Supplementary Online Content

Kaufman EJ, Morrison CN, Branas CC, Wiebe DJ. State firearm laws and interstate firearm deaths from homicide and suicide in the United States: a cross-sectional analysis of data by county. *JAMA Intern Med*. Published online March 5, 2018. doi:10.1001/jamainternmed.2018.0190

This supplementary material has been provided by the authors to give readers additional information about their work.

Supplementary Online Material

eMethods

eTable 1. List of sensitivity analyses

eFigure. Rates of firearm homicide and firearm suicide in U.S. counties, 2010-2014

eTable 2. Bayesian conditional autoregressive Poisson models for counts of homicide deaths, 3,108 counties nested within 48 states

eTable 3. Bayesian conditional autoregressive Poisson models for counts of suicide deaths, 3,108 counties nested within 48 states

Supplementary Online Material

This supplementary material provides further descriptions of the statistical analytic methods and results of sensitivity analyses.

Methods

Statistical Analyses

The Bayesian Poisson models used for these analyses were fitted using WinBUGS v14.[47] All models included a conditional autoregressive random effect that controlled for potential spatial autocorrelation of the model residuals and accounts for the small area problem.[44,48] We also included a non-spatial noise term which accounts for over-dispersion of the dependent variable, and a state level random effect to control for the possibility that counties within states were more alike than counties from different states. We allowed two Markov chains to converge over at least 250,000 iterations before obtaining model estimates from a further 50,000 iterations. Diagnostic tests included inspection of history trace plots to verify that the two chains had converged prior to sampling. We also mapped the posterior estimates of the non-spatial noise term for visual inspection and to measure local spatial autocorrelation (Moran's I).

Sensitivity Analyses

We conducted seven groups of sensitivity analyses to ensure that our results were not artefacts of our novel and non-validated policy score. The dependent variables and main independent variables for these sensitivity analyses are described in the Table S1. All analyses take county population as the expectancy, and include controls for land area, the proportion of the population who were male, median age, the proportion of the population who were black, the proportion of the population who were Hispanic, median household income, the proportion of the population receiving public assistance, the proportion of the population aged > 16 years and

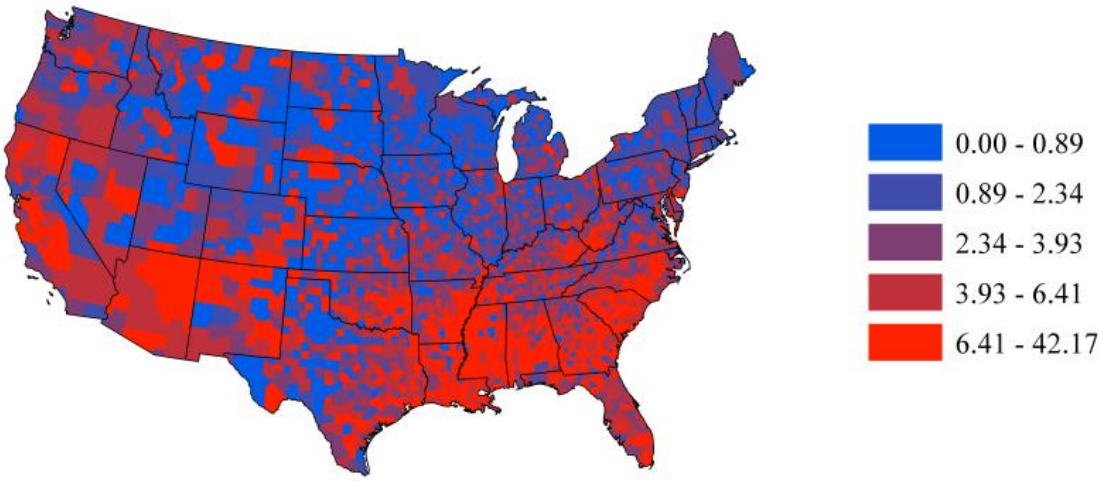
unemployed, the proportion of households that are female-headed, the proportion of the population aged < 25 without a high school certificate, property crimes, and violent crimes.

eTable 1. List of sensitivity analyses

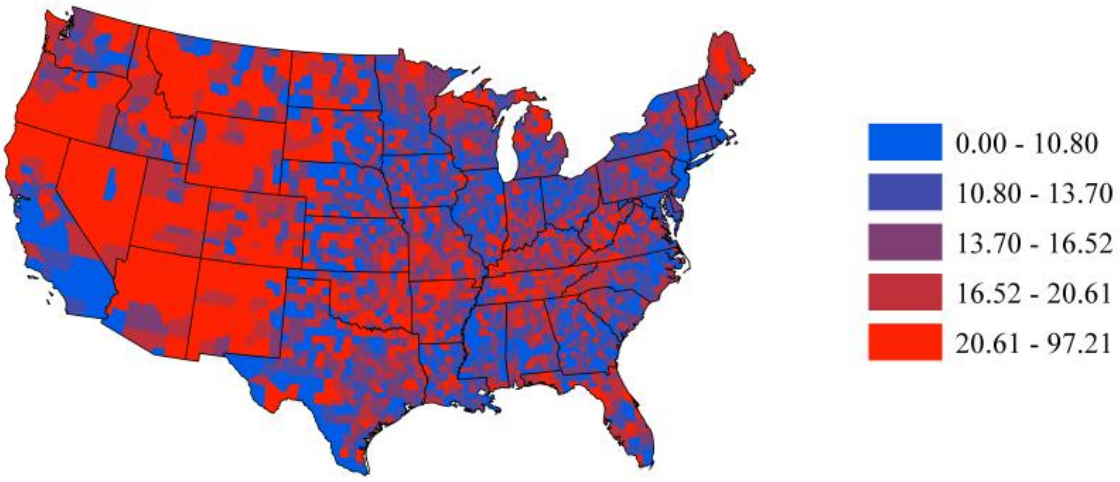
Model	Dependent Measures	Main Independent Measures
S1	2010-2014 Deaths	2010 policy scores
S2	2010-2014 Deaths	2010 policy score, with interstate policy score calculated using inverse distance square decay instead of inverse distance decay
S3	2010 Deaths	2010 policy score
S4	2010-2014 Deaths	2012 policy score
S5	2010-2014 Deaths	Law Center to Prevent Gun Violence score
S6	2010-2014 Deaths	Principle Components Analysis score
S7	2010-2014 Deaths	2010 policy score with local*near multiplicative interaction

eFigure: Rates of firearm homicide and firearm suicide in U.S. counties, 2010-2014

A) Average annual homicide rate per 100,000 population (2010-2014)



B) Average annual suicide rate per 100,000 population (2010-2014)



Results

Statistical Analyses

For the Bayesian spatial models for suicide presented in Table 3 of the main paper, the state random effect explained less than 11.6% of overall variance, and the conditional autoregressive random effect explained over 93.7% of error variance. For the homicide models presented in Table 4 of the model paper, the state random effect explained less than 11.5% of overall variance, and the conditional autoregressive random effect explained between 66.1% and 76.6% of error variance.

Visual inspection of the history plots for all analysis models confirmed that two chains converged prior to sampling. Moran's I for the non-spatial noise terms were not significant ($p < 0.05$) for all models, confirming that the conditional autoregressive random effect accounted for the spatial structure of the model residuals.

Sensitivity Analyses

Supplementary Tables S2 and S3 report results for sensitivity analyses for Bayesian conditional autoregressive Poisson models for homicide and suicide deaths. Results are substantively similar to the results of the models presented in the main paper. However, the main results are the only models to identify a relationship between gun policies and homicides.

eTable 2. Bayesian conditional autoregressive Poisson models for counts of homicide deaths, 3,108 counties nested within 48 states

	Firearm homicide			Non-firearm homicide			All homicide		
	Median	(95%	CI)	Median	(95%	CI)	Median	(95%	CI)
Model S1									
Home state policy score	0.937	(0.880,	1.001)	0.975	(0.926,	1.026)	0.951	(0.901,	1.004)
Interstate policy score	0.969	(0.911,	1.029)	0.991	(0.947,	1.036)	0.978	(0.935,	1.025)
Proportion variance explained by state random effect	*0.005*	*(0.000,*	*0.038)*	*0.068*	*(0.007,*	*0.191)*	*0.010*	*(0.001,*	*0.052)*
Proportion variance explained by CAR random effect	*0.763*	*(0.637,*	*0.866)*	*0.727*	*(0.547,*	*0.878)*	*0.772*	*(0.668,*	*0.859)*
Model S2									
Home state policy score	0.946	(0.892,	1.002)	0.980	(0.935,	1.027)	0.959	(0.916,	1.006)
Interstate policy score	0.982	(0.950,	1.013)	1.001	(0.980,	1.024)	0.991	(0.968,	1.015)
Proportion variance explained by state random effect	*0.005*	*(0.001,*	*0.038)*	*0.077*	*(0.011,*	*0.201)*	*0.011*	*(0.001,*	*0.057)*
Proportion variance explained by CAR random effect	*0.762*	*(0.636,*	*0.867)*	*0.718*	*(0.509,*	*0.878)*	*0.775*	*(0.662,*	*0.866)*
Model S3									
Home state policy score	0.972	(0.900,	1.049)	0.985	(0.928,	1.048)	0.980	(0.923,	1.042)
Interstate policy score	0.950	(0.884,	1.020)	0.998	(0.947,	1.056)	0.975	(0.919,	1.031)
Proportion variance explained by state random effect	*0.003*	*(0.000,*	*0.024)*	*0.021*	*(0.002,*	*0.179)*	*0.004*	*(0.001,*	*0.028)*
Proportion variance explained by CAR random effect	*0.560*	*(0.335,*	*0.749)*	*0.973*	*(0.636,*	*0.999)*	*0.572*	*(0.381,*	*0.741)*
Model S4									
Home state policy score	0.952	(0.877,	1.025)	1.016	(0.956,	1.077)	0.976	(0.916,	1.035)
Interstate policy score	0.976	(0.913,	1.038)	1.014	(0.971,	1.059)	0.992	(0.943,	1.042)
Proportion variance explained by state random effect	*0.006*	*(0.001,*	*0.041)*	*0.076*	*(0.010,*	*0.203)*	*0.012*	*(0.001,*	*0.060)*
Proportion variance explained by CAR random effect	*0.633*	*(0.757,*	*0.856)*	*0.720*	*(0.502,*	*0.873)*	*0.774*	*(0.658,*	*0.868)*

Model S5								
Home state policy score	0.945	(0.878,	1.023)	0.975	(0.918,	1.033)	0.952	(0.895,	1.011)
Interstate policy score	0.979	(0.923,	1.040)	0.998	(0.956,	1.043)	0.985	(0.940,	1.032)
Proportion variance explained by state random effect	*0.005*	*(0.001,*	*0.037)*	*0.074*	*(0.010,*	*0.195)*	*0.010*	*(0.001,*	*0.055)*
Proportion variance explained by CAR random effect	*0.763*	*(0.63,,*	*0.865)*	*0.719*	*(0.514,*	*0.868)*	*0.775*	*(0.657,*	*0.864)*
Model S6								
Home state policy score	0.948	(0.875,	1.025)	1.004	(0.944,	1.065)	0.968	(0.910,	1.028)
Interstate policy score	0.977	(0.917,	1.041)	1.007	(0.964,	1.052)	0.989	(0.941,	1.038)
Proportion variance explained by state random effect	*0.005*	*(0.001,*	*0.038)*	*0.079*	*(0.009,*	*0.202)*	*0.011*	*(0.001,*	*0.060)*
Proportion variance explained by CAR random effect	*0.762*	*(0.641,*	*0.859)*	*0.713*	*(0.511,*	*0.872)*	*0.776*	*(0.659,*	*0.866)*
Model S7								
Home state policy score	0.938	(0.875,	1.006)	0.965	(0.915,	1.018)	0.949	(0.896,	1.005)
Interstate policy score	0.974	(0.911,	1.046)	0.977	(0.927,	1.029)	0.977	(0.923,	1.032)
Interaction: Home state * interstate	0.991	(0.957,	1.026)	1.016	(0.990,	1.041)	0.999	(0.973,	1.027)
Proportion variance explained by state random effect	*0.005*	*(0.001,*	*0.038)*	*0.074*	*(0.007,*	*0.204)*	*0.010*	*(0.001,*	*0.055)*
Proportion variance explained by CAR random effect	*0.765*	*(0.640,*	*0.866)*	*0.711*	*(0.506,*	*0.874)*	*0.772*	*(0.665,*	*0.862)*

Nb. **Bolded** estimates have credible intervals that do not include IRR = 1.

eTable 3. Bayesian conditional autoregressive Poisson models for counts of suicide deaths, 3,108 counties nested within 48 states

	Firearm suicide			Non-firearm suicide			All suicide		
	Median	(95%	CI)	Median	(95%	CI)	Median	(95%	CI)
Model S1									
Home state policy score	**0.876**	**(0.836**,	**0.912)**	0.992	(0.963,	1.023)	**0.936**	**(0.910**,	**0.960)**
Interstate policy score	1.003	(0.969,	1.037)	**1.034**	**(1.008**,	**1.061)**	1.017	(0.995,	1.039)
Proportion variance explained by state random effect	*0.066*	*(0.020,*	*0.147)*	*0.023*	*(0.004,*	*0.084)*	*0.052*	*(0.012,*	*0.133)*
Proportion variance explained by CAR random effect	*0.993*	*(0.962,*	*0.999)*	*0.914*	*(0.800,*	*0.993)*	*0.959*	*(0.880,*	*0.994)*
Model S2									
Home state policy score	**0.874**	**(0.839**,	**0.908)**	0.976	(0.950,	1.003)	**0.926**	**(0.903**,	**0.949)**
Interstate policy score	1.000	(0.985,	1.015)	**1.008**	**(1.996,**	**1.020)**	0.003	(1.993,	1.013)
Proportion variance explained by state random effect	*0.068*	*(0.023,*	*0.150)*	*0.022*	*(0.003,*	*0.081)*	*0.058*	*(0.015,*	*0.145)*
Proportion variance explained by CAR random effect	*0.992*	*(0.958,*	*0.998)*	*0.923*	*(0.819,*	*0.994)*	*0.954*	*(0.872,*	*0.994)*
Model S3									
Home state policy score	**0.866**	**(0.821**,	**0.911)**	1.005	(0.966,	1.046)	**0.938**	**(0.909**,	**0.969)**
Interstate policy score	0.996	(0.952,	1.041)	**1.035**	**(1.001**,	**1.070)**	1.018	(0.991,	1.045)
Proportion variance explained by state random effect	*0.065*	*(0.006,*	*0.182)*	*0.021*	*(0.003,*	*0.128)*	*0.037*	*(0.005,*	*0.163)*
Proportion variance explained by CAR random effect	*0.987*	*(0.882,*	*0.998)*	*0.911*	*(0.675,*	*0.997)*	*0.950*	*(0.775,*	*0.996)*
Model S4									
Home state policy score	**0.876**	**(0.825**,	**0.925)**	0.992	(0.957,	1.029)	**0.935**	**(0.902**,	**0.969)**
Interstate policy score	0.988	(0.953,	1.023)	1.028	(0.999,	1.057)	1.006	(0.983,	1.032)
Proportion variance explained by state random effect	*0.110*	*(0.045,*	*0.215)*	*0.023*	*(0.004,*	*0.082)*	*0.083*	*(0.026,*	*0.186)*
Proportion variance explained by CAR random effect	*0.993*	*(0.966,*	*0.999)*	*0.917*	*(0.804,*	*0.991)*	*0.955*	*(0.881,*	*0.992)*

Model S5									
Home state policy score	**0.856**	**(0.815**,	**0.897)**	1.001	(0.964,	1.037)	**0.923**	**(0.894**,	**0.951)**
Interstate policy score	0.994	(0.963,	1.026)	**1.030**	**(1.004**,	**1.056)**	1.008	(0.988,	1.029)
Proportion variance explained by state random effect	*0.038*	*(0.007*,	*0.105)*	*0.026*	*(0.004*,	*0.090)*	*0.045*	*(0.009*,	*0.122)*
Proportion variance explained by CAR random effect	*0.994*	*(0.972*,	*0.999)*	*0.916*	*(0.806*,	*0.993)*	*0.955*	*(0.886*,	*0.991)*
Model S6									
Home state policy score	**0.874**	**(0.829**,	**0.921)**	0.989	(0.954,	1.024)	**0.932**	**(0.899,**	**0.963)**
Interstate policy score	0.991	(0.958,	1.024)	1.025	(0.998,	1.053)	1.007	(0.984,	1.030)
Proportion variance explained by state random effect	*0.090*	*(0.033*,	*0.186)*	*0.025*	*(0.004*,	*0.088)*	*0.068*	*(0.018*,	*0.167)*
Proportion variance explained by CAR random effect	*0.992*	*(0.963*,	*0.998)*	*0.920*	*(0.812*,	*0.994)*	*0.956*	*(0.879*,	*0.995)*
Model S7									
Home state policy score	**0.894**	**(0.855,**	**0.935)**	1.004	(0.972,	1.038)	**0.945**	**(0.915,**	**0.971)**
Interstate policy score	1.024	(0.987,	1.062)	**1.047**	**(1.016**,	**1.078)**	**1.027**	**(1.002**,	**1.053)**
Interaction: Home state * interstate	**0.975**	**(0.956**,	**0.993)**	0.988	(0.974,	1.003)	0.990	(0.978,	1.002)
Proportion variance explained by state random effect	*0.061*	*(0.019*,	*0.137)*	*0.023*	*(0.004*,	*0.082)*	*0.048*	*(0.011*,	*0.132)*
Proportion variance explained by CAR random effect	*0.993*	*(0.958*,	*0.999)*	*0.909*	*(0.797*,	*0.987)*	*0.956*	*(0.877*,	*0.993)*

Nb. **Bolded** estimates have credible intervals that do not include IRR = 1.