

State Gun Safe Storage Laws and Child Mortality Due to Firearms

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Context.—Since 1989, several states have passed laws that make gun owners criminally liable if someone is injured because a child gains unsupervised access to a gun. These laws are controversial, and their effect on firearm-related injuries is unknown.

Objective.—To determine if state laws that require safe storage of firearms are associated with a reduction in child mortality due to firearms.

Design.—An ecological study of firearm mortality from 1979 through 1994.

Setting.—All 50 states and the District of Columbia.

Participants.—All children younger than 15 years.

Main Outcome Measures.—Unintentional deaths, suicides, and homicides due to firearms.

Results.—Laws that make gun owners responsible for storing firearms in a manner that makes them inaccessible to children were in effect for at least 1 year in 12 states from 1990 through 1994. Among children younger than 15 years, unintentional shooting deaths were reduced by 23% (95% confidence interval, 6%-37%) during the years covered by these laws. This estimate was based on within-state comparisons adjusted for national trends in unintentional firearm-related mortality. Gun-related homicide and suicide showed modest declines, but these were not statistically significant.

Conclusions.—State safe storage laws intended to make firearms less accessible to children appear to prevent unintentional shooting deaths among children younger than 15 years.

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IN THE UNITED STATES in 1994, 902 children younger than 15 years were killed by firearms; 185 deaths were unintentional, 188 were suicides, 499 were homicides, and 30 were of undetermined intent.¹ For every child in this age group who dies from a firearm-related injury, an estimated 4.2 children suffer a nonfatal wound.² Some of these deaths may be related to the availability of firearms in the homes of many children. It has been estimated that about half of households

in the United States have a gun.^{3,4} In a 1994 national survey of gun owners, 14% of owners with a child younger than 18 years reported having a gun that was kept loaded and unlocked.⁵

In 1989, Florida passed a law to encourage gun owners to store loaded firearms in such a way that children could not readily obtain access to them.⁶ If an unsupervised child younger than 16 years obtains a firearm and shoots himself or herself or another person or threatens someone, the gun owner may be prosecuted.

Similar laws were adopted in 11 additional states by the end of 1993.⁷⁻¹⁷ All of these laws make it a criminal offense to store a firearm in such a way that a reasonable person would know that a child could gain access to the weapon. Violators can be prosecuted as felons in Florida, Connecticut, and California, while in the other states, the crime is classified as a misdemeanor. Most statutes declare that use of a locked box or

container^{6-11,13,14} or a trigger lock^{8,9,11,13} constitutes legal storage.

Safe storage laws were enacted to reduce unintentional shootings involving children. Some have argued that these laws are an unnecessary intrusion on gun owners, that they may cruelly subject a grieving parent to criminal prosecution, and that they are not likely to reduce injuries due to firearms.^{18,19} To assess the effectiveness of these laws, we examined whether unintentional firearm mortality among children younger than 15 years was reduced in states after these laws took effect. Limiting children's access to firearms might also reduce firearm suicide and homicide among children, and these outcomes were examined as well.

METHODS

Numbers of deaths and population data were obtained from the Compressed Mortality Files of the National Center for Health Statistics via the Internet.²⁰ We obtained data by sex for each available year (1979 to 1994) for each state and the District of Columbia for categories of age (<1, 1-4, 5-9, 10-14, 15-19, and 20-24 years) and race (white, black, or other). Deaths were identified using the *International Classification of Diseases, Ninth Revision (ICD-9)*²¹ external cause of death codes as follows: accident caused by a firearm missile (E922 to E922.9), firearm suicide (E955.0 to E955.4), other suicide (E950 to E954, E955.5 to E958.9), firearm homicide (E965.0 to E965.4), other homicide (E960 to E964, E965.5 to E968.9), shooting by a law officer (E970), and shooting of uncertain intent (E985.0 to E985.4).

Within each state, the time period affected by a safe storage law was considered to start with the first calendar year in which the law was in effect for at least 6 months. Incidence rate ratios were estimated using Poisson regression²² to compare time periods that had a storage law in effect with time periods without

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such a law within the same state; therefore, 50 indicator variables were included to represent each state and the District of Columbia. To control for national trends over time in firearm mortality rates, all states were included in the analysis, and 15 indicator variables were used to represent each calendar year. Categories of age, sex, and race were examined as potential confounders. To allow for possible overdispersion that might violate the restrictive assumptions of the Poisson distribution, final results were estimated using negative binomial regression.^{23,24}

Inequality of effects between different states or among age categories was tested using the likelihood ratio statistic.²⁵ Because rates within a state might be serially correlated over time, we calculated autocorrelation coefficients for the deviance residuals of each state in every regression model using lags of 1 through 5 years.^{23,26}

RESULTS

Over the 16 years of this study, there were 11 918 deaths due to firearms among children younger than 15 years in the United States; 4173 were unintentional, 2139 were suicides, and 5280 were homicides. Eleven fatal shootings by law enforcement and 315 shootings of uncertain intent were not analyzed further. In this age group, the unintentional gunshot mortality rate was 0.72 per 100 000 person-years in 1979; it fell to 0.32 in 1994. Suicide firearm mortality increased during the same interval from 0.16 to 0.33 per 100 000 person-years, and homicide firearm mortality increased from 0.45 to 0.81. Adjusting for changes in the age and sex distribution of the population, unintentional gunshot mortality decreased by 50% (95% confidence interval [CI], 36%-60%), suicide firearm mortality increased 111% (95% CI, 77%-151%), and homicide firearm mortality increased 71% (95% CI, 43%-104%).

From 1989 through 1993, gun safe storage laws were adopted in 12 states (Table). When the mortality rate in years affected by state safe storage laws was compared with the rate expected based on previous years within the same state and adjusted for secular trends, the incidence rate ratio for unintentional gun-related deaths was 0.77 (95% CI, 0.63-0.94) among children younger than 15 years. For gun-related suicide deaths and homicide deaths in the same age group, the associations with state safe storage laws were weaker and were not statistically significant. The rate ratio for gun suicides was 0.81 (95% CI, 0.66-1.01) and for gun homicides, 0.89 (95% CI, 0.76-1.05). For suicides by means other than a gun, the rate ratio was 0.95

States With Gun Safe Storage Laws in Effect for at Least 6 Months, 1979-1994

State	Year Law Passed	Date Law Went Into Effect	Period of Law Effectiveness for This Study	Age of Children for Whom Access Must Be Restricted, y
Florida	1989	10/1/89	1990-1994	<16
Iowa	1990	4/5/90	1990-1994	<14
Connecticut	1990	10/1/90	1991-1994	<16
Nevada	1991	10/1/91	1992-1994	<14
California	1991	1/1/92	1992-1994	<14
New Jersey	1991	1/17/92	1992-1994	<16
Wisconsin	1991	4/16/92	1992-1994	<14
Hawaii	1992	6/29/92	1992-1994	<16
Virginia	1991	7/1/92	1992-1994	<12
Maryland	1992	10/1/92	1993-1994	<16
Minnesota	1993	8/1/93	1994	<14
North Carolina	1993	12/1/93	1994	<18

(95% CI, 0.75-1.20), and for homicides by means other than a gun, the rate ratio was 0.96 (95% CI, 0.86-1.06). Further adjustment for sex, race, or age had no important effect on these ratios.

After safe storage laws were in effect, the decrease in unintentional firearm deaths was greater for children younger than 10 years and less for children aged 10 to 14 years (rate ratios, 0.68 [95% CI, 0.50-0.94] and 0.86 [95% CI, 0.67-1.09], respectively). The difference in these rate ratios, however, was not statistically significant ($P=.20$). We also examined the change in unintentional firearm mortality in older teenagers and young adults during the intervals affected by state safe storage laws. Using the same analytic method, we found that for teenagers aged 15 to 19 years, the incidence rate ratio was 0.91 (95% CI, 0.77-1.08), and for adults aged 20 to 24 years, it was 0.84 (95% CI, 0.68-1.03).

There was statistical evidence that the association between safe storage laws and unintentional shooting mortality among children younger than 15 years was not the same in each of the 12 states ($P=.01$). We classified state laws by whether they allowed for a felony prosecution. The overall mortality rate ratio fell to 0.59 (95% CI, 0.45-0.77) in California, Connecticut, and Florida, the states that allowed felony prosecutions, but did not change significantly in the 9 states that only provided for misdemeanor prosecutions (rate ratio, 1.14 [95% CI, 0.85-1.52]). With states classified by severity of penalty, the test for heterogeneity of effect was no longer statistically significant ($P=.30$). We also classified states by whether their statutes mentioned locked containers or trigger locks as suitable storage methods; the rate ratios were not statistically different between these 2 groups ($P=.08$), and this classification did not remove evidence of heterogeneity from the data.

Within a state, unintentional shooting death rates vary from year to year. If a state were to have a period of unusually

high rates as part of this expected variation, lawmakers might be stimulated to pass a safe storage law. Any subsequent mortality decline could be due partly to the tendency of rates to regress to their mean value.²⁷ To assess this, we calculated the unintentional gun mortality rate among children younger than 15 years in the 2-year period before a safe storage law went into effect compared with previous years in the same state and adjusted for national mortality trends. Little difference was found (rate ratio, 0.99 [95% CI, 0.81-1.21]).

There was no statistically significant evidence of serial correlation in any of our regression models.

COMMENT

From 1989 through 1993, a dozen states enacted gun safe storage laws. Once these statutes took effect, unintentional firearm-related deaths among children younger than 15 years were 23% (95% CI, 6%-37%) lower than expected in these states.

A study of the effect of a law is necessarily an ecological study that compares groups of people.²⁸ It is always difficult to be certain that the analysis has accounted for all differences between groups that might distort the measured association. However, the apparent impact of state storage laws on unintentional shooting deaths is plausible for several reasons. First, the effect was strongest among the young people who are specifically covered by the law. Second, the effect was strongest for the outcome that the laws were designed to prevent—unintentional shootings. Third, the states that passed these laws came from all regions of the country, and they do not appear to share a common set of other features, aside from safe storage laws, that could account for the decline in mortality that was found. Finally, the overall estimate of change in mortality was based on a comparison within each state, before and after the law took effect, so that differences between these

12 states and other states cannot account for the results; information from other states was only used to control for any national trend in mortality.

Regression to the mean can sometimes explain an apparent decrease in incidence. This is an unlikely explanation in this study, however, because within states that passed safe storage laws, the incidence of unintentional shooting deaths among children was not elevated in the 2-year period before the laws went into effect.

Our analysis was limited to laws passed by states. Some large cities have adopted their own gun safe storage laws.²⁹ Thus, within some states, some persons were subject to municipal statutes that encouraged safe storage at a time when no state law was in effect. It is possible that some municipal statutes were effective in reducing unintentional gunshot mortality in states that later passed a statewide law. If this occurred, then our analysis, which compared time periods after a state law went into effect with earlier time periods, would tend to underestimate the effectiveness of safe storage laws.

We are not aware that any large cities or counties passed gun safe storage laws

after a state law was in effect. If this happened, it is conceivable that some of the effect that we have attributed to state laws was due in part to a local safe storage ordinance.

Safe storage laws were associated with a modest decrease in both suicides and homicides among young children, as well as some decline in unintentional shooting deaths among older teenagers and young adults. None of these changes were statistically significant, but they are all in the same direction, raising at least the possibility that safe storage laws might have some impact on these outcomes. Since 1993, additional states have passed safe storage laws, and future analyses may clarify this issue.

Safe storage laws with felony penalties appeared to have a stronger effect on unintentional gun-related mortality than laws with only misdemeanor penalties. It may be that felony penalties make these laws more effective, but it is also possible that other characteristics of the states with felony penalties account for the differences that we found.

Any effect of safe storage laws would be more credible if there were data to show that gun storage actually changed after these statutes took effect. The Be-

havioral Risk Factor Surveillance System of the Centers for Disease Control and Prevention, Atlanta, Ga, now has supplementary questions on gun storage.³⁰ If these questions are used in enough states before and after the passage of safe storage laws, useful data relating the enactment of these laws to gun storage practices may become available.

During the years 1990 through 1994, 129 children younger than 15 years died in unintentional shootings in states that had a safe storage law in effect during the years the children died. Assuming that the mortality rate ratio of 0.77 best represents the effect of state safe storage laws on unintentional shooting deaths among children, then approximately $129(1.0-0.77)/0.77=39$ deaths of young children were prevented by these statutes. During the same 5 years, 940 children died in similar shootings in states when no safe storage law was in effect; $940(1.0-0.77)=216$ children might have lived had these laws been in effect in all states.

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