

Association Between Youth-Focused Firearm Laws and Youth Suicides

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SUICIDE IS THE THIRD LEADING cause of death among youth aged 10 to 19 years in the United States, accounting for 1883 deaths in 2001.¹ Firearms were used in approximately half of suicides within this age group in 2001; however, as recently as 1994, 7 of every 10 suicides among teenagers involved firearms.¹

Firearms are one of the most lethal methods of self-harm.² Case-control studies using community and clinical samples have consistently found that the presence of firearms in the home substantially increased the risk of adolescent suicide.³⁻⁷ In addition, a recent state-level study, using the ratio of firearm suicides to total suicides as a proxy for the prevalence of gun ownership, found that suicide rates among teenagers and adults are significantly higher in states with higher rates of gun ownership.⁸

Several firearm policies are intended to limit the access that underage youth have to firearms. Since 1968, federal law has required licensed firearms dealers to prohibit handgun sales to purchasers younger than 21 years. In 1994, a federal law established 18 years as the minimum legal age for possessing or purchasing handguns, including sales by gun owners who are not licensed dealers. Many states have also adopted laws establishing a minimum legal age for being able to purchase or possess a firearm. Another type

Context Firearms are used in approximately half of all youth suicides. Many state and federal laws include age-specific restrictions on the purchase, possession, or storage of firearms; however, the association between these laws and suicides among youth has not been carefully examined.

Objective To evaluate the association between youth-focused firearm laws and suicides among youth.

Design, Setting, and Participants Quasi-experimental design with annual state-level data on suicide rates among US youth aged 14 through 20 years, for the period 1976-2001. Negative binomial regression models were used to estimate the association between state and federal youth-focused firearm laws mandating a minimum age for the purchase or possession of handguns and state child access prevention (CAP) laws requiring safe storage of firearms on suicide rates among youth.

Main Outcome Measures Association between youth-focused state and federal firearm laws and rates of firearm, nonfirearm, and total suicides among US youth aged 14 to 17 and 18 through 20 years.

Results There were 63954 suicides among youth aged 14 through 20 years during the 1976-2001 study period, 39655 (62%) of which were committed with firearms. Minimum purchase-age and possession-age laws were not associated with statistically significant reductions in suicide rates among youth aged 14 through 20 years. State CAP laws were associated with an 8.3% decrease (rate ratio [RR], 0.92; 95% confidence interval [CI], 0.86-0.98) in suicide rates among 14- to 17-year-olds. The annual rate of suicide in this age group in states with CAP laws was 5.97 per 100000 population rather than the projected 6.51. This association was also statistically significant for firearm suicides (RR, 0.89; 95% CI, 0.83-0.96) but not for nonfirearm suicides (RR, 1.00; 95% CI, 0.91-1.10). CAP laws were also associated with a significant reduction in suicides among youth aged 18 through 20 years (RR, 0.89; 95% CI, 0.85-0.93); however, the association was similar for firearm suicides (RR, 0.87; 95% CI, 0.82-0.92) and nonfirearm suicides (RR, 0.91; 95% CI, 0.85-0.98).

Conclusions There is evidence that CAP laws are associated with a modest reduction in suicide rates among youth aged 14 to 17 years. As currently implemented, minimum age restrictions for the purchase and possession of firearms do not appear to reduce overall rates of suicide among youth.

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of law intended to keep firearms from youth are gun safe storage laws, often referred to as child access prevention (CAP) laws. As of 2001, 18 states had some form of CAP law that makes it a crime to store firearms in a manner that allows them to be easily accessed by children and adolescents. Most require gun owners to lock up their guns.

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There has been little empirical research on the association between these youth-focused laws and rates of suicide among youth. Marvel⁹ examined laws banning the possession of firearms by juveniles and found no evidence that these laws reduced youth suicides. However, in that study the outcome examined was suicides among youth aged 15 to 19 years, over half of which involve suicides among 18- and 19-year-olds, an age group not covered by most of the laws. We are not aware of any other study that has examined the association between minimum age restrictions for firearm purchases and firearm suicides among youth. In a study of the association between the first 12 CAP laws and mortality among youth through 1994, Cummings et al¹⁰ reported that state CAP laws were associated with a 19% decline in suicides among youth aged 10 to 14 years. This estimate was not emphasized by the authors, presumably because the upper bound of the 95% confidence interval for the rate ratio was 1.01. Lott and Whitley¹¹ reported no statistically significant association between CAP laws and suicides among children younger than 15 years or among youth aged 15 to 19 years. However, their use of Tobit regression to estimate the laws' effects is vulnerable to bias when data are highly skewed and heteroskedastic, as is the case for state-level data on youth suicides.¹²

The study herein seeks to address the gap in research on the effects of firearm laws specifically designed to reduce the access that children and youth have to firearms. We examine the association between these laws and suicides among youth aged 14 through 20 years, an age group at much greater risk of firearm suicide than the younger groups examined in prior research.

METHODS

Study Design

To estimate the association between youth-focused firearm policies and suicide, we used a quasi-experimental design and regression analyses (described below) to contrast changes in

rates of suicide among youth in states that adopted laws to restrict youth access to firearms with rate changes in states that did not make such changes in their laws, while controlling for potential confounders. State-level data sets were constructed that included the number of suicides among youth within each state for the years 1976 through 2001 for the 2 age groups potentially affected by the laws. Youth aged 14 to 17 years were the target group for laws establishing 18 years or younger as a minimum age for handgun purchase or possession, and for most CAP laws. Youth aged 18 through 20 years were legally affected by laws that increased the minimum age for handgun purchase or possession from 18 to 21 years.

Outcome Variables

The outcome variables were the number of total, firearm, and nonfirearm suicides in each age group targeted by the laws. Death certificate data from the National Center for Health Statistics were used to identify suicide as a cause of death (*International Classification of Diseases, Ninth Revision* external cause of death codes E950-E959¹³ and *International Classification of Diseases, 10th Revision* codes X60-X84, Y87.0, and U03¹⁴).

Firearm Laws

We conducted legal research and consulted existing compilations of state laws¹⁵ to obtain information about the youth-focused firearm laws of interest: minimum purchase age, minimum possession age, and CAP laws. When states had minimum-age cutoffs for purchase or possession of handguns that were different from those for purchase or possession of long guns, we used the cutoffs for handguns. We also collected information about other firearm laws, such as handgun licensing requirements (also known as permit-to-purchase laws), which might affect our outcomes of interest. For each law, we then determined the date it took effect, and whether there had been any changes to the law itself during the study period.

Dummy variables were created, set equal to 1 when the law was in effect for the whole year and equal to 0 when no law was in effect. For laws that were in effect for only part of a specific year, we set the law variable equal to 1 in a state-year if the law was in place for at least half of the year and equal to 0 otherwise. For the few laws that affected one part of our age groups (eg, age 17 years as the minimum age for firearm purchase), we set the law variable equal to 1 if the law applied to the majority of youth committing suicide in the age group and equal to 0 otherwise. The federal law establishing a minimum legal age for handgun purchase and possession was assumed to affect only states that, prior to the federal law, either had no minimum-age law of this type or had a law that established a minimum legal age younger than 18 years.

Statistical Analysis

To derive estimates of the association between the laws and youth suicide, we used negative binomial regression models and generalized estimating equations to estimate regression parameters. Negative binomial regression is appropriate for estimating models for count data that are overdispersed (ie, the variance is greater than the mean),¹⁶ as is the case with state-level youth suicide data. Likelihood ratio tests rejected the null hypothesis that the distributions were Poisson. Generalized estimating equations take into account that the data are correlated, in this case by state and year, and make appropriate adjustments to standard errors for accurate hypothesis testing.¹⁷ Correlation matrices of model residuals were examined to identify any clear pattern of autocorrelation; however, no pattern was evident. Therefore, the models were specified with unstructured autocorrelation, as is recommended for studies of this type,¹⁸ using the PROC GEN program in SAS version 8.2 (SAS Institute Inc, Cary, NC). Each model included the natural logarithm of the population as an offset variable with the coefficient constrained to equal 1. Model coefficients

were converted to rate ratios (RRs) so that effects could be expressed in terms of percentage changes in suicide rates. We used 2-tailed tests of significance and $\alpha \leq .05$ for rejecting the null hypothesis of no effect.

When statistically significant associations were identified, we assessed whether an association not attributable to change in the covariates could be attributable to differential prelaw trends in states that passed the law vs those that did not pass the law. This was assessed by estimating the effects for a set of dummy variables representing each of the 5 years just prior to the passage of the law and each of the first 5 years the law was in place. We assessed the plausibility that significant changes in suicide rates for an age group were caused by the law by examining whether statistically significant associations were specific to suicides using firearms and were not associated with changes in suicide rates among young persons aged 22 to 24 years, a group not legally affected by the laws. We also estimated a model that included only those states that had enacted their laws prior to 1996, providing at least 6 years of follow-up data. Model fit was assessed by comparing deviance statistics with their asymptotic χ^2 distribution¹⁹ and the Akaike information criterion statistic.²⁰

Other Explanatory Variables

In addition to the firearm law variables, the models included indicator variables for each state, suicides for a within-state comparison group (individuals aged 22 to 24 years), per capita beer consumption, percentage of the population living in rural areas, real income per capita, unemployment rates, percentage of the adult population with a bachelors degree, percentage of the population of black race, the ratio of adult firearm suicides to total suicides as a proxy for the prevalence of gun ownership, and percentage of the population affiliated with specific religious denominations. The dummy variables for each state control for baseline differences in youth suicide levels across the 50 states

(the District of Columbia was not included in our study). Because the state firearm policies of interest target a particular age group, we used within-state suicide rates among young persons aged 22 to 24 years who were not targeted by the law to control for difficult-to-measure social factors (eg, social norms regarding suicide) that influence suicide rates among young persons in a particular state and year. We used year dummy variables to control for national trends in suicides among youth but also estimated alternative models with linear trend parameters when such patterns were clearly evident.

Data on state population of youth aged 14 through 20 years²¹⁻²³ and the percentage of residents living in rural areas were obtained from the US Census.²⁴ Annual per capita beer consumption data based on beer sales were obtained from the Alcohol Epidemiologic Data System of the National Institute of Alcoholism and Alcohol Abuse.²⁵ Data on personal income, unemployment, educational attainment, and religious affiliation were provided by Markowitz et al,²⁶ who obtained the data from government and private sources.²⁷⁻²⁹

RESULTS

Youth-Focused Firearm Laws

As of 2001, federal law and the laws of 46 states have mandated a minimum age for the purchase of a handgun, with the age ranging from 14 to 21 years. Of these, 21 states enacted or changed their law during the study period. Federal law and the laws of 39 states mandated a minimum possession age, ranging from 15 to 21 years, with 29 states enacting or changing their law during the study period. Nearly all of these changes established 18 years as the minimum age for firearm possession. Only 3 states increased their minimum legal age for handgun possession to 21 years during the study period. Eighteen states had CAP laws as of 2001. The maximum age of youth covered by these CAP laws ranged from 13 to 17 years (TABLE 1). Only 3 states adopted permit-to-purchase firearms licensing systems during the study period.

Most law changes restricting the access of youth to firearms went into effect between 1990 and 1995. The federal law establishing 18 years as the minimum age for handgun purchase and possession went into effect in 1994. After Florida implemented the nation's first CAP law in late 1989, 14 more states followed suit before the end of 1995.

Suicide Trends Among Youth

There were 63 954 suicides among youth aged 14 through 20 years during the 1976-2001 study period, 39 655 (62%) of which were committed with firearms. Firearm suicide rates among youth aged 14 to 17 years increased steadily from 2.6 (per 100 000 population) in 1976 to 5.7 in 1994, and then declined rapidly to 2.5 in 2001 (FIGURE). There were less-dramatic changes in firearm suicide rates among youth aged 18 through 20 years, except for a steep decrease from 9.6 in 1994 to 5.9 in 2001. There were no noteworthy trends in rates of nonfirearm suicides within the 2 age groups.

Association Between Firearm Laws and Suicides Among Youth Aged 14 to 17 Years

Our regression models for suicides among youth aged 14 to 17 years reveal no statistically significant association between suicide rates and laws setting minimum ages for firearm purchase or possession enacted at the state or federal level (TABLE 2). State CAP laws were associated with an 8.3% reduction in suicide rates (RR, 0.92; 95% confidence interval [CI], 0.86-0.98). In states with CAP laws, the annual suicide rate for youth aged 14 to 17 years was 5.97 per 100 000 during the period in which these laws were in effect. Our model estimates that in the absence of these laws the expected rate would have been 6.51.

The reduction associated with CAP laws was observed for firearm suicides, which decreased an estimated 10.8% in response to the introduction of CAP laws (RR, 0.89; 95% CI, 0.83-0.96). There was no statistically significant association between CAP

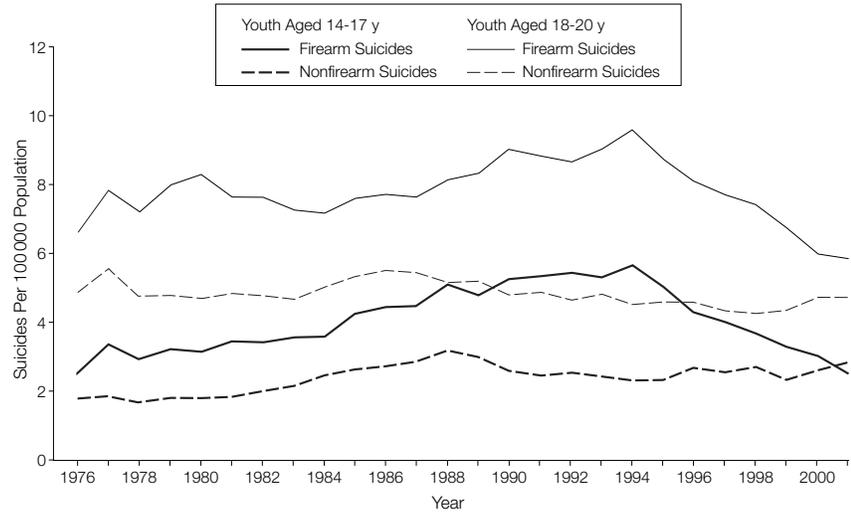
Table 1. State Firearm Laws Focused on Youth, 1976-2001

State	Minimum Purchase/Sale Age		Minimum Possession Age		CAP Law (Effective Date)
	Age, y	Change During Study Period (Effective Date)	Age, y	Change During Study Period (Effective Date)	
Federal law	18	No law to age 18 (09/19/94)	18	No law to age 18 (09/19/94)	NA
Alabama	18	NA	*	NA	NA
Alaska	16	No law to age 16 (09/14/92)	16	No law to age 16 (01/01/80)	NA
Arizona	18	NA	18	No law to age 18 (07/18/93)	NA
Arkansas	18	No law to age 18 (01/01/76)	18	No law to age 18 (03/17/89)	NA
California	18	NA	18	NA	Up to age 17 (01/01/92)
Colorado	18	No law to age 18 (09/13/93)	18	No law to age 18 (09/13/93)	NA
Connecticut	21	Age 18 to age 21 (10/01/95)	*	NA	Up to age 15 (10/01/90)
Delaware	21	Age 16 to age 21 (07/16/87)	18	No law to age 18 (07/15/94)	Up to age 17 (07/12/94)
Florida	18	NA	18	No law to age 18 (01/01/94)	Up to age 15 (10/01/89)
Georgia	18	Age 21 to age 18 (07/01/94)	18	No law to age 18 (07/01/94)	NA
Hawaii	21	Age 18 to age 21 (07/01/94)	*	NA	Up to age 15 (06/29/92)
Idaho	18	Age 16 to age 18 (07/01/94)	18	No law to age 18 (07/01/94)	NA
Illinois	21	NA	21	NA	Up to age 14 (01/01/00)
Indiana	18	Age 21 to age 18 (07/01/77)	18	No law to age 18 (07/01/94)	NA
Iowa	21	Age 18 to age 21 (01/01/79)	*	NA	Up to age 13 (04/05/90)
Kansas	18	NA	18	No law to age 18 (07/01/94)	NA
Kentucky	18	No law to age 18 (07/15/94)	18	No law to age 18 (07/15/94)	NA
Louisiana	18	NA	17	No law to age 17 (09/07/99)	NA
Maine	16	NA	*	NA	NA
Maryland	21	NA	21	No law to age 21 (10/01/96)	Up to age 15 (10/01/92)
Massachusetts	21	Age 18 to age 21 (10/21/98)	21	Age 18 to age 21 (10/21/98)	Up to age 17 (10/21/98)
Michigan	18	NA	18	No law to age 18 (03/28/91)	NA
Minnesota	18	NA	18	NA	Up to age 13 (08/01/93)
Mississippi	18	NA	18	No law to age 18 (07/01/94)	NA
Missouri	21	Age 18 to age 21 (09/28/81)	*	NA	NA
Montana	*	NA	*	NA	NA
Nebraska	21	Age 18 to age 21 (06/07/91)	18	NA	NA
Nevada	18	NA	18	Age 14 to age 18 (07/01/95)	Up to age 17 (10/01/91)
New Hampshire	18	NA	*	NA	Up to age 16 (01/01/01)
New Jersey	21	Age 18 to age 21 (01/01/01)	21	Age 18 to age 21 (01/01/01)	Up to age 15 (01/17/92)
New Mexico	*	NA	19	No law to age 19 (07/01/94)	NA
New York	21	No law to age 21 (11/01/00)	16	NA	NA
North Carolina	18	NA	18	No law to age 18 (09/01/93)	Up to age 17 (12/01/93)
North Dakota	18	Age 17 to age 18 (07/01/85)	18	Age 17 to age 18 (07/01/85)	NA
Ohio	21	Age 17 to age 21 (11/09/95)	*	NA	NA
Oklahoma	18	NA	18	No law to age 18 (07/01/94)	NA
Oregon	18	NA	18	No law to age 18 (01/01/90)	NA
Pennsylvania	18	NA	18	No law to age 18 (09/11/95)	NA
Rhode Island	21	NA	15	NA	Up to age 15 (06/19/95)
South Carolina	21	NA	21	NA	NA
South Dakota	*	NA	18	No law to age 18 (07/01/94)	NA
Tennessee	18	NA	18	No law to age 18 (07/01/94)	NA
Texas	18	NA	*	NA	Up to age 16 (09/01/95)
Utah	18	No law to age 18 (10/21/93)	18	NA	NA
Vermont	16	NA	16	NA	NA
Virginia	18	NA	18	No law to age 18 (07/01/93)	Up to age 13 (07/01/92)
Washington	18	Age 21 to age 18 (07/01/94)	18	No law to age 18 (07/01/94)	NA
West Virginia	18	No law to age 18 (07/08/89)	18	No law to age 18 (07/08/89)	NA
Wisconsin	18	NA	18	NA	Up to age 13 (04/16/92)
Wyoming	*	NA	*	NA	NA

Abbreviations: CAP, child access prevention; NA, not applicable/no change.

*Minimum age not established.

Figure. Youth Suicide Rates by Method and Age Group, United States, 1976-2001



laws and nonfirearm suicides among youth aged 14 to 17 years (RR, 1.00; 95% CI, 0.91-1.10). Estimates of the association between CAP laws and suicides among 14- to 17-year-olds were dependent on how national suicide trends were modeled. The estimates from the primary model noted above included separate linear-trend parameters for the 1976-1994 period of increasing suicide rates and for the 1995-2001 period of a downturn in rates. The trend parameters in this model were highly significant and, based on Akaike information criterion statistics, this model fit the data better than did a model that included year indicator variables. Models that assumed no overall pattern in youth suicide trends but that controlled for year-to-year fluctuations nationally with year indicator variables found no statistically significant association between CAP laws and suicide rates in the group aged 14 to 17 years. CAP law estimates did not vary substantially by whether violators could be charged with felony crimes or by the maximum age of youth targeted by the laws (data not shown).

The models used to estimate differences in suicide rates among youth aged 14 to 17 years in each of the 5 years before and after the adoption of a CAP law revealed no pattern of unmodeled dif-

ferences between states with and those without CAP laws just prior to the adoption of these laws. When we examined the relationship between the length of time a CAP law was in place and the effects of the laws, there was also no clear pattern in successive post-law year effects on total suicide rates, but the association between CAP laws and firearm suicide rates for this group was most pronounced for the first year the law was in effect (RR, 0.89; 95% CI, 0.77-1.02).

There was no statistically significant association between permit-to-purchase licensing laws and suicide rates among youth aged 14 to 17 years (RR, 1.06; 95% CI, 0.92-1.23). Association between the laws and suicide rates among youth aged 14 to 17 years were not substantially altered when the suicide rate among 22- to 24-year-olds and other covariates were removed from the model.

Association Between Firearm Laws and Suicides Among Youth Aged 18 Through 20 Years

The model for total suicides among youth aged 18 through 20 years estimated that state laws that increased the legal age for handgun possession to 21 years during the study period were associated with a 12.9% increase in sui-

cide rates (RR, 1.13; 95% CI, 1.01-1.27) (Table 2). This effect was not statistically significant, however, either for firearm suicides (RR, 1.14; 95% CI, 0.98-1.34) or nonfirearm suicides (RR, 1.07; 95% CI, 0.90-1.27). State laws raising the minimum legal purchase age to 21 years were associated with a 9.0% decline in rates of firearm suicides among youth aged 18 through 20 years (RR, 0.91; 95% CI, 0.83-1.00); however, there was no statistically significant association for overall suicide rates (RR, 0.97; 95% CI, 0.91-1.05).

State CAP laws were associated with an 11.1% decline in suicide rates among youth aged 18 through 20 years (RR, 0.89; 95% CI, 0.85-0.93). In this group, suicide reductions associated with CAP laws were similar for firearm suicides (-12.9%; RR, 0.87; 95% CI, 0.82-0.92) and nonfirearm suicides (-8.8%; RR, 0.91; 95% CI, 0.85-0.98). The 3 permit-to-purchase licensing laws were associated with a 17.7% increase in suicide rates (RR, 1.18; 95% CI, 1.04-1.34).

COMMENT

After steadily increasing between 1976 and 1994, rates of firearm suicides among youth have decreased sharply. Although many laws enacted during the early 1990s were intended to decrease access to firearms by children and youth, this study found no evidence that minimum-age restrictions for firearm purchase and possession have reduced suicide rates among the age groups targeted by the laws.

Our models estimate that 3 state laws that increased the minimum legal age for handgun possession to 21 years were associated with a 12.9% increase in total suicide risks among youth ages 18 through 20 years. There are several reasons, however, to doubt the validity of this estimate, including: (1) firearm and nonfirearm suicide rates were affected equally; (2) there was no increase in suicides among 14- to 17-year-olds associated with minimum possession age laws; (3) it is based on only 3 states, 2 of which adopted the change in the final 2 years of the study; and (4) the ab-

sense of a theory for how an intervention designed to reduced access to means of suicide could lead to a substantial increase in suicide rates. Similarly, our findings for permit-to-purchase licensing laws should be regarded with skepticism since they are based on just 3 changes in state law occurring during the study period, none

of which involved a very restrictive licensing scheme.

We did find convincing evidence that the 18 CAP laws adopted during the study period led to an 8.3% reduction in suicide rates among youth aged 14 to 17 years. As would be expected if these reductions were attributable to reduced access to firearms, the reduc-

tions were specific to suicides committed with firearms and to the age group principally targeted by CAP laws. We found no association between CAP laws and suicide rates among young persons aged 22 to 24 years. Our estimate of the association between CAP laws and firearm suicides (-10.8%; 95% CI, -18.4% to -3.7%) among youth aged 14

Table 2. Association Between Youth-Focused Firearm Laws and Suicides Among Youth Aged 14 to 17 Years and 18 Through 20 Years

	Aged 14 to 17 Years		Aged 18 Through 20 Years	
	RR (95% CI)	P Value	RR (95% CI)	P Value
Total Suicides				
Firearm laws				
Federal law				
Minimum purchase age	1.02 (0.91-1.14)	.72	NA	NA
Minimum possession age	0.98 (0.90-1.08)	.75	NA	NA
State laws				
Minimum purchase age	1.04 (0.90-1.21)	.58	0.97 (0.91-1.05)	.47
Minimum possession age	0.97 (0.90-1.05)	.44	1.13 (1.01-1.27)	.04
Child access prevention laws	0.92 (0.86-0.98)	.005	0.89 (0.85-0.93)	<.001
Permit to purchase laws	1.06 (0.92-1.23)	.43	1.18 (1.04-1.34)	.01
Other covariates				
Linear time trend, 1976-1994	1.10 (1.07-1.12)	<.001	NA	NA
Linear time trend, 1995-2001	0.95 (0.93-0.98)	<.001	NA	NA
Per capita beer consumption	0.99 (0.99-1.00)	.10	1.00 (0.99-1.01)	.27
Population living in rural areas	0.99 (0.98-1.01)	.37	1.00 (0.99-1.01)	.50
Unemployment	1.00 (0.99-1.00)	.48	1.01 (1.00-1.02)	.12
Real per capita income	1.00 (1.00-1.00)	.22	1.00 (1.00-1.00)	.85
Adult population with bachelors degree	0.99 (0.98-1.00)	.08	1.00 (0.99-1.01)	.78
Religious affiliation				
Southern Baptist	1.04 (1.00-1.07)	.01	1.01 (0.98-1.03)	.57
Other Protestant	1.01 (0.99-1.02)	.37	0.99 (0.98-1.00)	.16
Mormon	1.12 (1.05-1.18)	<.001	1.04 (0.98-1.09)	.17
Catholic	0.98 (0.97-1.00)	.006	0.98 (0.98-0.99)	.002
Proxy for adult firearm prevalence	0.41 (0.26-0.64)	<.001	0.46 (0.32-0.65)	<.001
Suicide rates among ages 22-24 y	1.01 (1.00-1.01)	.002	1.01 (1.00-1.01)	.002
Firearm Suicides				
Federal law				
Minimum purchase age	1.00 (0.87-1.16)	.96	NA	NA
Minimum possession age	0.99 (0.89-1.09)	.80	NA	NA
State laws				
Minimum purchase age	1.04 (0.87-1.16)	.66	0.91 (0.83-1.00)	.05
Minimum possession age	1.02 (0.92-1.12)	.77	1.14 (0.98-1.34)	.10
Child access prevention laws	0.89 (0.83-0.96)	.003	0.87 (0.82-0.92)	<.001
Permit to purchase laws	0.92 (0.76-1.10)	.33	1.22 (1.04-1.43)	.02
Nonfirearm Suicides				
Federal law				
Minimum purchase age	1.08 (0.91-1.28)	.40	NA	NA
Minimum possession age	1.12 (0.99-1.26)	.08	NA	NA
State laws				
Minimum purchase age	1.05 (0.85-1.31)	.64	1.05 (0.94-1.17)	.37
Minimum possession age	0.93 (0.82-1.05)	.24	1.07 (0.90-1.27)	.44
Child access prevention laws	1.00 (0.91-1.10)	.95	0.91 (0.85-0.98)	.02
Permit to purchase laws	1.27 (1.00-1.61)	.047	1.14 (0.93-1.39)	.21

Abbreviations: CI, confidence interval; NA, not applicable; RR, rate ratio.

to 17 years is consistent with, though smaller in magnitude than, the estimate of Cummings et al¹⁰ of the association between CAP laws and firearm suicides among adolescents younger than 15 years (-19.0%; 95% CI, -34.0% to +1.0%). CAP laws were also associated with statistically significant declines in suicide rates among those in the group aged 18 through 20 years. However, the statistically significant negative association between CAP laws and rates of suicide using means other than firearms casts doubt on any causal connection between the laws and lower suicide rates in this group of older youth.

Some may question whether the reductions in youth suicides that were associated with CAP laws in this study might be spurious, since many in the group aged 14 to 17 years were older than the maximum age required for safe firearm storage. However, many older youth have younger siblings, relatives, or friends that may prompt their parents to comply with CAP law requirements. In addition, CAP laws may encourage gun owners with children young enough to be covered by the law to adopt safe storage practices that endure even after their children are beyond the age required for safe firearms storage under the law. Finally, gun owners simply may not respond to very specific aspects of a CAP law in order to be in compliance. Instead, CAP laws may increase awareness and change social norms to encourage gun owners to secure firearms from underage youth. These interpretations are consistent with our finding that the ages covered by the CAP law were unrelated to the association between CAP laws and suicides among youth.

There are several reasons that CAP laws might be more effective than minimum-age restrictions for firearm purchases and possession in reducing suicides among youth. First, a large majority of youth who commit or attempt suicide with a firearm use guns owned by their parents or relatives.^{30,31} Second, the adopted restrictions on minimum purchase age did not affect the handgun sales practices re-

quired of licensed firearm dealers. Since 1968, federal law has prohibited licensed dealers from selling handguns to individuals younger than 21 years. In addition, there is little evidence that laws governing sales by those who are not dealers are vigorously enforced in most states³² (Frattaroli S, unpublished doctoral dissertation, 1999; on file with the authors).

Thus, it is important to recognize that our study is not a test of the relationship between firearm availability and risk of suicide among youth. Our results for minimum purchase-age and possession-age laws suggest that these laws have not substantially reduced the availability of firearms to youth at risk for suicide. Therefore, our results are not necessarily inconsistent with prior research, such as findings from Wintemute et al³³ that adult handgun purchasers were at higher risk for suicide, even 6 years after purchase. If a youth's risk of suicide were greatest several years after he or she had acquired a firearm, we may have underestimated the full effect of these laws. But when we limited the analysis to state laws enacted through 1995—providing at least 6 years of follow-up data for the remaining 45 states—we still identified no significant effects for these laws.

As with prior studies of CAP laws, we were unable to directly measure whether these laws resulted in actual changes in firearm storage practices. Nevertheless, our weapon-specific estimates of the effects of CAP laws suggest that these laws did limit the access that youth have to firearms.

This study does not examine the full range of potential effects of CAP laws. Lott and Whitley¹¹ report that CAP laws were associated with increases in rapes (9%) and robberies (10%), presumably because firearms kept in locked storage are potentially less available for self-defense. Their findings are questionable because the vast majority of these crimes take place outside the home³⁴ and firearms are very rarely used for self-defense.³⁵

Our study also does not consider the potential role that laws restricting the

access of youth to firearms might have in reducing unintentional shootings or homicides. Two prior studies of the association between CAP laws and deaths among children younger than 15 years from unintentional shootings, with similar methods but over different time periods, produced similar estimates of aggregate effect (-23% and -17%).^{10,36} However, one of these studies³⁶ found that the aggregate benefits were largely driven by a single state law (Florida). Marvel⁹ found no evidence that laws prohibiting possession of firearms by juveniles were associated with youth being killed by guns or with their use of guns to commit homicide.

The reductions in suicides associated with CAP laws are relatively modest in terms of percentage change. However, because the laws target an important risk factor, a high-risk group, and a leading cause of death, the public health significance of the laws is meaningful. Assuming that the observed association is causal, we estimate that the 18 CAP laws implemented prior to 2002 have prevented 333 suicides among youth aged 14 to 17 years from the time that Florida implemented the nation's first CAP law (October 1989) through 2001. In 2001 alone, we estimate that there were 35 fewer suicides among this group in the 18 states with CAP laws than would have been expected without the laws. These benefits have been obtained with very modest levels of publicity and enforcement. Increased efforts to encourage compliance with CAP laws have the potential to enhance their effectiveness in preventing deaths and injuries resulting from unsupervised access of youth to firearms.

Further research is needed to ascertain what factors have contributed to the recent decline in firearm suicides among youth in the United States. The timing of the decline is coincident with the adoption of several laws designed to reduce youth access to firearms, yet the only evidence we found that these laws are responsible for reductions in suicides among youth was a modest reduction associated with CAP laws. The

passage of many youth-focused firearm restrictions during the early 1990s may have been associated with broader changes in those social norms that involve allowing youth access to firearms—norms that affect states both with and without recent changes to their firearm laws. If the passage of laws restricting youth access to firearms influenced norms and practices both within and outside the states that adopted the laws, our estimates would

understate the effect of these laws on suicide rates among youth.

Author Contributions: Dr Webster, as principal investigator of this study, had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analyses.

Study concept and design; drafting of the manuscript; obtained funding: Webster, Vernick.

Acquisition of data; critical revision of the manuscript for important intellectual content; administrative, technical, or material support: Vernick, Manganello, Zeoli.

Analysis and interpretation of data: Webster, Vernick, Manganello, Zeoli.

Statistical analysis; study supervision: Webster.

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dividuals already infected with HIV should thus continue vigilant personal protection through safe-sex practices or clean needle use for injection drugs, even if their risk exposures are with other HIV-infected people.

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CORRECTIONS

Incorrect Dosages: In the Original Contribution entitled "Safety and Efficacy of Enoxaparin vs Unfractionated Heparin in Patients With Non-ST-Segment Elevation Acute Coronary Syndromes Who Receive Tirofiban and Aspirin: A Randomized Controlled Trial" published in the July 7, 2004, issue of *JAMA* (2004;292:55-64), there were 2 incorrect dosages on page 56. At the bottom of column 2, the sentence should read, "The dosing regimen for tirofiban in the A to Z trial was a hybrid between the previously proven ACS and percutaneous coronary intervention dosing regimens: a bolus of 10 µg/kg over 3 minutes, followed by a maintenance infusion of 0.1 µg/kg per minute for a suggested minimum of 48 hours (or a minimum of 12 hours after intervention) and a maximum of 120 hours.^{9,13}"

Funding Source Omitted: In the Original Contribution entitled "Association Between Youth-Focused Firearm Laws and Youth Suicides" published in the August 4, 2004, issue of *JAMA* (2004;292:594-601), a funding source was omitted. In addition to the sources cited, the study also received support from the David and Lucile Packard Foundation.