Suicide Rates and State Laws Regulating Access and Exposure to Handguns

Michael D. Anestis, PhD, and Joye C. Anestis, PhD

Objectives. Using previous research, we examined the impact of 4 handgun laws (waiting periods, universal background checks, gun locks, and open carrying regulations) on suicide rates.

Methods. We used publicly available databases to collect information on statewide laws, suicide rates, and demographic characteristics for 2013.

Results. Each law was associated with significantly lower firearm suicide rates and the proportion of suicides resulting from firearms. In addition, each law, except for that which required a waiting period, was associated with a lower overall suicide rate. Follow-up analyses showed a significant indirect effect on overall suicide rates through the proportion of suicides by firearms, indicating that the reduced overall suicide rate was attributable to fewer suicide attempts, fewer handguns in the home, suicide attempts using less lethal means, or a combination of these factors. States that implemented any of these laws saw a decreased suicide rate in subsequent years, whereas the only state that repealed 1 of these laws saw an increased suicide rate.

Conclusions. Our results were supportive of a potentially vital role in suicide prevention for state legislation that limits access and exposure to handguns. (*Am J Public Health.* 2015;105:2049–2058. doi:10.2105/AJPH.2015.302753)

In 2013, a total of 41 149 individuals died by suicide in the United States, which resulted in a rate of 13.02 per 100 000 people.[1] By comparison, in 2012, 10.7 per 100 000 individuals died in traffic accidents.[2] More than half of the deaths by suicide (51.5%) resulted from self-inflicted gunshot wounds, despite the fact that less than 5% of all self-harm episodes (nonsuicidal self-injury and suicide) reported that year involved firearms.[1] Despite the fact that firearms are used in such a small percentage of self-harm incidents, the 2013 US firearms suicide rate was 6.7 per 100 000 individuals, meaning that the number of individuals who died by suicide by this 1 specific method was more than half the total number of individuals who died in traffic accidents. This discrepancy highlights the high lethality of firearms.[3,4] Previous studies have reported lethality rates ranging from 82.5% to 92% for this method.[5,6]

Because of the high likelihood of death in any suicide attempt involving firearms, the potential utility of means restriction in suicide prevention efforts is clear. Previous research has supported the notion that restricting access to firearms is associated with reduced suicide rates both in the United States[7,8] and abroad.[9] Means restriction can take many forms, including microlevel approaches, such as family members removing a gun from the home, and macrolevel approaches, such as legislation that delays or prevents the acquisition of a gun. Firearms legislation is a politically charged issue; however, previous research has demonstrated that laws restricting access to firearms are associated with a reduction in firearms suicides[10–12] and in the overall suicide rate[13–15] in the United States.

Recently, Anestis et al.[16] demonstrated that several state laws regulating the ownership of handguns were associated with lower overall suicide rates, lower firearm suicide rates, and a lower proportion of suicides accounted for by firearms in 2010. These authors also reported that reductions in overall suicide rates were largely accounted for by the lower proportion of suicides resulting from firearms in states with the laws in place, indicating that individuals in such states attempted suicide less often, attempted using less lethal means, or both. Many researchers conceptualized the percentage of suicide deaths resulting from firearms to be a strong proxy measure of overall gun ownership,[17] which raised the possibility that the results from Anestis et al[16] were largely explained by a simple reduction in privately owned firearms in states with such laws in place. Lastly, Anestis et al. also reported that states that instituted such laws exhibited decreased suicide rates in the years following implementation, whereas other states saw a continued rise in their suicide rates. That final point mitigated concerns that the between group differences simply reflected the implementation of firearms legislation in states that would have had lower suicide rates independent of such laws.

In their article, Anestis et al.[16] focused on 3 laws: the requirement of (1) a permit to purchase a handgun, (2) a license to own a handgun, and (3) registration of handguns once purchased. The authors noted that these laws were tracked on a state-by-state basis by the National Rifle Association[18] and, as such, they assumed that examining such laws would minimize concerns that they selected laws arbitrarily, which could have spuriously influenced results in a manner that favored legislation regulating handgun ownership. Although minimizing potential bias has clear value, a case could be made that these laws—despite their robust associations with overall suicide rates—do not represent optimal choices, because they do not all involve limiting access or minimizing exposure to handguns. Among the laws tracked on a state-by-state basis by the Law Center to Prevent Gun Violence (LCPGV),[19] legislation that requires a waiting period to obtain a handgun, mandatory background checks before the purchase of a handgun, and gun locks on purchased handguns, as well as legislation that regulates the open carrying of handguns seem more likely to directly affect the frequency with which individuals are exposed to and the ease with which they can

acquire and use handguns. Because theoretical and empirical work that demonstrated that increased access to and familiarity with highly lethal means could facilitate the transition from suicidal ideation to suicidal behavior,[20,21] the degree to which legislation affected these specific variables appeared to be a vital consideration.

In an effort to expand upon the findings of Anestis et al.,[16] we thus aimed to examine whether overall suicide rates, firearm suicide rates, and the proportion of suicide deaths that resulted from firearms were lower in states that had laws in place involving (1) a waiting period for completing handgun purchases, (2) mandatory background checks at the point of transfer or before acquiring a permit to purchase from private sellers, (3) a requirement that privately owned handguns be locked at least in some circumstances, and (4) the restriction of the open carrying of handguns in 2013 (the most recent year for which suicide data are currently available). To test the specificity of the effects, we examined these relationships while controlling for the effects of statewide poverty levels, population density, statewide education levels, race/ethnicity, and age. We further examined whether there was a significant indirect effect of each of these laws on overall suicide rates through the proportion of suicide deaths resulting from firearms, which would indicate that such legislation was associated with fewer suicide attempts, the use of less lethal means during suicide attempts, fewer handguns in the home, or some combination of these variables. We also anticipated that states that implemented any of the 4 laws during the time period for which data were available would exhibit decreased suicide rates in the following years, whereas states that repealed any of the 4 laws would see increased suicide rates.

However, considering the impact of firearm legislation on suicide deaths in isolation did not allow for a broader comparison of the impact of legislation in general on problematic behaviors and subsequent death rates. Because of the controversial nature of gun legislation in the United States, an effort to understand the impact of such legislation relative to similar legislation on other behaviors might serve to facilitate a clearer understanding of the utility of this particular form of means restriction. As such, in an effort to provide context for our findings, we sought to compare the association between our selected firearms laws and suicide rates to the association among 3 laws that regulate driving behavior (primary enforcement of seat belt use, restriction of handheld cellular phone use, and primary enforcement of text messaging while driving) on traffic deaths. We selected these traffic laws because of their noncontroversial nature and their intuitive appeal as legislative methods for reducing traffic deaths. Should our results prove consistent with our hypotheses, this would indicate that state laws that restrict exposure and access to handguns are robustly associated with overall suicide rates—not just firearm suicides—thereby indicating a potentially vital role for state governments in suicide prevention efforts through targeted legislation.

METHODS

We gathered data on statewide suicide rates (overall and firearms related) from the Web-based Injury Statistics Query and Reporting System (WISQARS), which is developed and made publically available by the Centers for Disease Control and Prevention.[1] Data in this system are derived from the National Center for Health Statistics. The online reporting system allows users access to national and statewide data related to fatal injuries. Individuals can specify suicide as the intent of the injury and can also select the method by which the individual died (e.g., firearms). Our analyses used data from 2013, which was the most recent year available at the time of data extraction.

We obtained data on firearm laws from the LCPGV.[19] The LCPGV is a nonprofit organization run by attorneys that provides an online database of state and national laws related to various aspects of firearm sales and ownership. Users can sort by law or state, and each subsection contains detailed descriptions of laws and references to specific statutes relevant to the topic being examined. We used this site to determine which states had laws in place that (1) required a waiting period for completing handgun purchases, (2) required background checks at the point of transfer or before acquiring a permit to purchase a handgun from a private seller, (3) required that handguns be locked at least during certain circumstances, and (4) regulated the open carrying of handguns. In addition, the LCPGV informed us that they have been tracking changes in state laws regulating firearms ownership since 2009 and provided us with their data. From that data, we extracted data relevant to the 4 laws tracked within this article.

We gathered data for our analyses that examined the association among state legislation of driving behavior on traffic fatalities from 2 sources. We acquired information regarding laws (primary enforcement of seat belt utilization, regulation of handheld cellular phone usage, and primary enforcement of text messaging while driving) from the Web site for the Governors Highway Safety Association.[22] We derived information on state-by-state traffic fatality rates from the Web site for the Insurance Institute for Highway Safety and the Highway Loss Data Institute.[2]

In an effort to control for potential confounders and to increase confidence in the specificity of our effects, we used 2013 numbers to control for the percentage of each state that was under the poverty line, the percentage of state residents older than 25 years who had a college degree, the percentage of the state that was White, the median age of state residents, and statewide population density. We obtained data regarding poverty rates from the Congressional Research Service.[23] We gathered data regarding population density, education, age, and race/ethnicity from the United States Census Bureau.[24]

We used analyses of covariance (ANCOVAs) to test the association among state laws that regulated exposure and access to handgun and suicide-related outcomes (overall suicide rate, firearm suicide rate, and proportion of suicide deaths accounted for by firearms) while we controlled for poverty, population density, education, race/ethnicity, and age. For each law, we examined between-group differences on each of the 3 suicide-related outcomes, which resulted in a total of 12 ANCOVAs. We used partial η^2 as an index of effect size ($_p\eta^2$; small = 0.01, medium = 0.06, large = 0.14).[25] All rates derived from our between-group analyses were presented as aggregate rather than average rates.

We used bootstrapping methods (10 000 resamples, 95% bias-corrected confidence

intervals) to test for the significance of the indirect effect of each state law on overall suicide rates through the proportion of suicide deaths caused by firearms. We used the ratio of the indirect effect to the total effect and κ^2 as indexes of the effect size (small = 0.01, medium = 0.09, large = 0.25).[26]

We also used a series of ANCOVAs to test the association among state laws that regulate driving behavior on statewide traffic fatalities. For this set of analyses, we used a total of 3 ANCOVAs, 1 for each law (primary enforcement of seat belt use, regulation of handheld cellular phone use, and primary enforcement of texting while driving), with traffic fatality rate serving as the dependent variable in all 3 cases. The same covariates were used as in our analyses that examined suicide-related outcomes. We used ${}_p\eta^2$ as the index of effect size.

RESULTS

State-by-state information regarding law status, suicide rates (overall, firearms, percentage of firearms), and population are shown in Table 1.

Suicide-Related Outcomes

Waiting periods. Results indicated that states with a law in place that required a waiting period for the completion of handgun sales exhibited a lower overall suicide rate (11.45 vs 15.72; $F = 12.51$; $P = .001$; $R^2 = 0.20$; ${}_p\eta 2 = 0.20$), a lower firearms suicide rate (4.43 vs 8.98; $F = 20.23$; $P < .001$; $R^2 = 0.29$; ${}_p\eta^2 = 0.29$), and a lower proportion of suicide deaths resulting from firearms (35.8% vs 55.8%; $F = 20.72$; $P < .001$; $R^2 = 0.30$; ${}_p\eta^2 = 0.30$). After controlling for the effects of poverty, population density, age, education, and race/ethnicity, states with such laws in place still exhibited a lower firearms suicide rate (6.14 vs 8.51; $F = 6.06$; $P = .018$; $R^2 = 0.60$; ${}_p\eta^2 = 0.12$) and a lower proportion of suicides by firearms (45.9% vs 53.0%; $F = 4.44$; $P = .041$; $R^2 = 0.74$; ${}_p\eta^2 = 0.09$), but the difference on overall suicide rate became nonsignificant (13.02 vs 15.29; $F = 3.08$; $P = .086$; $R^2 = 0.43$; ${}_p\eta^2 = 0.07$). These results are listed in Tables 2 and 3.

Furthermore, in the 11 states in which waiting periods were required, the length of the waiting period was significantly correlated with the firearm suicide rate ($r = -0.73$; $P = .01$) and the proportion of suicides resulting from firearms ($r = -0.70$; $P = .02$). Although not statistically significant, the correlation between the waiting period and overall suicide rate was fairly high ($r = -0.49$; $P = .13$).

Universal background checks. Our results indicated that states with a law in place that required universal background checks at the point of transfer or before obtaining a permit to purchase a handgun from a private seller exhibited a lower overall suicide rate (11.42 vs 16.49; $F = 29.49$; $P < .001$; $R^2 = 0.38$; ${}_p\eta^2 = 0.38$), a lower firearms suicide rate (4.53 vs 9.74; $F = 49.41$; $P < .001$; $R^2 = 0.50$; ${}_p\eta^2 = 0.50$), and a lower proportion of suicide deaths resulting from firearms (36.8% vs 58.8%; $F = 44.13$; $P < .001$; $R^2 = 0.47$; ${}_p\eta^2 = 0.47$). Our results were unchanged after accounting for the effects of poverty, population density, age, education, and race/ethnicity, because states with such laws in place exhibited lower overall suicide rates (12.45 vs 15.97; $F = 10.16$; $P = .003$; $R^2 = 0.51$; ${}_p\eta^2 = 0.19$), lower firearm suicide rates (5.90 vs 9.05; $F = 15.14$; $P < .001$; $R^2 = 0.67$; ${}_p\eta^2 = 0.26$), and a lower proportion of suicides by firearms (44.9% vs 54.8%; $F = 11.58$; $P = .001$; $R^2 = 0.77$; ${}_p\eta^2 = 0.21$). These results are listed in Tables 2 and 3.

Gun locks. Our results indicated that states with a law in place that required handguns be locked at least in certain circumstances exhibited a lower overall suicide rate (9.20 vs 15.28; $F = 10.42$; $P = .002$; $R^2 = 0.18$; ${}_p\eta^2 = 0.18$), a lower firearms suicide rate (2.68 vs 8.45; $F = 12.32$; $P = .001$; $R^2 = 0.20$; ${}_p\eta^2 = 0.20$), and a lower proportion of suicide deaths resulting from firearms (28.5% vs 53.4%; $F = 12.05$; $P = .001$; $R^2 = 0.20$; ${}_p\eta^2 = 0.20$). Results were unchanged after accounting for the effects of poverty, population density, age, education, and race/ethnicity, because states with such laws in place exhibited lower overall suicide rates (11.04 vs 15.12; $F = 5.15$; $P = .028$; $R^2 = 0.46$; ${}_p\eta^2 = 0.11$), lower firearms suicide rates (5.17 vs 8.24; $F = 4.96$; $P = .031$; $R^2 = 0.60$; ${}_p\eta^2 = 0.10$), and a lower proportion of suicides by firearms (38.9% vs 52.6%; $F = 8.72$; $P = .005$; $R^2 = 0.76$; ${}_p\eta^2 = 0.17$). These results are listed in Tables 2 and 3.

Restriction of open carrying of handguns. Our results indicated that states with a law in place restricting the open carrying of handguns exhibited a lower overall suicide rate (12.16 vs 16.50; $F = 20.61$; $P < .001$; $R^2 = 0.30$; ${}_p\eta^2 = 0.30$), lower firearms suicide rate (5.58 vs 9.56; $F = 22.58$; $P < .001$; $R^2 = 0.32$; ${}_p\eta^2 = 0.32$), and lower proportion of suicide deaths resulting from firearms (42.1% vs 57.5%; $F = 16.33$; $P < .001$; $R^2 = 0.25$; ${}_p\eta^2 = 0.25$). Results were unchanged after accounting for the effects of poverty, population density, age, education, and race/ethnicity, as states with such laws in place exhibited lower overall suicide rates (12.96 vs 15.99; $F = 9.95$; $P = .003$; $R^2 = 0.50$; ${}_p\eta^2 = 0.18$), lower firearms suicide rates (6.55 vs 8.93; $F = 10.68$; $P = .002$; $R^2 = 0.64$; ${}_p\eta^2 = 0.20$) and lower proportion of suicides by firearms (47.5% vs 54.1%; $F = 6.26$; $P = .016$; $R^2 = 0.75$; ${}_p\eta^2 = 0.13$). These results are listed in Tables 2 and 3.

Association of State Laws and Suicide Rates

Test of indirect effect through proportion of suicide deaths accounted for by firearms. Our results indicated that, for all 4 laws, there was a significant indirect effect of the law on the overall state suicide rate through the proportion of suicide deaths accounted for by firearms (95% confidence intervals = < 4.28– < 0.47; $\kappa^2 > 0.25$). In each case, there was a significant total effect of the law on the overall suicide rate ($b < -4.28$; $P < .002$). Both laws requiring mandatory background checks ($b = -2.77$; $P = .026$) and laws restricting the open carrying of handguns ($b = -2.42$; $P = .016$) also exhibited significant direct effects on the overall suicide rate. These results are listed in Table 4.

Longitudinal association. Based upon data provided by the LCPGV, only 4 states implemented or repealed any of these 4 laws during the period for which data were available (2009–2013). Specifically, South Dakota (2009) repealed a required 48-hour waiting period to purchase a handgun, California (2011) restricted the open carrying of handguns, the District of Columbia (2011) extended their waiting period such that it began at the time of purchase rather than the time of application, and Oklahoma (2012) instituted a requirement that individuals obtain a concealed carry permit to openly carry a handgun. The small number of changes precluded the use of our statistical models that examined the

TABLE 1—Law Status, Suicide Rates, and Population by State: Suicide Rates and State Laws Regulating Handguns, United States, 2013

State	Waiting Period	Background Check	Gun Lock	Open Carry	2013 Population	2013 Suicide Rate	Suicide Rate Rank	Suicide by Firearm (%)
Alabama	No	No	No	No	4 833 722	14.92	22	70
Alaska	No	No	No	No	735 132	23.26	2	70
Arizona	No	No	No	No	6 626 624	17.55	13	56
Arkansas	No	No	No	No	2 959 373	17.44	14	62
California	Yes	Yes	Yes	Yes	38 332 521	10.50	44	39
Colorado	No	Yes	No	No	5 268 367	19.11	8	49
Connecticut	No	Yes	Yes	Yes	3 596 080	9.18	47	28
Delaware	No	Yes	No	No	925 749	13.18	32	49
District of Columbia	Yes	Yes	No	Yes	646 449	5.88	51	0
Florida	Yes	No	No	Yes	19 552 860	14.97	21	53
Georgia	No	No	No	Yes	9 992 167	12.13	41	62
Hawaii	Yes	Yes	No	Yes	1 404 054	12.18	40	16
Idaho	No	No	No	No	1 612 136	19.77	6	65
Illinois	Yes	Yes	No	Yes	12 882 135	10.25	45	38
Indiana	No	No	No	Yes	6 570 902	14.37	27	55
Iowa	Yes	Yes	No	Yes	3 090 416	14.16	28	49
Kansas	No	No	No	No	2 893 957	14.69	25	57
Kentucky	No	No	No	No	4 395 295	15.95	18	65
Louisiana	No	No	No	No	4 625 470	12.60	37	70
Maine	No	No	No	No	1 328 302	18.44	9	56
Maryland	Yes	Yes	No	Yes	5 928 814	9.60	46	45
Massachusetts	No	Yes	Yes	Yes	6.692,824	8.55	49	20
Michigan	No	Yes	No	No	9 895 622	13.09	33	52
Minnesota	Yes	No	No	Yes	5 420 380	12.51	39	50
Mississippi	No	No	No	No	2 991 207	12.97	36	72
Missouri	No	No	No	No	6 044 171	15.88	19	58
Montana	No	No	No	No	1 015 165	23.94	1	60
Nebraska	No	Yes	No	No	1 868 516	11.77	42	50
Nevada	No	No	No	No	2 790 136	19.39	7	54
New Hampshire	No	No	No	No	1 323 459	13.98	30	44
New Jersey	Yes	Yes	No	Yes	8 899 339	8.51	50	26
New Mexico	No	No	No	No	2 085 287	20.67	4	52
New York	No	Yes	Yes	Yes	19 651 127	8.58	48	28
North Carolina	No	Yes	No	No	9 848 060	13.04	34	60
North Dakota	No	No	No	No	723 393	17.69	12	59
Ohio	No	No	No	No	11 570 808	13.19	31	52
Oklahoma	No	No	No	Yes	3 850 568	17.27	17	65
Oregon	No	No	No	No	3 930 065	17.76	11	56
Pennsylvania	No	Yes	No	No	12 773 801	14.00	29	51
Rhode Island	Yes	Yes	No	Yes	1 051 511	12.55	38	26
South Carolina	No	No	No	Yes	4 774 839	14.58	26	68
South Dakota	No	No	No	No	844 877	17.40	16	48
Tennessee	No	No	No	Yes	6 495 978	15.86	20	66
Texas	No	No	No	Yes	26 448 193	11.57	43	58
Utah	No	No	No	Yes	2 900 872	19.96	5	51
Vermont	No	No	No	No	626 630	17.86	10	53
Virginia	No	No	No	No	8 260 405	12.98	35	56

Continued

TABLE 1—*Continued*

Washington	No	No	No	No	6 971 406	14.73	24	47
West Virginia	No	No	No	No	1 854 304	17.42	15	70
Wisconsin	Yes	No	No	No	5 742 713	14.80	23	51
Wyoming	No	No	No	No	582 658	22.14	3	69

Note. Background check = law in place requiring universal background checks at the point of transfer or before obtaining a permit to purchase a handgun from a private seller; gun lock = law in place requiring purchased handguns to be locked at least in some circumstances; open carry = law in place prohibiting open carrying of handguns or requiring a permit for the open carrying of handguns; suicide rate rank = ranking of overall suicide rate relative to other states, with lower numbers indicative of higher suicide rates; waiting period = law in place requiring waiting period for completion of handgun sales.

significance of changes; however, we still observed trends consistent with our hypotheses.

In the year immediately following the repeal of their waiting period law, South Dakota saw a 7.6% increase in its overall suicide rate compared with 3.3% for the United States in general. Between 2009 and 2013, South Dakota saw an increase of 8.9% in its suicide rate compared with 8.2% for the United States in general. In the year following implementation of their law restricting open carry, California saw a 3.5% decrease in their overall suicide rate compared with a 2.1% increase in the United States in general. Between 2011 and 2013, California saw an overall decrease of 1.0% in their overall suicide rate compared with a 2.7% increase in the United States overall. In the year following implementation of a law that extended the waiting period for acquiring a handgun, DC saw a 2.2% decrease in their overall suicide rate compared with a 2.1% increase in the United States overall. Between 2011 and 2013, DC saw a 1.5% decrease in their overall suicide rate compared with a 2.7% increase in the United States overall. Lastly, in prior year following the implementation of a law that required a concealed carry permit to openly carry a handgun, Oklahoma saw a 1.7% decrease in their overall suicide rate compared with a 0.6% increase in the United States overall. This law was implemented in 2012, and as such, no additional longitudinal data are currently available. These results are listed in Table 5.

TABLE 2—Suicide Rates in States With and Without Specific Handgun Legislation in Place: Suicide Rates and State Laws Regulating Handguns, United States, 2013

Variable	No.	Statewide Suicide Rate for 2013, Mean (SD)	Statewide Suicide by Firearm Rate for 2013, Mean (SD)	Statewide Deaths by Firearms for 2010, %, Mean (SD)
Waiting period				
Yes	11	11.45 (2.82)	4.43 (2.57)	35.8 (17.1)
No	40	15.72 (3.72)	8.98 (3.07)	55.8 (11.6)
Background check				
Yes	17	11.42 (3.06)	4.53 (2.62)	36.8 (16.2)
No	34	16.49 (3.18)	9.74 (2.43)	58.8 (7.6)
Open carry restricted				
Yes	20	12.16 (3.44)	5.58 (3.38)	42.1 (18.9)
No	31	16.50 (3.27)	9.56 (2.60)	57.5 (8.0)
Gun lock required				
Yes	4	9.20 (0.91)	2.68 (1.02)	28.5 (8.0)
No	47	15.28 (3.72)	8.45 (3.25)	53.4 (14.1)

Note. Statewide suicide rates (total and by firearms) are presented as number of individuals per 100 000. Information on laws was compiled from the Law Center to Prevent Gun Violence. Information on suicide deaths was compiled from the Centers for Disease and Control Prevention.

Laws Regulating Driving Behavior and Traffic Fatalities

Our results indicated that after controlling for population density, poverty, education, race/ethnicity, and age, states with and without a law in place involving primary enforcement of seat belt use did not differ on statewide traffic fatality rates (11.80 vs 12.51; $F=1.94$; $P=.171$; $R^2=0.55$; ${}_p\eta^2=0.04$). Similarly, states with and without a law in place involving the regulation of handheld cellular phone use while driving did not differ on statewide traffic fatality rates (10.54 vs 12.93; $F=0.19$; $P=.665$; $R^2=0.53$; ${}_p\eta^2=0.00$). Lastly, our results indicated that states with and without a law in place involving primary enforcement banning text messaging while driving did not differ on statewide traffic fatality rates (11.36 vs 14.48; $F=0.55$; $P=.481$; $R^2=0.53$; ${}_p\eta^2=0.01$). These results are listed in Table 6.

DISCUSSION

Our primary aim of this research was to explore the extent to which legislation limiting access and exposure to handguns (waiting period for completing handgun purchases, mandatory background checks, gun locks, and open carry restrictions) affected suicide rates (overall rates, firearm suicide rates, and the proportion of suicide deaths resulting from firearms). We also sought to place the findings in context by examining the impact of other legislation aimed at increasing public safety and decreasing death (i.e., 3 laws that regulate driving behavior: primary enforcement of seat belt use, restriction of handheld cellular phone use, and primary enforcement of text

TABLE 3—State Laws Regulating Handgun Ownership and Their Association With Suicide-Related Outcomes, Controlling for Demographic and Clinical Characteristics: Suicide Rates and State Laws Regulating Handguns, United States, 2013

Variable	Statewide Suicide Rate for 2013			Statewide Suicide by Firearm Rate for 2013			Statewide Proportion of Suicide Deaths by Firearms for 2013		
	R^2	b (95% CI)	$_p\eta^2$	R^2	b (95% CI)	$_p\eta^2$	R^2	b (95% CI)	$_p\eta^2$
Set–waiting period	0.43			0.60			0.74		
Population density		0.000 (−0.001, 0.001)	0.00		0.000 (0.000, 0.001)	0.01		0.000 (0.000, 0.000)	0.02
% of state below poverty line		−0.211 (−0.633, 0.211)	0.02		−0.112 (−0.425, 0.201)	0.01		0.005 (−0.006, 0.016)	0.02
% aged > 25 y with college degree		−0.293* (−0.582, 0.003)	0.09		−0.360** (−0.574, 0.145)	0.21		−0.014** (−0.021, 0.006)	0.23
% White		0.057 (−0.012, 0.126)	0.06		0.054* (0.003, 0.105)	0.09		0.002* (0.000, 0.004)	0.11
Median age		−0.318 (−0.727, 0.091)	0.05		−0.298 (−0.602, 0.005)	0.08		−0.011* (−0.022, 0.000)	0.09
Waiting period		2.271 (−0.339, 4.881)	0.07		2.366* (0.430, 4.303)	0.12		0.072* (0.003, 0.140)	0.09
Set–background check	0.51			0.67			0.77		
Population density		0.000 (−0.001, 0.001)	0.00		0.000 (−0.001, 0.001)	0.00		0.000 (0.000, 0.000)	0.06
% of state below poverty line		−0.187 (−0.565, 0.191)	0.02		−0.074 (−0.351, 0.203)	0.01		0.006 (−0.004, 0.016)	0.03
% aged > 25 y with college degree		−0.169 (−0.445, 0.108)	0.03		−0.245* (−0.448, 0.043)	0.12		−0.010** (−0.017, 0.003)	0.15
% White		0.046 (−0.018, 0.109)	0.05		0.047* (0.001, 0.094)	0.09		0.002* (0.000, 0.003)	0.10
Median age		−0.254 (−0.637, 0.129)	0.04		−0.253 (−0.533, 0.028)	0.07		−0.009 (−0.019, 0.001)	0.07
Background check		3.519** (1.294, 5.744)	0.19		3.146*** (1.517, 4.775)	0.26		0.099** (0.040, 0.157)	0.21
Set–open carry restricted	0.50			0.64			0.75		
Population density		0.000 (−0.001, 0.001)	0.00		0.000 (−0.001, 0.001)	0.00		0.000 (0.000, 0.000)	0.05
% of state below poverty line		−0.136 (−0.511, 0.239)	0.01		−0.024 (−0.309, 0.261)	0.00		0.008 (−0.003, 0.018)	0.05
% aged > 25 y with college degree		−0.215 (−0.486, 0.057)	0.05		−0.292** (−0.499, 0.086)	0.16		−0.012** (−0.019, 0.004)	0.18
% White		0.051 (−0.011, 0.114)	0.06		0.055* (0.008, 0.103)	0.11		0.002* (0.000, 0.004)	0.12
Median age		−0.414* (−0.787, 0.040)	0.10		−0.394** (−0.677, 0.110)	0.15		−0.014* (−0.024, 0.003)	0.14
Open carry restricted		3.025** (1.092, 4.957)	0.18		2.381** (0.912, 3.850)	0.20		0.066 * (0.013, 0.120)	0.13
Set–gun lock required	0.46			0.60			0.76		
Population density		−0.001 (−0.002, 0.001)	0.03		0.000 (−0.001, 0.001)	0.01		0.000 (0.000, 0.000)	0.12
% of state below poverty line		−0.024 (−0.421, 0.374)	0.00		0.062 (−0.243, 0.367)	0.00		0.011* (0.001, 0.021)	0.10
% aged > 25 y with college degree		−0.144 (−0.448, 0.160)	0.02		−0.241* (−0.474, 0.008)	0.09		−0.009* (−0.016, 0.001)	0.10
% White		0.072* (0.009, 0.135)	0.11		0.072** (0.024, 0.120)	0.17		0.002** (0.001, 0.004)	0.18
Median age		−0.356 (−0.748, 0.037)	0.07		−0.349* (−0.650, 0.048)	0.11		−0.012* (−0.022, 0.002)	0.12
Gun lock required		4.085* (0.456, 7.713)	0.11		3.073* (0.291, 5.855)	0.10		0.137** (0.043, 0.230)	0.17

Note. CI = confidence interval. All demographic and clinical characteristics refer to status and numbers from 2013. Information on laws was compiled from the Law Center to Prevent Gun Violence.
Source. Information on suicide deaths was compiled from the Centers for Disease and Control Prevention. Information on poverty and population density was compiled from the US Census Bureau.
*$P < .05$; **$P < .01$; ***$P < .001$.

TABLE 4—Indirect Effect of Handgun Legislation on Overall Suicide Rate Through the Proportion of Suicide Deaths Resulting From Firearms: Suicide Rates and State Laws Regulating Handguns, United States, 2013

Independent Variable[a]	R^2	Coefficient (SE; *P*) or Bootstrap Coefficient (SE; 95% CI)	Ratio, Indirect:Total	κ^2
Waiting period	0.42		0.67	0.29
Total		−4.28 (1.21; .001)		
Direct path		−1.42 (1.25; .261)		
Indirect path		−2.86 (0.93; −5.30, −1.42)		
Background check	0.46		0.45	0.26
Total		−5.07 (0.93; < .001)		
Direct path		−2.77 (1.21; .026)		
Indirect path		−2.30 (0.89; −4.28, −0.73)		
Open carry	0.29		0.44	0.25
Total		−4.35 (0.96; < .001)		
Direct path		−2.42 (0.97; .016)		
Indirect path		−1.93 (0.69; −4.36, −0.47)		
Gun lock	0.18		0.59	0.25
Total		−6.07 (1.88; .002)		
Direct path		−2.47 (1.77; .169)		
Indirect path		−0.3.60 (1.01; −6.06, −1.93)		

Note. CI = confidence interval.
Source. Information on laws was compiled from the Law Center to Prevent Gun Violence. Information on suicide deaths was compiled from the Centers for Disease and Control Prevention.
[a]The dependent variable was statewide suicide rate.

messaging while driving). The results largely supported our hypotheses.

All 4 pieces of legislation were associated with a lower overall rate of suicide, lower rates of suicide by firearm, and a lower proportion of suicide deaths by firearms at the univariate level. After controlling for an extensive list of covariates, 11 of our 12 planned comparisons remained significant. The 1 exception was the association between waiting periods and overall suicide rates (13.02 vs 15.29; $P = .086$; ${}_p\eta^2 = 0.07$). That being said, the effect size for that analysis was medium, which might indicate that the statistical power (only 50 states plus DC were available for these analyses) affected the result. Effects sizes for several of the other 11 analyses were classified as large, which indicated that these 4 laws were associated with a robust difference in several suicide-related outcomes.

TABLE 5—Longitudinal Trends in Suicide Rates in States That Implemented or Repealed Any of the Laws During the Period for Which Data Were Available: Suicide Rates and State Laws Regulating Handguns, United States, 2013

State	Law Change	% Change in Suicide Rate (% US Overall Change)	
		1 Year After Law Change	Year of Law Change Through 2013
California	Restrict open carry	−3.5 (2.1)	−1.0 (2.7)
DC	Extend waiting period	−2.2 (2.1)	−1.5 (2.7)
Oklahoma	Restrict open carry	−1.7 (0.6)	−1.7% (0.6)
South Dakota	Repeal waiting period	7.6 (3.3)	8.9 (8.2)

Source. Information regarding changes in laws was acquired from the Law Center to Prevent Gun Violence. Data on suicide rates were acquired from the Centers for Disease Control and Prevention.

Data on the length of waiting periods were also available, which allowed for a more fine-tuned analysis of this particular law. In the 11 states with waiting periods, we observed large negative correlations between suicide outcome and the length of the waiting period, such that the longer the waiting period, the lower the firearm suicide rate and the proportions of suicides resulting from firearms. In these 11 states, a large negative correlation was also observed between the length of waiting period and the overall suicide rate, although it did not reach statistical significance; again, this was likely because of the sample size. Each of the laws demonstrated a significant indirect effect on overall suicide rates through the proportion of suicide deaths caused by firearms and a significant total effect of the law on the overall suicide rate.

The potent effects of the 4 pieces of legislation examined here gained more resonance when translated into probabilities (for our purposes, by using the common language [CL] statistic). For legislation on waiting periods, in 82% of pairings between a state with waiting period requirements and a state without such requirements, the statewide suicide rate would be lower in the state that required waiting periods. The same probability applied to open carry restrictions (CL = 0.82). For mandatory background checks, the probability was 87.5% that the statewide suicide rate would be lower in a state with a background check law, relative to a state without such a law. In 94.4% of pairings, the statewide suicide rates would be lower in a state with gun lock requirements. In addition, Anestis et al.[16] determined that legislation regarding gun ownership had a strong relationship with overall suicide rates, rates of firearm suicides, and the proportion of suicide deaths accounted for by firearms. They found medium effect sizes for laws that required registration of purchased permits, medium to large effect sizes for laws that required a license to purchase handguns, and large effect sizes for laws that required a permit to purchase handguns. Although there are well-documented problems with depending on the benchmarks for interpreting effect sizes,[27,28] we pointed out that the size of the effects of the 4 laws examined in the present study were uniformly

TABLE 6—Traffic Death Rates in States With and Without Specific Legislation in Place Regulating Particular Driving Behaviors: Suicide Rates and State Laws Regulating Handguns, United States, 2013

Variable	No.	Traffic Death Rate, Mean ±SD or b (95% CI)	$_p\eta^2$	R^2
Seat belt				
Yes	34	11.80 ±4.60		0.55
No	17	12.51 ±5.20		
Predictors				
Population density		0.001 (−0.001, 0.002)	0.02	
% of state below poverty line		0.220 (−0.219, 0.658)	0.02	
% aged > 25 y with college degree		−0.572** (−0.890, 0.253)	0.23	
% White		0.031 (−0.044, 0.106)	0.02	
Median age		−0.014 (−0.463, 0.436)	0.00	
Seat belt		1.640 (−0.733, 4.013)	0.04	
Hands-free				
Yes	19	10.54 ±4.90		0.53
No	32	12.93 ±4.56		
Predictors				
Population density		0.000 (−0.001, 0.002)	0.01	
% of state below poverty line		0.189 (−0.259, 0.637)	0.02	
% aged > 25 y with college degree		−0.537** (−0.848, 0.216)	0.21	
% White		0.043 (−0.034, 0.121)	0.03	
Median age		−0.056 (−0.525, 0.412)	0.00	
Seat belt		0.510 (−1.849, 2.869)	0.00	
No texting				
Yes	40	11.36 ±4.92		0.53
No	11	14.48 ±3.59		
Predictors				
Population density		0.000 (−0.001, 0.002)	0.01	
% of state below poverty line		0.183 (−0.263, 0.630)	0.02	
% aged > 25 y with college degree		−0.525** (−0.847, 0.203)	0.20	
% White		0.049 (−0.022, 0.120)	0.04	
Median age		−0.078 (−0.522, 0.366)	0.00	
Seat belt		0.888 (−1.631, 3.407)	0.01	

Note. CI = confidence interval; hands-free = law in place prohibiting the use of hand held cellular phones while driving; no texting = law in place requiring primary enforcement of prohibition of text messaging while driving; seat belt = law in place requiring primary enforcement of seat belt utilization. Statewide suicide rates (total and by firearms) are presented as number of individuals per 100 000. Reference to laws, % of state below poverty line, and population density refer to status and numbers from 2013.
Source. Information on laws was compiled from the Governors Highway Safety Association. Information on suicide deaths was compiled from the Centers for Disease Control and Prevention. Information on poverty and population density was compiled from the US Census Bureau.
**$P < .01$.

large and robust. This suggested that the some laws, particularly those that limited access and exposure, had more impact than others.

Although only 4 states enacted or repealed any of these 4 laws during the time for which data were available, these changes allowed us to take a preliminary look at longitudinal trends and mitigate concerns that might otherwise stem from our cross-sectional analyses. As anticipated, when states enacted 1 of the laws examined in this article, they saw immediate and lasting decreases in their statewide overall suicide rates. Importantly, this was in contrast to continued increases in suicide rates at the national level. Similarly, the 1 state that decreased regulation of handgun ownership—South Dakota—saw an immediate and lasting increase in its statewide suicide rate after repealing the requirement for a waiting period. Although the nation overall also saw increases during these periods, the increases in South Dakota exceeded that of the nation overall.

These results combined to paint a consistent picture that limiting access at the point of purchase (waiting periods, background checks), placing impediments to access after purchase (gun locks), and limiting day-to-day exposure (open carry) to handguns each affected death by suicide across methods. Taken together with previous studies,[7–9] it seemed apparent that such legislation had a profound impact on public safety. Although previous work in this area spoke to the impact of regulating gun ownership on suicide outcomes,[16] our findings suggested a mechanism of action, namely, means restriction. Restriction of lethal means is a well-established deterrent to suicidal behavior.[7–9,13–15] Because suicide by firearm is almost always deadly, these restrictions deter the use of one of the most deadly instruments of self-harm. Furthermore, some proposed that easy access to firearms and exposure to deadly means could enable an individual to quickly move from thinking about suicide to enacting suicidal behavior.[20,21] Limiting access and exposure then might slow down this transition in many individuals, thereby increasing the number of opportunities to intervene and mitigate risk. In short, these data made it evident that legislating access and exposure to firearms saves lives.

As noted earlier, however, examining the association between firearm legislation and suicide deaths in isolation did not allow for an understanding of how this relationship compared with the association between other laws that might theoretically impact death rates. A significant association that was substantially less robust than others might have less clinical value than the statistical significance might otherwise suggest. In an effort to address that potential limitation, we also conducted an analysis of the association among 3 largely noncontroversial laws regulating driving behavior—seat belt utilization (primary enforcement), handheld cellular phone use, and texting while driving (primary enforcement)—and traffic fatalities. Although difficult to quantify,

our sense was that these laws were largely supported because of a belief in their ability to decrease fatalities. The less robust association between these laws and traffic fatalities relative to the association between our selected handgun legislation and suicide deaths thus could serve to shift the tone of the conversation regarding handgun legislation. Specifically, it was logically problematic to argue for driving legislation and not firearms legislation because the effort to reduce fatalities when the data indicated the firearms legislation was substantially more useful in preventing deaths.

Although there might be other benefits to the traffic laws we selected (e.g., fewer traffic accidents, fewer injuries), these 3 laws were not associated with statistically significant differences in traffic fatalities after accounting for the same list of covariates we used in our primary analyses. In contrast, the 4 pieces of handgun legislation we examined were associated with a significant reduction in the number of lives lost annually to suicide in the United States. For example, the percentage of statewide suicide deaths by firearms dropped from 53.4% in states that did not have gun lock requirements to 28.5% in states with such requirements, which was a decrease of 24.9%. This was a substantial decrease that translated into many lives saved.

The results regarding driving behaviors might speak to the fact that legislation does not solve all problems, and we did not propose that it does. The behavior itself has to change, and legislation might have a more prominent role in prompting behavior change in some situations than in others. With seatbelts, texting while driving, and handheld cellular phone use, the behavior might change for other reasons, perhaps because people recognized the dangers differently, because the importance of these behaviors has been emphasized in the media for many years, or because of cultural norms that emphasized the protection of others' lives versus the reduction of suicide risk. The differential role of handgun versus traffic laws in these particular public health outcomes also might largely be driven by the manner in which the specific legislation targets behavior change. Handgun legislation might change behavior through limiting access and exposure to handguns, as opposed to altering private behavior through the threat of punishment. As such, there was likely a bigger role for government in affecting public health in the case of suicide.

Limitations

Our findings must be interpreted in light of its limitations. Other variables that could potentially be relevant to suicide-related outcomes at statewide levels (e.g., religiosity, prevalence of specific mental illnesses) were not included because of the difficulty in quantifying such variables. In addition, the Centers for Disease Control and Prevention did not make nonfatal injury data available at the statewide level, and as such, we were unable to determine the extent to which handgun legislation was associated with reductions in nonfatal suicidal behavior in addition to death by suicide. Such data would enable a clearer understanding of the mechanism of change by answering whether overall suicide rates were lower in states with handgun legislation in place because of a reduction in suicide attempts, a tendency to attempt suicide using less lethal means, or a combination of these 2 factors. It was also unclear to what extent having more than 1 of these laws or specific combinations of laws might have a more potent impact relative to having only 1 (or an alternative combination) in place. Because of issues of statistical power, such comparisons were difficult to implement; however, future work that considers this question would have clear value.

Conclusions

We believe this study has important implications for mental health practitioners and policymakers alike. These data suggest that means restriction, both at the point of purchase and after purchase, could have a profound effect on public safety, at least when applied to handguns. The costs of enacting the precautions examined here (waiting periods, background checks, open carry restrictions, gun locks) translated into numerous lives saved. Although we were certainly not the first authors to consider the association between firearms legislation and suicide, we believe our findings provided incremental value for a number of reasons. First, our data represented information that used the most recently available data, which ensured the findings applied to current situations and more recent laws. Second, our findings built upon recent work by considering laws with a clear potential mechanism for action—increasing the difficulty of accessing and decreasing the frequency of exposure to handguns—as opposed to recent work that examined laws based upon their importance to the National Rifle Association. Third, our analyses included both cross-sectional and longitudinal data, and used cutting edge model testing to consider both direct and indirect effects. Fourth, our analyses included far more covariates than other relevant studies, thereby enhancing confidence in the specificity of our findings. In summary, we believe our findings not only provided clear evidence for the importance of firearms legislation in suicide prevention efforts on a grand scale, but also provided a clear model for understanding the manner in which such laws exhibit such a robust impact. ■

About the Authors

Michael D. Anestis and Joye C. Anestis are with the University of Southern Mississippi, Hattiesburg.

Correspondence should be sent to Michael D. Anestis, PhD, Nina Bell Suggs Professor of Psychology, Department of Psychology, University of Southern Mississippi. 118 College Drive, Box #5025, Hattiesburg, MS 39406 (e-mail: michael.anestis@usm.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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Contributors

M. D. Anestis developed the initial study idea, performed the data extraction, ran the analyses, and wrote approximately 60% of the article. J. C. Anestis contributed ideas for several hypotheses and wrote approximately 40% of the article.

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