

Supplementary Online Content

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

eAppendix 1: Data Sources

How Opioid, Drug and Alcohol Related Deaths Were Identified

The Centers for Disease Control and Prevention (CDC) identifies drug-poisoning deaths using underlying cause-of-death codes X40–X44, X60–X64, X85, and Y10–Y14.¹ CDC identifies alcohol-poisoning deaths using underlying cause-of-death ICD–10 codes X45 (accidental poisoning by and exposure to alcohol), Y15 (poisoning by and exposure to alcohol, undetermined intent).² The CDC identifies opioid-related deaths based on cause-of-death codes T40.0, T40.1, T40.2, T40.3, T40.4, or T40.6.¹

Imputation of Number of Drug Courts

Where needed, we used linear interpolation to calculate missing numbers of adult drug court values in years between two available data points to achieve improved observation counts. The imputed number of drug courts was used in all models in lieu of the sparsely populated number of drug courts.

eTable 1: Summary Statistics

Binary Variables	% of state-years with policy	% of state-years without policy	Number of observations
Medicaid expansion under ACA (1=expanded; 0=not expanded)	14	86	700
Mental health parity laws (1=any; 0=none)	86	14	700
Full mental health parity laws (1=yes; 0 = no)			
Full mental health parity laws (1=yes; 0=no)	28	72	700
Mandatory minimum sentencing laws (1=yes; 0=no)	86	14	695
Good Samaritan laws (1=yes; 0=no)	16	84	700
State support for naloxone programs (1=yes; 0=no)	14	86	700
Medical cannabis programs (1=yes; 0=no)	28	72	700
Continuous Variables	Mean	SD	Number of observations
Number of drug courts per 100,000 population ^a	0.39	0.33	600
Total SAMHSA funding ^b	1,061.78	251.74	550
Medicaid eligibility threshold (fraction of FPL)	0.88	0.54	691
Unemployment rate	6.62	2.08	700
Median income ^c	58,071.26	8,331.83	650
Fraction poverty	0.14	0.03	650
Fraction black	0.13	0.08	700
Fraction female	0.51	0.01	700
Fraction elderly	0.13	0.02	700
SUD-related deaths per 100,000 population	21.15	6.05	700

^aNumber of drug courts was imputed using linear interpolation.

^bTotal SAMHSA funding is expressed in thousands of 2016 US dollars per 100,000 population.

^cMedian income is expressed in 2016 US dollars.

ACA: Affordable Care Act; CI: confidence interval; FPL: Federal poverty level; SAMHSA: Substance Abuse and Mental Health Services Administration; SUD: substance use disorder

eTable 2: Medicaid Eligibility threshold as a proportion of the federal poverty level

State	Proportion of the federal poverty level by study year ³													
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Alabama	0.21	0.20	0.19	0.19	0.26	0.26	0.25	0.24	0.24	0.24	0.24	0.23	0.16	0.18
Alaska	0.79	0.81	0.81	0.81	0.81	0.81	0.85	0.81	0.81	0.81	0.81	0.78	1.28	1.46
Arizona	1.07	2.00	2.00	2.00	2.00	2.00	2.00	1.06	1.06	1.06	1.06	1.06	1.38	1.38
Arkansas	0.21	0.20	0.20	0.19	0.18	0.18	0.17	0.17	0.17	0.17	0.17	0.16	1.38	1.38
California	1.07	1.07	1.07	1.07	1.07	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.38	1.38
Colorado	0.42	0.47	0.39	0.38	0.67	0.66	0.66	0.66	0.66	1.06	1.06	1.06	1.38	1.38
Connecticut	1.57	1.07	1.07	1.57	1.57	1.91	1.91	1.91	1.91	1.91	1.91	1.91	2.01	2.01
Delaware	1.22	1.20	1.17	1.07	1.07	1.06	1.21	1.21	1.21	1.20	1.19	1.20	1.38	1.38
Florida	0.66	0.63	0.62	0.60	0.58	0.56	0.55	0.53	0.53	0.59	0.58	0.56	0.35	0.34
Georgia	0.62	0.59	0.58	0.56	0.55	0.53	0.52	0.50	0.50	0.50	0.49	0.48	0.39	0.38
Hawaii	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.38	1.38	1.38
Idaho	0.33	0.32	0.32	0.30	0.43	0.42	0.28	0.27	0.27	0.39	0.39	0.37	0.27	0.27
Illinois	0.56	0.83	1.40	1.92	1.92	1.91	1.85	1.85	1.85	1.91	1.91	1.39	1.38	1.38
Indiana	0.31	0.30	0.29	0.28	0.27	0.26	0.26	0.25	0.25	0.36	0.24	0.24	0.24	0.24
Iowa	0.87	0.84	0.82	0.79	0.77	0.89	0.86	0.83	0.83	0.83	0.82	0.80	1.38	1.38
Kansas	0.40	0.39	0.38	0.37	0.36	0.34	0.34	0.32	0.32	0.32	0.32	0.31	0.38	0.38
Kentucky	0.75	0.71	0.70	0.68	0.66	0.64	0.62	0.62	0.62	0.62	0.59	0.57	1.38	1.38
Louisiana	0.22	0.21	0.20	0.20	0.20	0.20	0.26	0.25	0.25	0.25	0.25	0.24	0.24	0.24
Maine	1.57	1.57	1.57	1.57	2.07	2.06	1.06	1.06	2.06	2.00	2.00	2.00	1.05	1.05
Maryland	0.43	0.41	0.40	0.38	0.38	0.37	1.16	1.16	1.16	1.16	1.16	1.22	1.38	1.38
Massachusetts	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.38	1.38
Michigan	0.63	0.61	0.59	0.58	0.61	0.61	0.66	0.64	0.64	0.64	0.63	0.64	1.38	1.38
Minnesota	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.15	2.15	2.15	2.15	2.15	2.05	1.38
Mississippi	0.38	0.36	0.35	0.34	0.33	0.32	0.46	0.44	0.44	0.44	0.44	0.29	0.29	0.28
Missouri	1.07	0.84	0.82	0.42	0.40	0.39	0.26	0.25	0.25	0.37	0.36	0.35	0.24	0.23
Montana	0.69	0.67	0.65	0.64	0.62	0.60	0.58	0.56	0.56	0.56	0.55	0.54	0.52	0.51
Nebraska	0.55	0.57	0.56	0.60	0.58	0.59	0.58	0.58	0.58	0.58	0.57	0.58	0.55	0.55
Nevada	0.90	0.88	0.87	0.84	0.86	0.94	0.91	0.88	0.88	0.88	0.87	0.84	1.38	1.38
New Hampshire	0.62	0.61	0.60	0.58	0.56	0.55	0.51	0.49	0.49	0.49	0.49	0.47	0.75	1.38
New Jersey	2.00	0.42	0.41	1.00	1.15	1.33	2.00	2.00	2.00	2.00	2.00	2.00	1.38	1.38
New Mexico	0.58	0.71	0.69	0.67	0.65	0.63	0.69	0.67	0.67	0.67	0.85	0.85	1.38	1.38
New York	1.33	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.38	1.38

North Carolina	0.62	0.59	0.57	0.56	0.54	0.52	0.51	0.49	0.49	0.49	0.49	0.47	0.45	0.45	
North Dakota	1.10	0.94	0.69	0.67	0.65	0.63	0.62	0.59	0.59	0.59	0.59	0.57	1.38	1.38	
Ohio	1.00	1.00	1.00	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.96	1.38	1.38	
Oklahoma	0.48	0.46	0.45	0.44	0.43	0.50	0.48	0.47	0.47	0.53	0.53	0.51	0.48	0.46	
Oregon	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.40	0.40	0.40	0.40	0.39	1.38	1.38	
Pennsylvania	0.56	0.66	0.66	0.63	0.61	0.59	0.36	0.34	0.34	0.46	0.46	0.58	0.38	1.38	
Rhode Island	Medicaid eligibility threshold not recorded in data 2002-2010										1.81	1.81	1.81	1.38	1.38
South Carolina	1.00	0.98	0.97	0.97	0.97	1.00	0.90	0.89	0.89	0.93	0.91	0.89	0.67	0.67	
South Dakota	0.65	0.63	0.61	0.59	0.58	0.56	0.54	0.52	0.52	0.52	0.52	0.50	0.54	0.53	
Tennessee	0.81	1.00	1.00	0.81	0.80	0.80	1.34	1.29	1.29	1.27	1.26	1.22	1.11	1.03	
Texas	0.32	0.34	0.33	0.30	0.29	0.28	0.27	0.26	0.26	0.26	0.26	0.25	0.19	0.19	
Utah	0.55	0.53	0.53	0.50	0.49	0.47	0.68	0.44	0.44	0.44	0.44	0.42	0.47	0.46	
Vermont	1.92	1.92	1.92	1.91	1.92	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.38	1.38	
Virginia	0.31	0.37	0.36	0.31	0.31	0.31	0.30	0.29	0.29	0.31	0.31	0.30	0.52	0.45	
Washington	2.00	0.86	0.86	0.76	0.79	0.76	0.77	0.74	0.74	0.74	0.73	0.71	1.38	1.38	
Washington, DC	2.00	2.00	2.00	2.00	2.07	2.07	2.07	2.07	2.07	2.07	2.06	2.06	2.21	2.21	
West Virginia	0.28	0.39	0.38	0.35	0.36	0.35	2.00	0.33	0.33	0.33	0.32	0.31	1.38	1.38	
Wisconsin	1.85	1.85	1.92	1.91	1.92	1.91	0.34	2.00	2.00	2.00	2.00	2.00	1.00	1.00	
Wyoming	0.65	0.62	0.60	0.55	0.57	0.55	0.54	0.52	0.52	0.52	0.51	0.50	0.59	0.58	

eTable 3: Fixed Effects Regression Results

Policy	Coefficient (Outcome: SUD Deaths) (95% CI)
Medicaid eligibility (% FPL before and after ACA)	-1.373** (-2.732, -0.014)
Mental health parity laws (Any)	-0.809 (-2.148, 0.529)
Mandatory minimum sentencing laws	-1.838* (-3.829, 0.153)
Number of drug courts ^a	4.632*** (2.299, 6.964)
Good Samaritan laws	-0.555 (-1.952, 0.842)
State support for naloxone programs	1.316** (0.037, 2.596)
Medical cannabis programs	2.918*** (1.578, 4.257)
Demographic covariates	Included
Economic controls	Included
Observations	538

*p<0.1; **, p<0.05; ***p<0.01

^aNumber of drug courts was imputed using linear interpolation.

ACA: Affordable Care Act; CI: confidence interval; FPL: federal poverty level; SUD: substance use disorder.

Results were estimated using a fixed effects regression model of SUD-related deaths on Medicaid eligibility threshold with economic controls (the state's unemployment rate, median household income, and fraction of the state population with income below the federal poverty level), demographic controls (the fractions of state population that were black, elderly (65+), and female) and other policy controls (listed in the table).

eAppendix 2: Results of Sensitivity Analyses

The results of the alternative specifications of our base case model are presented in eTable 4.

Additional policies included in the sensitivity analyses were:

1. Medicaid expansion status under the ACA;
2. Existence of full mental health parity laws;
3. SAMHSA funding.

Medicaid expansion status under the ACA was not included in the base case analysis because it is somewhat redundant with the Medicaid eligibility threshold and minimally affects the data; since we examined the effect of policies in 2002-2014 on SUD-related deaths in 2003-2015, the last year of policies in the data is 2014. This implies that the expansion variable affects 2 years of data out of a total 14, as states could not implement Medicaid expansions prior to 2013 without a special waiver. SAMHSA funding and existence of full mental health parity laws were excluded from the base case and chosen as controls for the sensitivity analyses instead because both were sparsely populated.

eTable 4: Main Sensitivity Analyses

Policy	SA1: Year fixed effects Coefficient (95% CI)	SA2: Vary control policy variables Coefficient (95% CI)			SA3: No population weights Coefficient (95% CI)
		Medicaid expansion	SAMHSA funding	Full mental health parity	
Medicaid eligibility (% FPL before and after ACA)	-1.555** (-2.939, -0.171)	-1.371** (-2.735, -0.007)	-1.86** (-3.660, -0.060)	-1.304* (-2.634, 0.026)	-1.852* (-3.721, 0.016)
Medicaid expansion under the ACA	Not included	-0.067 (-1.266, 1.132)	Not included	Not included	Not included
SAMHSA funding	Not included	Not included	0 (-0.002, 0.002)	Not included	Not included
Mental health parity laws (Full)	Not included	Not included	Not included	0.972 (-0.207, 2.151)	Not included
Mental health parity laws (Any)	-0.635 (-1.783, 0.514)	-0.822 (-2.206, 0.562)	-0.229 (-1.970, 1.511)	Not included	-0.443 (-1.780, 0.894)
Mandatory minimum sentencing laws	-1.936* (-3.978, 0.107)	-1.824* (-3.866, 0.218)	-1.315 (-3.680, 1.049)	-1.544 (-3.211, 0.123)	-1.061 (-3.678, 1.556)
Number of drug courts ^a	4.728*** (2.431, 7.026)	4.621*** (2.244, 6.997)	4.736*** (1.362, 8.109)	4.557*** (2.190, 6.924)	4.319*** (1.274, 7.365)
Good Samaritan laws	-0.798 (-2.053, 0.456)	-0.543 (-2.048, 0.962)	-0.987 (-2.268, 0.294)	-0.663 (-1.982, 0.655)	-0.292 (-1.711, 1.127)
State support for naloxone programs	0.989* (-0.090, 2.068)	1.305* (-0.050, 2.660)	0.671 (-0.487, 1.829)	0.585 (-0.703, 1.873)	0.783 (-0.370, 1.936)
Medical cannabis programs	2.784*** (1.535 - 4.034)	2.921*** (1.587, 4.255)	2.665*** (1.305, 4.025)	3.172*** (1.853, 4.491)	2.464*** (0.950, 3.978)
Demographic covariates	Included	Included	Included	Included	Included
Economic covariates	Included	Included	Included	Included	Included
Observations	538	538	442	538	538

*p<0.1; **p<0.05; ***p<0.01

^aNumber of drug courts was imputed using linear interpolation.

ACA: Affordable Care Act; CI: confidence interval; FPL: federal poverty level; SA: sensitivity analysis; SAMHSA: Substance Abuse and Mental Health Services Administration; SUD: substance use disorders.

eTable 5. Sensitivity Analysis Measuring Whether SUD Deaths in Previous Years Predict Policy in Current Year^a

Policy ^b	Coefficient of SUD Deaths in Previous Year (Standard Error)
Medicaid eligibility (% FPL before and after ACA)	-0.00574 (-0.0357, 0.0242)
Medicaid expansion under ACA	0.00107 (-0.00764, 0.00978)
Mental health parity laws (Any)	0.00816 (-0.0087, 0.0250)
Full mental health parity laws	-0.00292 (-0.0222, 0.0163)
Mandatory minimum sentencing laws	-0.00418 (-0.0203, 0.0119)
Number of drug courts	0.0138* (-0.00261, 0.0303)
Good Samaritan laws	0.00381 (-0.00732, 0.0149)
State support for naloxone programs	0.0106 (-0.00212, 0.0234)
Medical cannabis programs	0.0370*** (0.0225, 0.0515)
Total SAMHSA funding	15.79*** (6.041, 25.55)

*** p<0.01, ** p<0.05, * p<0.1

^aEconomic, population, and quadratic time trends controls were included in each model.

^bEach policy had a separate regression.

ACA: Affordable Care Act; CI: confidence interval; FPL: federal poverty level; SA: sensitivity analysis; SAMHSA: Substance Abuse and Mental Health Services Administration; SUD: substance use disorders.

eTable 6. Sensitivity Analysis Measuring Whether a Shortened Panel Data Demonstrated a Significant Relationship between SUD Deaths and Medicaid Expansions^a

Policy (Lagged by 1 Year)	Coefficient of SUD Deaths in Current Year (95% CI)
Medicaid eligibility (% FPL before and after ACA)	0.404 (-2.349, 3.157)
Mental health parity laws (Any)	0.326 (-0.775, 1.426)
Mandatory minimum sentencing laws	-3.211*** (-5.020, -1.401)
Number of drug courts ^b	2.758 (-5.933, 11.45)
Good Samaritan laws	-0.491 (-1.272, 0.289)
State support for naloxone programs	0.184 (-1.188, 1.556)
Medical cannabis programs	2.259* (-0.150, 4.669)

*** p<0.01, ** p<0.05, * p<0.1

^aBase case analysis covered 2002-2015; this analysis covers 2010-2015, with 199 observations. Economic, population, quadratic time trends controls, and state fixed effects were included in the model.

^bNumber of drug courts was imputed using linear interpolation.

ACA: Affordable Care Act; CI: confidence interval; SUD: substance use disorder.

eReferences

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