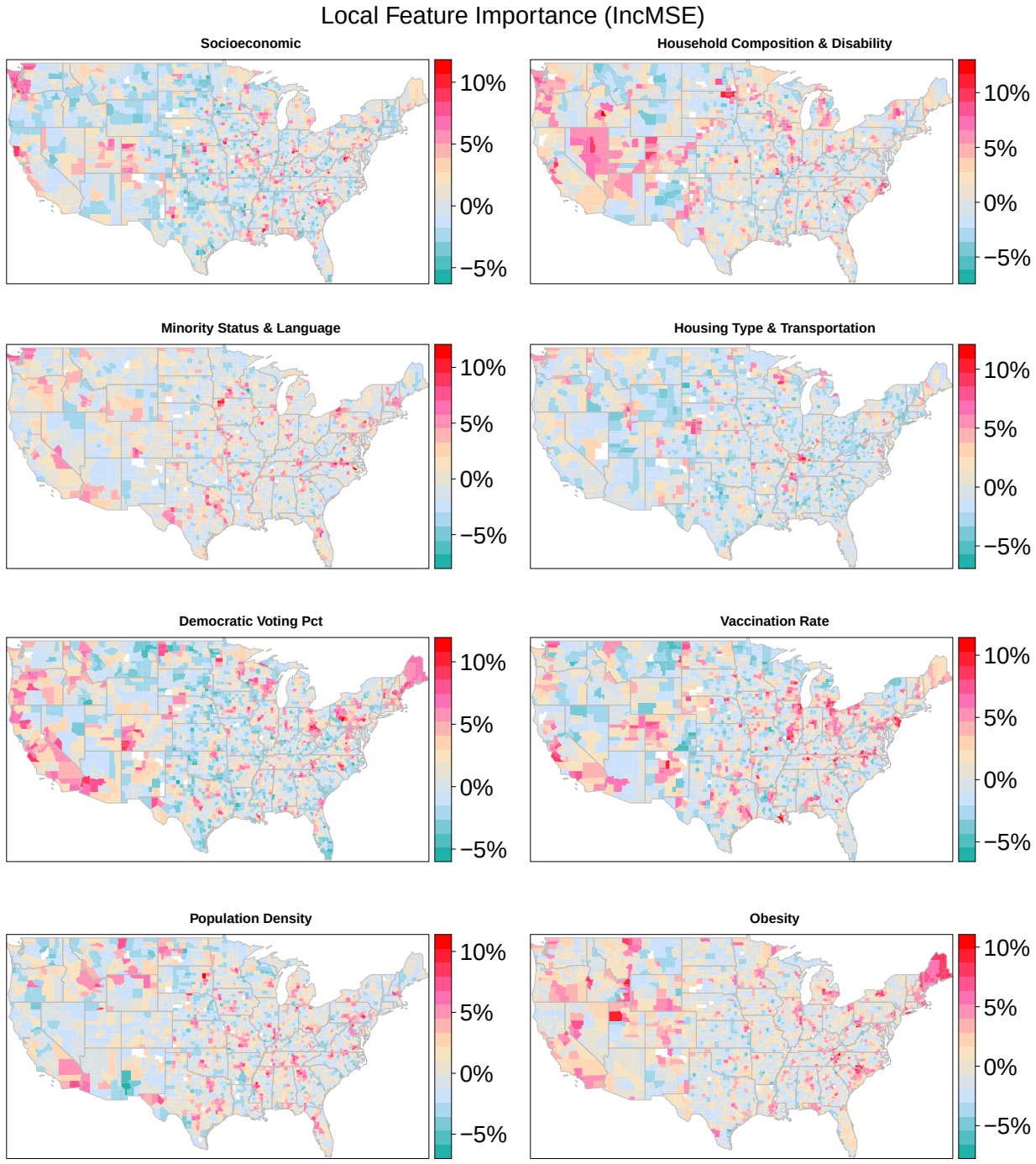


Figure S35: GWRF Omicron Wave: Model Feature Importance



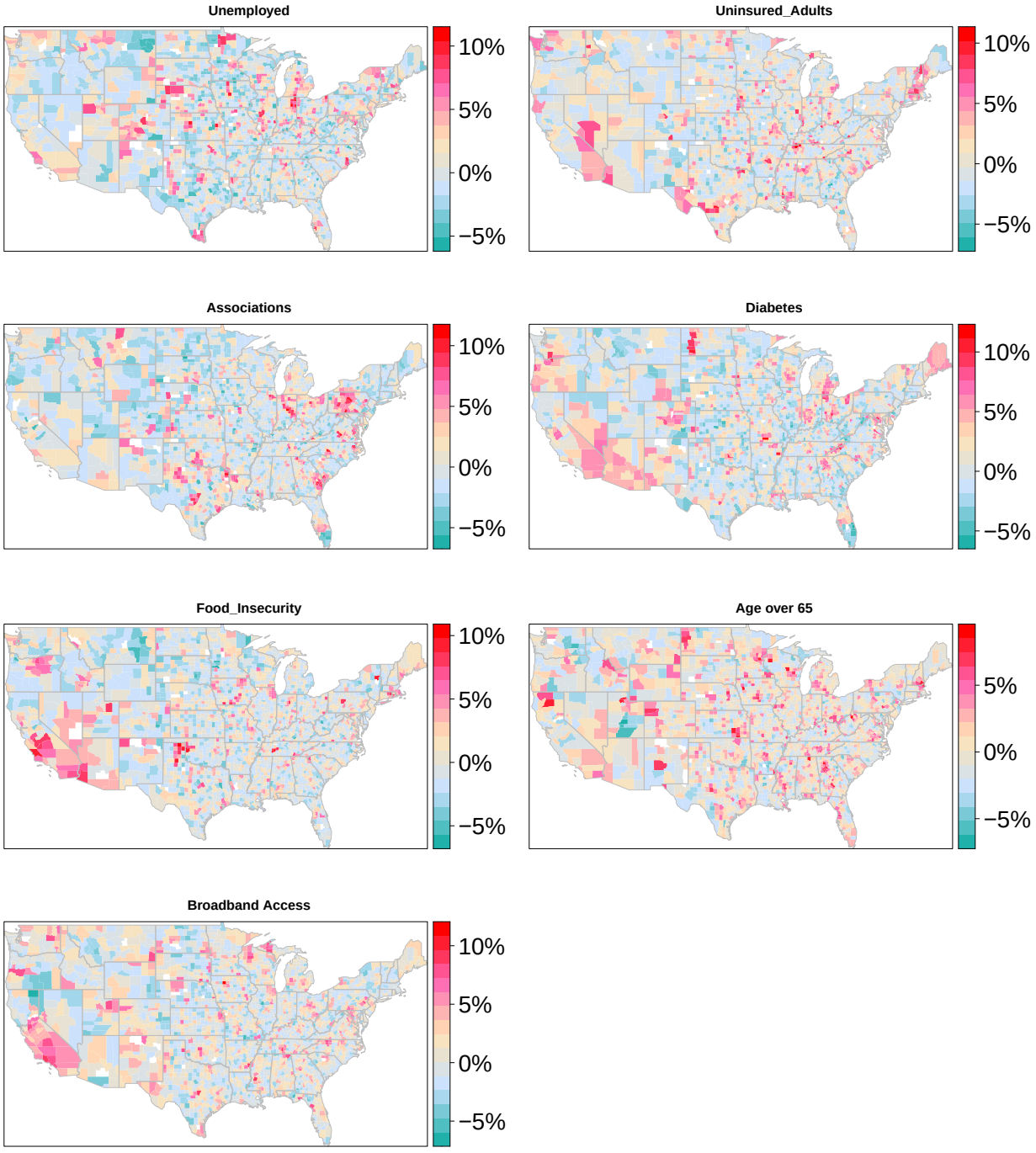


Table T18: GWRF Omicron Wave: OOB vs Global R2

Out of Bag R2	Global R2
0.3424833	0.8803354