The Impact of State Firearm Laws on Homicide and Suicide Deaths in the USA, 1991–2016: a Panel Study

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BACKGROUND: Firearm injuries are a major cause of mortality in the USA. Few recent studies have simultaneously examined the impact of multiple state gun laws to determine their independent association with homicide and suicide rates.

OBJECTIVE: To examine the relationship between state firearm laws and overall homicide and suicide rates at the state level across all 50 states over a 26-year period.

DESIGN: Using a panel design, we analyzed the relationship between 10 state firearm laws and total, age-adjusted homicide and suicide rates from 1991 to 2016 in a difference-in-differences, fixed effects, multivariable regression model. There were 1222 observations for homicide analyses and 1300 observations for suicide analyses.

PARTICIPANTS: Populations of all US states.

MAIN MEASURES: The outcome measures were the annual age-adjusted rates of homicide and suicide in each state during the period 1991–2016. We controlled for a wide range of state-level factors.

KEY RESULTS: Universal background checks were associated with a 14.9% (95% CI, 5.2–23.6%) reduction in overall homicide rates, violent misdemeanor laws were associated with a 18.1% (95% CI, 8.1–27.1%) reduction in homicide, and "shall issue" laws were associated with a 9.0% (95% CI, 1.1–17.4%) increase in homicide. These laws were significantly associated only with firearm-related homicide rates, not non-firearm-related homicide rates. None of the other laws examined were consistently related to overall homicide or suicide rates.

CONCLUSIONS: We found a relationship between the enactment of two types of state firearm laws and reductions in homicide over time. However, further research is necessary to determine whether these associations are causal ones.

KEY WORDS: community health; firearms; health policy; injury; prevention; public health.

INTRODUCTION

From 1991 to 2016, the average annual firearm death rate in the USA was 11.4 per 100,000 individuals.[1] This amounts to 859,871 lives lost due to a single cause of preventable death over a 26-year period.[1] Although numerous studies have evaluated the impact of state firearm laws on homicide or suicide rates (Online Supplemental Tables S1, S2), a major limitation is that most examined the impact of only one type of policy. Because states that enact one type of law are also more likely to enact others,[2] it is difficult to isolate the effect of one law without considering the simultaneous impact of other policies.

To improve our ability to draw causal inferences, a stronger study design would examine the relationship between the enactment of *multiple* types of state firearm laws over time and differences in fatality rates between states. However, we are aware of only one multi-year panel study of homicide rates that examined multiple laws and included data from the past decade; this study was conducted at the level of urban counties, and only 34 states were included.[3] We are not aware of any panel study at the state level that used data within the past decade to assess simultaneously the effect of multiple state firearm laws on homicide or suicide death rates.

One reason why many previous studies have focused on a single type of law is the absence of a comprehensive national database of state firearm laws. For most previous studies, researchers had to track down the status of state firearm laws by conducting their own legal research, a painstaking process that precluded a single study of a large range of gun-related policies. We recently created a novel database in which we recorded, quantified, and classified the largest-to-date compilation of firearm provisions by state over a 26-year period.[2] In this study, we examine the simultaneous impact of 10 different types of state firearm laws on overall homicide and suicide rates over a 26-year period using the same model specification.

METHODS

Data Sources

We ascertained the annual presence or absence of 10 state firearm laws in all 50 states from 1991 to 2016 using the State Firearm Law Database, which provides a panel of firearm-related laws in each state, for each year.[2] The database was

compiled using the Thompson Reuters Westlaw database of state statutes and session laws and a database assembled by Everytown for Gun Safety.[4]

We obtained homicide and suicide mortality data from the Centers for Disease Control and Prevention Web-Based Injury Statistics Query and Reporting System (WISQARS), which are derived from the vital statistics death registry of the National Center for Health Statistics.[1] WISQARS reports annual state-specific, age-adjusted fatality rates for homicide and suicide.

Study Population

We assembled annual, state-specific age-adjusted total homicide and suicide rates in each state from 1991 to 2016. We excluded homicides due to legal intervention (1% of firearm deaths), unintentional firearm fatalities (2.5% of firearm deaths), and fatalities of undetermined intent (1% of firearm deaths) from our analysis.

Outcome Measures

The main outcome measures were the annual, age-adjusted homicide rate and age-adjusted suicide rate in each state over the study period. Because there were 50 states and 26 years, the total number of possible observations was 1300. However, the CDC does not report death rates when the absolute number of deaths in a state during a given year is less than 10. For this reason, we did not have a complete panel of homicide data for three states: North Dakota, Vermont, and Wyoming. We therefore excluded these states from the homicide analyses, yielding a total of 1222 observations. There were no missing data for suicide death rates, so there were 1300 observations for analyses involving this outcome.

Main Predictor Variables

From the state law database, we selected 10 laws to analyze based on several considerations: (1) laws that are currently being considered by state legislatures; (2) laws that have been examined in prior research; and (3) laws that were enacted by at least two states during the study period. We analyzed the following 10 laws (defined in detail in Table 1): (1) universal background checks, either through point-of-purchase checks or a permit to purchase requirement; (2) ban on handgun possession for people convicted of a violent misdemeanor; (3) age 21 limit for handgun possession; (4) "shall issue" laws; (5) permitless carry laws; (6) prohibition against gun trafficking; (7) ban on "junk guns"; (8) "stand your ground" laws; (9) assault weapons ban; and (10) ban on large-capacity ammunition magazines. Laws were lagged by 1 year in the analysis; that is, we considered the potential effect of a law only in the full first year after its enactment.

Data Analysis

Unlike many earlier analyses in the public health literature, we employed a difference-in-differences approach to the analysis of policy outcomes,[5, 6] an approach that is widely used in the econometric and criminology literature on the effect of state firearm laws and was first introduced by Lott and Mustard in their classic 1997 paper.[7] Using multivariable linear regression, we evaluated the association between the firearm law provisions in each state (which were time-varying) and the homicide and suicide rates over the study period, while controlling for several other time-varying state-level factors. We included year and state fixed effects and estimated cluster-robust standard errors, which account for the clustering of observations, serial autocorrelation, and heteroskedasticity.[8] By including state fixed effects, our analysis focuses on the time series of observations within each state, comparing changes in homicide or suicide rates within a state from before to after the implementation of a particular firearm law, using states without that law as controls. Because the outcome variables are not normally distributed but skewed, we log-transformed the homicide and suicide rates.

Our final model was as follows:

$$ln\,(\mu_{st}) = \alpha + (B_* LAW_{st}) + (C_* CONTROL_{st}) + S + T + e,$$

where μ_{st} is the homicide or suicide rate in state s in year t, LAW_{st} is a dummy variable for the presence or absence of a particular state firearm law in state s in year t, $CONTROL_{st}$ is a vector of control variables, S represents state fixed effects, and T represents year fixed effects.

We controlled for the following time-varying state-level factors, chosen because of their association with homicide or suicide rates in the published literature and their association with both death rates and the adoption of firearm laws in our data set: (1) the percent of the population that is black; (2) the percent of population ages 15–29 that is male; (3) per capita law enforcement officers; (4) the violent crime rate (excluding homicide); (5) the divorce rate; (6) the unemployment rate; (7) the poverty rate; (8) per capita alcohol consumption; (9) the incarceration rate; (10) population density; (11) log of population; and (12) household gun ownership percentage.

Because annual survey data of household gun ownership at the state level are not available, most previous studies have used the ratio of firearm suicides to all suicides (FS/S) as a proxy for household firearm ownership.[9] This proxy is highly correlated ($r = 0.80$) with state-specific measures of firearm ownership on a cross-sectional basis.[10] Recently, we developed a new proxy measure that improves the correlation with survey-measured gun ownership from 0.80 to 0.95.[10] This new proxy measure incorporates a state's hunting license rate in addition to FS/S.[10] In this study, we used this new proxy.

Per capita law enforcement officers and violent crime rates were obtained from the FBI Uniform Crime Reports;[11] incarceration rates were obtained from the Bureau of Justice Statistics;[12] and per capita alcohol consumption was obtained from the National Institute on Alcohol Abuse and Alcoholism (NIAAA) for 1991–2015[13] and from Statistica[14] for 2016. Hunting licensing data were obtained from the U.S. Fish and Wildlife Service.[15] The remaining variables were obtained

Table 1 Description of State Firearm Laws Examined

Law	Brief description	Detailed description	States with law in 1991	Additional states with law in 2016	Law changes from 1991 to 2016
Universal background checks	Background checks conducted through permit requirement for all firearm sales or through required background checks for all sales)	Individuals must undergo a background check to purchase any type of firearm, either at the point of purchase or through a license/permit application. This may or may not include exemptions for buyers who have already undergone a background check for a concealed carry permit or other licensing requirements.	CA, IL, MA, NJ, RI	CO, CT, DE, HI, NY, OR, WA	7
Violent misdemeanor is prohibiting for handgun possession	Handgun possession is prohibited for people who have committed a violent misdemeanor punishable by less than 1 year of imprisonment	Must cover possession of handguns, not just purchase. Must cover assault, not just aggravated assault. Must extend beyond domestic violence-related misdemeanors, restraining orders, and stalking. Must not require that misdemeanor be punishable by imprisonment of more than 1 year. Must not require that misdemeanor involve use of a firearm or result in injury.	CA, HI, NY	CT, MD	2
Age 21 limit for handgun possession	No possession of handguns until age 21	You must be 21 to possess a handgun. No exemption for parental consent. Exclusions for adult-supervised hunting, sporting, or training activities are OK. Exception for possession on private premises NOT OK unless minor required to be under adult supervision.	IA, RI, SC	CT, HI, MD, MA, NJ, NY (SC repealed)	7
Shall issue law	Law provides no discretion to law enforcement authorities in deciding whether to grant a concealed carry permit.	A permit must be issued unless the applicant meets pre-established disqualifying criteria.	FL, GA, ID, IN, IA, ME, MS, MT, NH, ND, OR, PA, SD, WA, WV	AL, AR, CO, IL, KY, LA, MI, MN, MO, NE, NV, NM, NC, OH, OK, SC, TN, TX, UT, VA, WA, WI (WV moved to permitless carry)	23
Permitless carry	No permit is required to carry a concealed handgun.	Age restrictions may apply, and a voluntary permitting system may still be in place.	VT	AK, AZ, ID, KS, ME, MS, WV, WY	8
Trafficking prohibited	No person may purchase a firearm with the intent to re-sell to a person who is prohibited from buying or possessing a firearm	The law prohibits the purchase of a firearm with the intent to re-sell to a prohibited person. We make no distinction between whether the trafficker (original purchaser) must actually know or have reason to believe that the buyer is prohibited. An exemption for sale to relatives is acceptable.	FL, MA, ND, OH, VA	CA, CO, CT, DE, IL, MN, NY, UT, VA	9
Junk gun ban	Ban on junk guns (sometimes called "Saturday night specials")	The law prohibits the sale of handguns that fail to meet one or more of the following requirements: (1) Passes drop testing and firing testing; (2) Passes a melting point test; (3) Possesses specific handgun safety features; (4) Appears on a list of approved handguns. This may or may not apply to private sellers.	HI, IL, MD, MN, SC	CA, MA (SC repealed)	3
Stand your ground law	A "stand your ground" law is in place	Use of deadly force is allowed to be a first resort if you are threatened in a public place in which you have the right to be present. There is no duty to retreat. Does not count as stand your ground law if it only	None	AL, AK, AZ, FL, GA, IN, KS, KY, LA, MI, MS, MO, MT, NV, NH, NC, OK, PA, SC, SD, TN, TX, UT, WV	24

(continued on next page)

Table 1. (continued)

Law	Brief description	Detailed description	States with law in 1991	Additional states with law in 2016	Law changes from 1991 to 2016
		applies when person is in a vehicle.			
Assault weapons ban	Ban on sale of assault weapons beyond just assault pistols	Law bans the sale of both assault pistols and other assault weapons.	CA, NJ	CT, MD, MA, NY	4
Large capacity ammunition magazine ban	Ban on sale large capacity magazines beyond just ammunition for pistols	Law bans the sale of both assault pistol ammunition and other large-capacity magazines.	NJ	CA, CO, CT, MD, MA, NY	6

from the U.S. Census. We conducted the analysis using Stata version 15 (StataCorp LP, College Station, TX).

Because the outcome variables are log-transformed, the regression coefficients can be interpreted as the percentage change in the firearm homicide or suicide rate associated with the presence of a particular law by exponentiating the coefficient, subtracting 1, and then multiplying by 100 (i.e., a coefficient of 0.10 for a given law would indicate a 10.5% increase in the mortality rate associated with that law).

To test the plausibility of any observed associations between firearm laws and overall homicide or suicide rates, we conducted a falsification test: we analyzed the relationship between these laws and firearm compared to non-firearm mortality rates. These laws would be expected to primarily affect only the firearm-related rates.

In a final sensitivity analysis, we modeled the secular time trend in firearm homicide or suicide rates by including year as a continuous variable in the model rather than as a fixed effect.

RESULTS

Over the 26-year study period, there was a substantial variation in the violent death rates across states. In 2016, overall homicide rates ranged from a low of 1.3 per 100,000 in Maine and New Hampshire to a high of 14.2 per 100,000 in Louisiana (Table 2). In 2016, overall suicide rates ranged from a low of 7.2 per 100,000 in New Jersey to a high of 26.0 per 100,000 in Montana. Across the study period, there were a total of 93 law changes among the 10 laws studied (Table 1).

When examined individually, universal background checks and violent misdemeanor laws were significantly associated with lower overall homicide rates and "shall issue" laws were significantly associated with higher homicide rates (Table 3). After simultaneously controlling for all 10 firearm laws, universal background checks were associated with 14.9% lower overall homicide rates (95% confidence interval [CI], 5.2%–23.6%); violent misdemeanor laws were associated with 18.1% lower homicide rates (95% CI, 8.1–27.1%); and "shall issue" laws were associated with 9.0% higher homicide rates (95% CI, 1.1%–17.4%). None of the other seven laws were significantly associated with overall homicide rates. In a

falsification test, each of these three laws was found to be significantly associated only with the firearm-related homicide rate, not the non-firearm-related homicide rate (Online Supplemental Table S3).

In the fully adjusted model, household gun ownership was not associated with overall rates of homicide (Table 3). Factors that were significant positive predictors of overall homicide rates were the percentage of males, the violent crime rate, and population density. Overall population was negatively associated with homicide rates.

When examined individually, four of the 10 firearm laws were significantly associated with overall suicide rates (Table 4). However, after simultaneously controlling for all 10 firearm laws, only two laws were significantly related to suicide rates: bans on junk guns were associated with 6.4% lower suicide rates (95% CI, 3.5–9.2%) and permitless carry laws were associated with 5.1% higher suicide rates (95% CI, 0.2–10.4%). Both laws failed the falsification test, as both were significantly related to non-firearm as well as firearm homicide rates (Online Supplemental Table S4). None of the other laws were significantly associated with overall suicide rates.

In the fully adjusted model, household gun ownership was not associated with overall rates of suicide (Table 4). Factors that were significant positive predictors of suicide rates were the violent crime rate, unemployment rate, poverty rate, and per capita alcohol consumption. Overall population was negatively related to suicide rates.

Entering year as a continuous variable instead of as a fixed effect had no appreciable impact on the results (Online Supplemental Table S5).

DISCUSSION

To the best of our knowledge, this is the first study using data from within the past decade to simultaneously model the effect of multiple state firearm laws on homicide and suicide rates at the state level using a multi-year panel design. Using a difference-in-differences analysis, we found that laws requiring universal background checks and those prohibiting firearm possession by people with a conviction for a violent

Table 2 Status of State Firearm Laws and Violent Death Rates, 2016

State	UBC	VM	21	SI	PC	TP	JG	SYG	AW	LCM	Age-adjusted overall homicide rate (per 100,000)	Age-adjusted overall suicide rate (per 100,000)
Louisiana				√				√			14.2	14.1
Mississippi					√			√			12.0	12.7
Alabama			√					√			11.8	15.6
Maryland		√	√				√		√	√	10.0	9.3
Missouri				√							9.9	18.3
New Mexico				√							9.5	22.5
Illinois	√			√		√	√				9.2	10.7
South Carolina				√				√			9.0	15.7
Tennessee				√				√			8.7	16.3
Arkansas				√							8.7	18.2
Oklahoma				√				√			8.6	20.9
Georgia				√				√			7.9	13.3
Alaska					√			√			7.5	25.4
Indiana				√				√			7.5	15.4
North Carolina				√				√			7.4	13.0
Nevada				√				√			7.4	21.4
Kentucky				√				√			7.1	16.8
Delaware	√					√					7.0	11.5
Florida				√		√		√			6.8	13.9
Michigan				√				√			6.6	13.3
Ohio				√		√					6.5	14.1
West Virginia					√			√			6.3	19.5
Arizona					√			√			6.3	17.6
Pennsylvania				√				√			6.0	14.7
Texas				√				√			6.0	12.6
Virginia				√		√					5.5	13.2
Kansas					√			√			5.3	17.9
California	√	√				√	√		√	√	5.2	10.5
Wisconsin				√							4.8	14.6
South Dakota				√				√			4.7	20.5
New Jersey	√		√						√	√	4.6	7.2
Montana				√				√			4.3	26.0
Colorado	√			√		√				√	4.2	20.5
New York	√	√	√						√	√	3.5	8.1
Nebraska				√							3.3	13.0
Oregon	√			√							3.2	17.8
Wyoming					√						3.0	25.2
Washington	√										2.9	14.8
Iowa		√	√								2.8	14.5
Hawaii	√	√	√				√				2.8	12.0
Connecticut	√	√	√			√			√	√	2.6	10.0
Utah				√		√		√			2.5	21.8
Minnesota				√		√	√				2.4	13.2
Rhode Island	√		√								2.3	11.1
North Dakota				√		√					2.2	19.0
Massachusetts	√		√			√	√		√	√	2.0	8.7
Idaho					√						2.0	21.3
Vermont					√						1.9	17.3
New Hampshire				√				√			1.3	17.3
Maine					√						1.3	15.7

Includes the following 10 laws: UBC, universal background checks; VM, violent misdemeanor prohibitor; 21, age 21 limit for handgun purchase; SI, shall issue; PC, permitless carry; TP, trafficking prohibited; JG, junk gun ban; SYG, stand your ground law; AW, assault weapons ban; LCM, large capacity magazine ban

misdemeanor were associated with significant reductions in the overall homicide rate, while "shall issue" laws were associated with a significant increase in the homicide rate. There was no significant association between homicide and the other laws studied, and we did not find consistent relationships between any of the laws and overall suicide rates.

This study has several strengths. First, it is one of the first studies to clearly define each law with attention to the detailed provisions of the law, including its scope, exceptions, and exemptions. One reason for some of the conflicting results of previous studies (Online Supplemental Tables S1, S2) may be the inconsistent definition of state statutes.

Second, using a difference-in-differences approach helps to address the major threat to validity in this type of research: states with lower homicide rates to begin with may be more likely to enact stronger gun laws. By including state and year fixed effects, we are using a "within-estimator" that assesses differences within states over time.[5, 6] Studies that do not include state fixed effects are also assessing differences across states at a given time ("between effects"), which may reflect different propensities of states with lower or higher homicide rates to enact laws, rather than law effects. Thus, the difference-in-differences approach is less subject to the possibility of "reverse causation" (i.e., it is the level of the homicide

Table 3 Linear Regression Model Results: Factors Affecting Homicide Rates, 1991–2016

	Regression coefficient for state firearm laws entered one at a time (95% CI)	Regression coefficient, fully adjusted model [all laws entered together] (95% CI)
Percent black		0.043 (−0.004, 0.089)
Percent male among population ages 15–29		*0.100* (0.021, 0.179)*
Per capita law enforcement officers		−0.023 (−0.079, 0.033)
Violent crime rate		*0.054* (0.026, 0.081)*
Divorce rate		−0.030 (−0.066, 0.005)
Unemployment rate		0.002 (−0.015, 0.019)
Poverty rate		0.002 (−0.005, 0.010)
Per capita alcohol consumption		0.138 (−0.021, 0.298)
Incarceration rate (per 1000 population)		−0.025 (−0.058, 0.008)
Population density (per 0.1 mile^2)		*0.032* (0.010, 0.054)*
Log of population		*−0.629* (−1.081, −0.177)*
Proxy for household gun ownership percentage		0.001 (−0.004, 0.007)
Firearm laws		
Universal background checks	*−0.173* (−0.299, −0.048)*	*−0.161* (−0.269, −0.053)*
Violent misdemeanor is prohibiting for handgun possession	*−0.155* (−0.276, −0.033)*	*−0.200* (−0.316, −0.084)*
Age 21 limit for handgun possession	−0.117 (−0.245, 0.010)	−0.068 (−0.200, 0.064)
Shall issue law	*0.082* (0.018, 0.146)*	*0.086* (0.011, 0.160)*
Permitless carry law	−0.063 (−0.152, 0.027)	0.015 (−0.101, 0.131)
Trafficking prohibited	−0.045 (−0.133, 0.044)	0.005 (−0.050, 0.061)
Junk gun ban	−0.028 (−0.177, 0.121)	−0.010 (−0.136, 0.116)
Stand Your Ground law	0.020 (−0.042, 0.083)	0.009 (−0.050, 0.067)
Ban on assault weapons	−0.143 (−0.300, 0.013)	−0.092 (−0.222, 0.039)
Ban on large capacity ammunition magazines	−0.089 (−0.205, 0.027)	0.038 (−0.036, 0.112)
R^2		0.94

Outcome variable is the log of the age-adjusted total homicide rate. All models include year and state fixed effects. Standard errors are robust and adjusted for state-level clustering
CI, confidence interval
*Coefficient is statistically significant from zero (p < 0.05). Also shown in italic

rates that are affecting the law enactment, not the other way around). The inclusion of state fixed effects has the added advantage of controlling for any differences between states in time-invariant factors.

Third, including a large panel of time-varying state factors as independent variables helps address the problem of omitted variable bias. Nevertheless, it is still possible that states which were experiencing large declines in homicide were more likely to enact a particular law; even the within-estimator may not be sufficient to rule out the possibility of reverse causation.

Our finding of a negative association between universal background checks (including permit requirements) and homicide rates is consistent with several other studies.[3, 16–20] Our finding of a negative association between violent misdemeanor laws and homicide rates is consistent with one other recent study, which reported a 24% reduction in intimate partner homicide in states with these laws.[21] However, caution should be exercised when interpreting this finding because only two states implemented violent misdemeanor laws during the study period. While historically the literature on the impact of concealed carry–permitting laws has been inconsistent and several studies have found an association between "shall issue" laws and reduced murder rates,[7, 22–29] the three most recent studies to examine these laws found a positive association with homicide rates.[3, 30, 31]

Our finding that there was no association between stand your ground laws and homicide rates conflicts with the findings of two previous studies on these laws.[32, 33] However, both of these studies examined only the decade of 2000–2010.

When we restrict our analysis to that decade, we obtain similar results.

A second important finding of this study is that changes in household gun ownership were not found to be significantly associated with homicide or suicide rates, a result that differs from several previous studies.[34, 35] The discrepancy in these results could possibly be due to our inclusion of state fixed effects. It is possible that although there is a strong cross-sectional relationship between the prevalence of firearm ownership and homicide and suicide rates, small changes in firearm ownership that are observed over time are not sufficient enough to result in measurable differences in overall population homicide or suicide rates. Even if we had survey-based measures of household gun ownership, the margin of error is probably greater than the actual change in gun ownership levels from year to year. There is too much noise in our measure of gun ownership and too little variability in true levels of household gun ownership to determine if changes in gun ownership are related to differences in homicide or suicide rates. Few of the previous studies included state fixed effects. Because of the conflict with the existing literature, further study is required before any definitive conclusion is drawn.

It is important to note that the absence of an observed association of a law and overall homicide or suicide rates does not necessarily mean that these laws are ineffective. It may also be that the laws are not broad enough to affect overall population death rates or that the laws are not being adequately enforced.

Table 4 Linear Regression Model Results: Factors Affecting Suicide Rates, 1991–2016

	Regression Coefficient for State Firearm Laws Entered One at a Time (95% CI)	Regression Coefficient, Fully Adjusted Model [All Laws Entered Together] (95% CI)
Percent black		−0.015 (−0.033, 0.003)
Percent male among population ages 15–29		0.018 (−0.014, 0.049)
Per capita law enforcement officers		0.006 (−0.015, 0.027)
Violent crime rate		*0.018* (0.007, 0.029)*
Divorce rate		−0.008 (−0.028, 0.012)
Unemployment rate		*0.008* (0.001, 0.016)*
Poverty rate		*0.004* (0.000, 0.007)*
Per capita alcohol consumption		*0.075* (0.012, 0.138)*
Incarceration rate (per 1000 population)		0.007 (−0.011, 0.025)
Population density (per 0.1 mile^2)		−0.001 (−0.010, 0.007)
Log of population		*−0.349* (−0.601, −0.097)*
Proxy for household gun ownership percentage		0.001 (−0.001, 0.003)
Firearm laws		
Universal background checks	0.008 (−0.034, 0.050)	−0.010 (−0.033, 0.053)
Violent misdemeanor is prohibiting for handgun possession	−0.024 (−0.064, 0.016)	−0.043 (−0.090, 0.004)
Age 21 limit for handgun possession	*−0.040* (−0.078, −0.001)*	−0.030 (−0.070, 0.010)
Shall issue law	0.000 (−0.025, 0.024)	0.004 (−0.022, 0.029)
Permitless carry law	*0.063* (0.006, 0.120)*	*0.050* (0.002, 0.099)*
Trafficking prohibited	−0.013 (−0.047, 0.021)	−0.002 (−0.043, 0.038)
Junk gun ban	*−0.074* (−0.101, −0.047)*	*−0.066* (−0.097, −0.036)*
Stand Your Ground law	−0.014 (−0.033, 0.006)	−0.018 (−0.037, 0.001)
Ban on assault weapons	−0.037 (−0.081, 0.006)	0.001 (−0.063, 0.066)
Ban on large-capacity ammunition magazines	*−0.052* (−0.099, −0.005)*	−0.004 (−0.053, 0.046)
R^2		0.94

Outcome variable is the log of the age-adjusted total suicide rate. All models include year and state fixed effects. Standard errors are robust and adjusted for state-level clustering
CI confidence interval
*Coefficient is statistically significant from zero (p < 0.05). Also shown in italic

Several other limitations deserve mention. First, the firearm ownership proxy has been validated with cross-sectional data, but not with longitudinal data.[36] It is not clear whether this proxy is able to accurately measure changes in household gun ownership over time.

Second, while we controlled for a range of state-level factors associated with homicide death rates, there may be unidentified omitted variables. For example, in the early 1990s, firearm homicide rates were very high in many cities, seemingly related to the crack cocaine epidemic.[37, 38] Nevertheless, when we restrict the analysis to the period 2000–2016, our results remain essentially unchanged, although the precision of the estimates decreases.

Third, we accounted only for the presence or absence of firearm law provisions, not for the implementation and enforcement of these laws. Fourth, trying to incorporate the most important explanatory variables in a large regression almost invariably leads to some multicollinearity. For example, when we use all the other independent variables to explain variations in the gun ownership proxy, the adjusted R^2 is 0.69.

Finally, we do not disaggregate homicide rates by the age or other characteristics of either the offender or victim, which could mask the effect of laws intended to affect a particular subpopulation. For example, age restrictions on gun possession would only be expected to affect youth suicide rates, not adult rates.

In conclusion, this study provides evidence that universal background checks and laws prohibiting gun ownership by people with a history of a violent misdemeanor are associated with lower overall homicide rates, while laws that provide no discretion to law enforcement officials in approving concealed carry permits are associated with higher homicide rates. Further research on the impact of state firearm laws is necessary to assess causality and should rely upon detailed definitions of each law.

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