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Firearm Laws and Firearm Homicides
A Systematic Review

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IMPORTANCE Firearm homicide is a leading cause of injury death in the United States, and there is considerable debate over the effectiveness of firearm policies. An analysis of the effectiveness of firearm laws on firearm homicide is important to understand optimal policies to decrease firearm homicide in the United States.

OBJECTIVE To evaluate the association between firearm laws and preventing firearm homicides in the United States.

EVIDENCE REVIEW We evaluated peer-reviewed articles from 1970 to 2016 focusing on the association between US firearm laws and firearm homicide. We searched PubMed, CINAHL, Lexis/Nexis, Sociological Abstracts, Academic Search Premier, the Index to Legal Periodicals and Books, and the references from the assembled articles. We divided laws into 5 categories: those that (1) curb gun trafficking, (2) strengthen background checks, (3) improve child safety, (4) ban military-style assault weapons, and (5) restrict firearms in public places and leniency in firearm carrying. The articles were assessed using the standardized Guide to Community Preventive Services data collection instrument and 5 additional quality metrics: (1) appropriate data source(s) and outcome measure(s) were used for the study, (2) the time frame studied was adequate, (3) appropriate statistical tests were used, (4) the analytic results were robust, and (5) the disaggregated results of control variables were consistent with the literature.

FINDINGS In the aggregate, stronger gun policies were associated with decreased rates of firearm homicide, even after adjusting for demographic and sociologic factors. Laws that strengthen background checks and permit-to-purchase seemed to decrease firearm homicide rates. Specific laws directed at firearm trafficking, improving child safety, or the banning of military-style assault weapons were not associated with changes in firearm homicide rates. The evidence for laws restricting guns in public places and leniency in gun carrying was mixed.

CONCLUSIONS AND RELEVANCE The strength of firearm legislation in general, and laws related to strengthening background checks and permit-to-purchase in particular, is associated with decreased firearm homicide rates. High-quality research is important to further evaluate the effectiveness of these laws. Legislation is just 1 part of a multipronged approach that will be necessary to decrease firearm homicides in the United States.

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On June 12, 2016, in Orlando, Florida, a man with a semiautomatic handgun and an assault rifle perpetrated the deadliest shooting in modern US history, killing 49 and wounding more than 50 others.[1] Previously, on January 4, 2016, President Barack Obama issued an executive action to expand background checks and require all sellers of firearms to be licensed in an effort to decrease firearm-related violence.[2] That executive action occurred a month after a mass shooting in San Bernardino, California,[3] and 2 years after the elementary school massacre in Newtown, Connecticut.[4] Firearm homicides are the second leading cause of injury death in people 15 to 24 years old in the United States.[5] Deaths from firearms are estimated to cause $21 billion in lifetime work loss and medical costs; this figure does not include emotional or other societal costs.[6]

A public health approach can decrease firearm homicides and injuries.[7] Legislation is one important component of such a public health strategy (**Figure 1**).[7,8] In 2004 and 2005, 2 comprehensive reviews of US firearm legislation conducted by the Task Force on Community Preventive Services, an independent, nonfederal organization working with the US Department of Health and Human Ser-

Key Points

Question What are the effects of firearm laws on firearm homicides in the United States?

Findings We found evidence that stronger firearm laws are associated with reductions in firearm homicide rates. The strongest evidence is for laws that strengthen background checks and that require a permit to purchase a firearm. The effect of many of the other specific types of laws is uncertain, specifically laws to curb gun trafficking, improve child safety, ban military-style assault weapons, and restrict firearms in public places.

Meaning Given the magnitude and gravity of firearm homicides in the United States, effective legal and public health policies and adequate funding to enable high-quality research are essential.
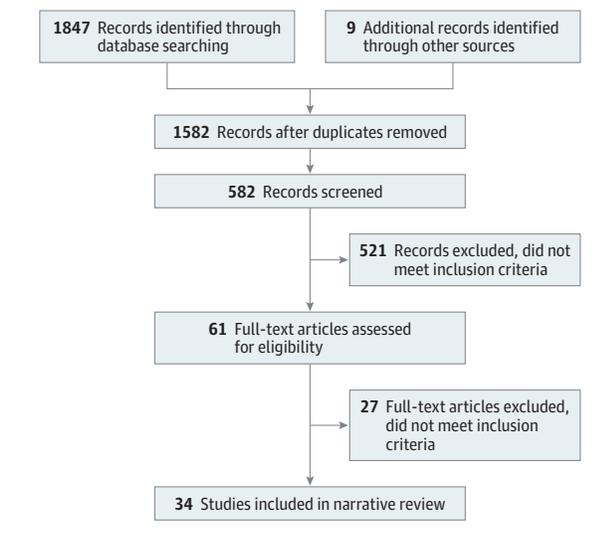
vices, and the National Academy of Sciences concluded that the published evidence was insufficient to determine the effectiveness of any specific type of firearm legislation, either independently or in

Figure 1. US Firearm Laws and State Homicide Rates 2011-2014

Firearm homicide rate per 100 000
- 0.39-1.30
- 1.31-2.45
- 2.46-3.79
- 3.80-4.80
- 4.81-9.40
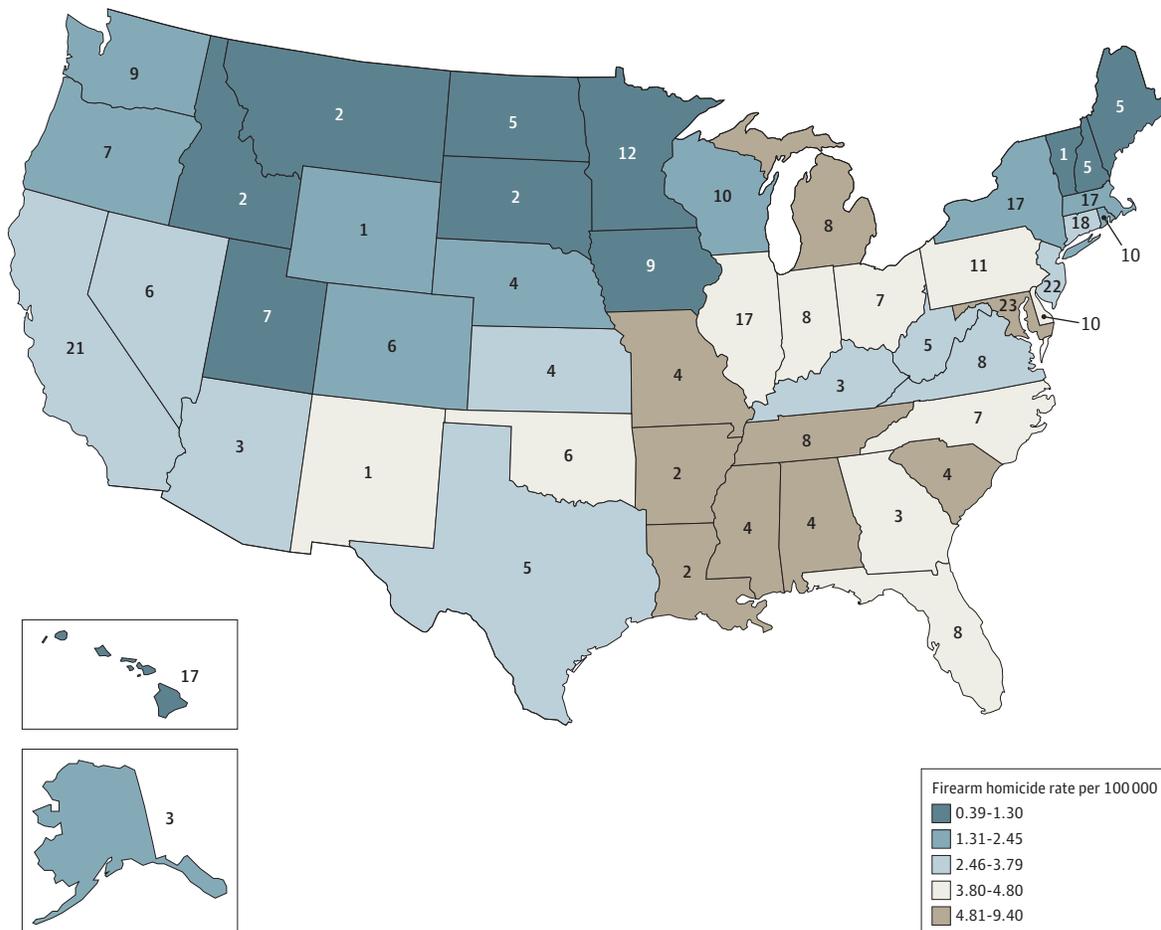
The average age-adjusted firearm homicide rate per 100 000 persons and number of firearm laws for each state from 2011 to 2014. The number on each state indicates the total firearm laws in that state (does not include permissive laws, eg, those that permit firearms in public places).

Figure 2. Firearm Laws and Firearm Homicides Article Selection Process

Methods

Search for Evidence
We conducted searches in PubMed, CINAHL, Lexis/Nexis, Sociological Abstracts, Academic Search Premier, and the Index to Legal Periodicals and Books. The MESH terms used in the literature search are shown in the eTable in the Supplement. References from the assembled articles were also reviewed. We included only published articles from peer-reviewed journals. Articles were included if they met the following criteria: (1) firearm homicide was the primary outcome, (2) the specific law or laws evaluated were associated with firearms, (3) the setting was in the United States, and (4) the article was published between January 1970 and August 2016. We excluded studies with a primary outcome of interpersonal violence and those without a specific outcome of firearm homicide (eg, general homicide or murder). This search yielded 582 abstracts, which were reviewed by the study team members. From this abstract review, we selected 61 articles for further analysis, and 34 articles met all inclusion criteria (Figure 2, Table 1).

Abstraction and Evaluation of Individual Studies
Each article was read by 2 reviewers. The standardized Guide to Community Preventive Services data collection instrument was used to evaluate the study evidence,[44] and the data were entered into a REDCap database. The data for every article were reviewed by the study team to ensure consistency in the assessment of the study design, suitability, and quality; disagreements between the reviewers were reconciled by consensus of the team members. The articles were then categorized into 5 types of firearm legislation: laws that (1) curb firearm trafficking, (2) strengthen background checks, (3) improve child safety, (4) ban military-style assault weapons, and (5) restrict firearms in public places (Table 2).[16,46]

Assessing Study Quality and Summarizing the Body of Evidence of Effectiveness
In addition to the study design and suitability of the articles, we also evaluated the studies using 5 additional quality metrics: (1) Were appropriate data source(s) and outcome measure(s) used for the study question? (2) Was the time frame studied adequate (eg, sufficient surveillance before and after a law)? (3) Were appropriate statistical tests used? (4) Were the results robust to variations in the variables and analyses? (5) Were the disaggregated data and results of control variables consistent with the literature? Based on these factors, an overall quality score was assigned to each article by the study team.[9] If all 5 metrics were achieved, a score of 3 (good quality) was assigned. If 3 to 4 metrics, including appropriate statistical testing, were achieved, a score of 2 (fair quality) was assigned. If 1 to 2 metrics, or 3 to 4 metrics but without appropriate statistical testing, were achieved a score of 1 (poor quality) was assigned (Table 2 and Table 3).

Observations
All 34 studies were ecological; 3 had a before-and-after design, 19 were time series, and 12 were cross-sectional (Table 1). The articles were from the following disciplines: 21 medical literature, 6 sociology and/or social science literature, and 7 legal journals. The quality evaluation was as follows: good (3 studies), fair (20 studies), and poor (11 studies) (Table 3).

Six studies examined the overall effects of firearm laws on firearm homicides, but only 2 focused on the comprehensive categories of gun control laws in at least 4 categories of laws (Table 2).[16,36] These studies analyzed the number of gun control laws enacted by city or state, the leniency or strength of these laws, and the efficacy of specific types of laws (Table 1). The remaining 4 studies evaluated multiple individual laws within at least 4 categories of firearm legislation.[21,22,25,33]

One study,[16] published in 2013 and conducted by some of us (L.K.L., E.W.F., D.H., and M.C.M.) examined whether the "legislative strength score" of a state, based on the number and type of 28 possible laws to regulate firearms, was associated with a lower rate of firearm homicides using multivariate Poisson regression modeling to control for state socioeconomic (SES) and demographic factors. The 2013 study[16] found that states in the quartile with the highest legislative strength score had a lower adjusted incidence rate ratio (aIRR) for firearm homicide (0.60; 95% CI, 0.38-0.95) when compared with the states with the lowest strength score. The most recent study[21] (2016) analyzed the independent effect of firearm laws on firearm homicide and used multivariate Poisson regression modeling to control for state-specific characteristics, including firearm ownership. The study found that background checks and firearm identification laws (eg, laws requiring ballistic fingerprinting or microstamping to identify firearms) were associated with the largest reduction in firearm homicides; however, the results were mixed for the other laws.

Category 1. Curb Firearm Trafficking Legislation
This category of laws regulates the sale and trafficking of firearms including gun dealer regulations, limiting bulk purchases (eg, a person can buy only 1 handgun per month), banning sales of certain guns (eg, "Saturday night special" handguns—small, inexpensive, low-quality handguns that are easy to conceal but prone to

combination with other laws.[9,10] Herein, we update these previous reviews and focus on the effect of firearm laws on 1 specific outcome, firearm homicides.

Table 1. The 34 Articles on the Effects of Firearm Laws on Firearm Homicides Included in the Review

Source	Design, Statistical Analysis	Intervention, Comparison	Study Period, Location, Unit of Analysis	Reported Effect[a]
Beaver et al,[11] 1993	• Ecologic, before-and-after design[b] • Wilcoxon rank sum	• Intervention: Ban sales of "Saturday night specials" in MD • Comparison: MD firearm fatalities in children <16 y old before and after law	• 1979-1992 • MD • Firearm homicides in children <16 y old	• Increase in percentage of homicide deaths due to guns from 48% to 67% after law
Britt et al,[12] 1996	• Ecologic, time series • Reanalysis of data for Loftin,[13] 1991 study • ARIMA	• Intervention: Ban sales of handguns in Washington, DC • Comparison: Baltimore, MD (with no similar law)	• 1968-1987 • Washington, DC, and Baltimore, MD, • Monthly firearm homicides	• Both cities had a statistically significant decrease in monthly homicides during this time • No point estimate or P value reported.
Cummings et al,[14] 1997	• Ecologic, cross-sectional • Multivariate Poisson regression • Multivariate negative binomial regression	• Intervention: Passage of gun safe storage laws in 12 states • Comparison: Rate expected based on prior years, adjusted for secular trends. Rate compared with changes in United States overall	• 1979-1994 (156 state-years prelegislation, 36 state- years postlegislation) • 12 states (FL, IA, CT, NV, CA, NJ, WI, HI, VA, MD, MN, NC) • State-level firearm homicide rates in children <15 y old	• aIRR firearm homicide: 0.89 (95% CI, 0.76 to 1.05)
Fife and Abrams,[15] 1989	• Ecologic, time series • Univariate regression	• Intervention: Minimum sentence for crime with a gun • Comparison: NJ homicides before and after law	• 1974-1986 • NJ • Firearm homicide counts	• Firearm homicides became a decreasing proportion of all NJ homicides after the law • No point estimate or P value reported
Fleegler et al,[16] 2013	• Ecologic, cross-sectional • Multivariate Poisson regression	• Intervention: Legislative strength score based on category and number of laws in a state • Comparison: By strength quartile	• 2007-2010 • 50 US states • State-level firearm homicide rates	• Higher state legislative strength scores were associated with lower state rates of firearm homicides • aIRR, 0.60 (95% CI, 0.38 to 0.95)
French and Heagerty,[17] 2008	• Ecologic, time series • Multivariate generalized estimating and generalized linear mixed models	• Intervention: Repeal of gun use restriction (granting shall-issue status) • Comparison: State-level homicides before repeal	• 1979-1998 • 50 US states • State-level firearm homicide rates	• Effect of enacting shall-issue laws varies depending on analytic method, rate ratios from 0.93 to 1.10
Ginwalla et al,[18] 2014	• Ecologic, before-after design • χ^2, relative risk	• Intervention: State law allowing citizens to conceal carry a gun without a permit or training course • Comparison: Arizona homicides before law	• August 2008 to July 2012 • Southern Arizona • Firearm homicide counts	• Gun-related homicides significantly increased in the postlegislation period • RR, 1.27 (95% CI, 1.02 to 1.58)
Hepburn et al,[19] 2004	• Ecologic, cross-sectional • Multivariate negative binomial regression	• Intervention: Changes in state laws related to concealed carry of firearm to "shall issue" laws • Comparison: States without "shall issue" laws	• 1979-1998 • 50 US states • State-level firearm homicide rates	• No association between nondiscretionary concealed carry laws and firearm homicide • aIRR, 1.01 (95% CI, 0.94 to 1.01)
Irvin et al,[20] 2014	• Ecologic, time series • Multivariate Poisson regression	• Intervention: Regulations of federally licensed firearm dealers including state-required licensing, recording of sales, allowable inspections, and mandatory theft reporting laws • Comparison: Strength of these state regulations	• 1995-2010 • 50 US states • State-level firearm homicide rates	• Protective effect was stronger in states requiring both licensing and inspections of federally licensed firearm dealers: aIRR, 0.49 (95% CI, 0.42 to 0.58) • Lower homicide rates in states with at ≥3 laws regulating firearm dealers: aIRR, 0.76 (95% CI, 0.67 to 0.86)
Kalesan et al,[21] 2016	• Ecologic, cross-sectional • Multivariate Poisson regression	• Intervention: Different state firearm laws • Comparison: States without the laws	• 2008-2010 • 50 US states • State-level firearm homicide rates	• Firearm dealer report records to state: aIRR, 0.65 (95% CI, 0.53 to 0.81) • Mandatory theft reporting: aIRR, 2.16 (95% CI, 1.26 to 3.68) • Limit 1 handgun purchase/mo: aIRR, 1.81 (95% CI, 1.26 to 2.59) • Owner firearm identification: aIRR, 0.07 (95% CI, 0.02 to 0.29) • Owner theft reporting: aIRR, 0.42 (95% CI, 0.21 to 0.82) • Universal background checks: aIRR, 0.21 (95% CI, 0.07 to 0.63) • Ammunition background checks: aIRR, 0.07 (95% CI, 0.02 to 0.33) • Firearm locks: aIRR, 10.9 (95% CI, 2.95 to 40.6) • Child age restriction for firearms: aIRR, 0.83 (95% CI, 0.73 to 0.94) • Assault weapon ban: aIRR, 2.83 (95% CI, 1.30 to 6.20) • Law enforcement discretion permitted for carrying concealed weapons permits: aIRR, 1.83 (95% CI, 1.45 to 2.32)
Kleck et al,[22] 1993	• Ecologic, cross-sectional • Multivariate 2-stage least-squares model	• Intervention: Gun control laws • Comparison: Cities with different laws	• 1979-1981 • 170 US cities • City-level firearm homicide rates	• No effect of any type of gun control laws on homicide rates. • No point estimate or P value reported

(continued)

Table 1. The 34 Articles on the Effects of Firearm Laws on Firearm Homicides Included in the Review (continued)

Source	Design, Statistical Analysis	Intervention, Comparison	Study Period, Location, Unit of Analysis	Reported Effect[a]
Koper and Roth,[23] 2001	• Ecologic, cross-sectional • Multivariate pooled cross-sectional time series model	• Intervention: 1994 federal law banning sale of semi-automatic weapons and large-capacity magazines • Comparison: State homicide rates before passage of law	• 1980-1995 • 50 US states • State-level firearm homicide rates	• Slight decrease in gun homicide rate but not powered to detect statistical significance given the brief postlegislation time period • 6.7% Reduction in firearm homicide ($P = .35$)
La Valle et al,[24] 2012	• Ecologic, time series • Multivariate regression models	• Intervention: Passage of "right to carry" firearms "shall issue" laws and "may issue" laws • Comparison: City-level homicide rates prior to the laws	• 1980-2006 • 57 US cities • City-level firearm homicide rates	• "Shall issue" laws associated with increased homicide rate of 27% ($P < .05$) • "May issue" laws associated with homicide rate reduction of 26%-30% ($P < .05$ for all comparisons)
Lester and Murrell,[25] 1982	• Ecologic, cross-sectional • Principal component analysis	• Intervention: "Guttman scale of strictness" for handgun control statutes of 1968 • Comparison: By state strictness scale	• 1960 and 1970 • 50 US states • State-level firearm homicide rates	• The stricter the gun control in a state, the smaller the proportion of homicides committed by firearms, although this did not have an impact on the overall homicide rate
Loftin and McDowall,[26] 1981	• Ecologic, time series • ARIMA	• Intervention: 2-y mandatory sentence for felonies committed with a gun • Comparison: Detroit, MI homicides before the law	• 1969-1978 • Detroit, MI • Firearm homicide counts	• Statistically significant decline in firearm homicides after law implementation • Decline of 10.9 (95% CI, −17.1 to −4.6) firearm homicides per month
Loftin et al,[13] 1991	• Ecologic, interrupted time-series • ARIMA	• Intervention: Banned possession, transfer, purchase, or sales of handguns by civilians • Comparison: MD and VA (without these laws)	• 1968-1987 • Washington, DC • Firearm homicide counts	• Restrictive handgun licensing associated with 25% decline (13-9.7/mo) in firearm homicides in Washington, DC, no change in MD or VA cities
Lott and Mustard,[27] 1997	• Ecologic, time series • Multivariate weighted 2-stage least-squares regression	• Intervention: Effect of "shall issue" concealed weapon carry laws • Comparison: States and counties with no "shall issue" laws	• 1982-1991 • US counties with population >100 000 people • County-level firearm homicide rates	• Counties with "shall issue" laws have 9% decrease in rates of gun homicides
Ludwig and Cook,[28] 2000	• Ecologic time series • Multivariate regression models	• Intervention: Brady Act mandating federal background checks and 5-d waiting period on handgun purchases • Comparison: Firearm homicide rates before passage of law	• 1985-1997 • 50 US states • State-level firearm homicide rates	• No reduction in homicide rates with Brady Act in all models • Weighted least-squares model: aIRR, −0.12 (95% CI, −1.12 to 0.88) • Negative binomial model: aIRR, 0.99 (95% CI, 0.86 to 1.13)
Mahler and Fielding,[29] 1977	• Ecologic, before-and-after design[b] • Percentage change	• Intervention: Mandated 1-y jail sentence for anyone convicted of a violation of firearm licensing and registration laws • Comparison: Firearm homicide counts before the law	• 1974-1976 • Boston, MA • Firearm homicide counts	• Homicides by firearms decreased by 31% (141 to 97). The proportion of homicides by firearm decreased from 52% to 46% after the law
Marvell and Moody,[30] 1995	• Ecologic, pooled time series • Multivariate linear regression	• Intervention: Firearm sentence enhancement, including minimum sentence/extra prison term for felony with gun) • Comparison: States without firearm sentence enhancement laws	• 1970-1993 • 50 US states • State-level firearm homicide rates	• No association between firearm homicide and either the aggregate or individual firearm sentence enhancement measures. • Coefficient = 0.02, $t = 0.79$
Marvell,[31] 2001	• Ecologic, time series • Multivariate, time series regression, weighted by state size, fixed-effect models	• Intervention: Passage of law banning juvenile (<18 y) gun possession • Comparison: States without this law	• 1970-1998 • 50 US states • State-level firearm homicide rates	• No significant change in firearm homicide in victims 15-24 y old, all ages. • No point estimate or P value reported
McDowall et al,[32] 1995	• Ecologic, interrupted time-series • ARIMA	• Intervention: Change from "may issue" to "shall issue" for firearm concealed carry • Comparison: Firearm homicide rates before the statute change	• 1973-1992 • Large urban areas within FL, MS, and OR • City-level monthly firearm homicide rates	• Easing concealed carry restrictions was associated with an increase in firearm homicides in 4 out of 5 large urban areas studied • Annual average increase in firearm homicides of 4.5 firearm homicides per 100 000 persons ($P < .05$)
Murray et al,[33] 1975	• Ecologic, cross-sectional • Multivariate regression	• Intervention: 7 Gun control laws • Comparison: States without these laws	• 1970 • 50 US states • Firearm homicide counts	• No law had a significant effect on a single measure of violence • No point estimate or P value reported.
O'Carroll et al,[34] 1991	• Ecologic, interrupted time-series • ARIMA	• Intervention: Mandatory imprisonment if convicted of unlawfully carrying or concealing a firearm in Detroit, MI • Comparison: Detroit, MI firearm homicides before ordinance	• 1980-1987 • Detroit, MI • Monthly firearm homicide counts	• No significant change in firearm homicides • 13% Increase in firearm homicides ($P= .24$)
Olson and Maltz,[35] 2001	• Ecologic, pooled time series • Multivariate weighted ordinary least-squares regression	• Intervention: Shall-issue concealed firearm statutes • Comparison: Firearm homicide rates prior to the statues	• 1977-1992 • Large counties within 10 states (FL, GA, ID, ME, MS, MT, OR, PA, VA, WV) • County-level firearm homicide rates	• Right-to-carry laws associated with a 20.9% reduction in homicide

(continued)

Table 1. The 34 Articles on the Effects of Firearm Laws on Firearm Homicides Included in the Review (continued)

Source	Design, Statistical Analysis	Intervention, Comparison	Study Period, Location, Unit of Analysis	Reported Effect[a]
Price et al,[36] 2004	• Ecologic, cross-sectional • ANCOVA	• Intervention: Various gun control laws • Comparison: Different states with various laws	• 1999 • 50 US states • State-level firearm homicide rates	• State gun laws had limited effects on firearm related homicides ($r = 0.311$)
Rosengart et al,[37] 2005	• Ecologic, time series • Multivariate Poisson regression	• Intervention: "Shall issue," age restriction and junk gun ban laws • Comparison: Different states with various laws	• 1979-1998 • 50 US states • State-level firearm homicide rates (person-years)	• No law was associated with a decrease in firearm homicide rates • "Shall issue" law: aIRR, 1.11 (95% CI, 0.99 to 1.24) • Minimum age, 21 y for purchase: aIRR, 0.98 (95% CI, 0.91 to 1.06) • Minimum age, 21 y for possession: aIRR, 1.06 (95% CI, 0.88 to 1.27) • 1 Gun purchase/ mo: aIRR, 1.02 (95% CI, 0.89 to 1.17) • Junk gun ban: aIRR, 0.94 (95% CI, 0.73 to 1.19)
Ruddell and Mays,[38] 2005	• Ecologic, cross-sectional • Multivariate ordinary least-squares regression	• Intervention: Strength of state laws for background checks • Comparison: States with less comprehensive state laws for background checks	• 1999-2001 • 50 US states • State-level firearm homicide rates	• States with less stringent background checks on firearm purchases were significantly associated with firearm homicides • Adjusted r^2: 0.799
Rudolph et al,[39] 2015	• Ecologic, time-series using synthetic controls • Multivariate permutation-based test	• Intervention: CT's handgun permit-to-purchase law • Comparison: Synthetic control of CT firearm homicides had the law not been implemented	• 1984-1994, 1996-2005 • CT • State-level firearm homicide rates	• 40% Decrease in CT's firearm homicide rates during the first 10 y of the law, but no change in nonfirearm homicides
Sen and Panjamapirom,[40] 2012	• Ecologic, time-series • Multivariate negative binomial regression model	• Intervention: Type of background information states used to perform background checks • Comparison: Index of laws in states with different background check requirements and states checking for criminal history only	• 1996-2005 • 50 US states • Homicide counts	• Lower firearm homicide rates in states with higher index of background check laws: aIRR, 0.93 (95% CI, 0.91 to 0.96) • Restraining orders: aIRR, 0.87 (95% CI, 0.79 to 0.95) • Fugitive status: aIRR, 0.79 (95% CI, 0.72 to 0.88)
Sloan et al,[41] 1988	• Ecologic, cross-sectional • Univariate analysis	• Intervention: Seattle, WA, firearm regulations (20-y minimum prison sentence for first-degree murder, permit for concealed weapons on the street) • Comparison: Vancouver, Canada regulations (25-y minimum prison sentence for first-degree murder, restricted-weapons permit required for sporting/collecting)	• 1980-1986 • Seattle, WA and Vancouver, Canada • City-level firearm homicide rates	• Increased risk of being a victim of firearm homicide in Seattle compared with Vancouver: RR, 5.08 (95% CI, 3.54 to 7.27)
Sumner et al,[42] 2008	• Ecologic, cross-sectional • Multivariate negative binomial regression	• Intervention: States using state or county level agencies for background checks • Comparison: States using federal-level agencies for background checks	• 2002-2004 • 50 US states • State-level firearm homicide rates	• No statistically significant difference in homicide rates in states using state or local agencies for background checks compared with states using federal level agencies. • State level: aIRR, 0.84 (95% CI, 0.65 to 1.08) • Local level: aIRR, 0.78 (95% CI, 0.61 to 1.01)
Webster et al,[43] 2002	• Ecologic, time series • ARIMA	• Intervention: Maryland law banning "Saturday night special" handguns • Comparison: Homicide rates before-and-after law	• 1975-1998 • Maryland • State-level firearm homicide rates	• Models with the assumption of a gradual effect of the ban produced estimates with firearm homicide rates lower than expected • Delayed start, constant effect: −11.5% (95% CI −17.3 to −2.4) • Immediate start, gradual effect: −8.6% (95% CI −14.5 to −2.6) • Delayed start, gradual effect: -6.8 (95% CI, −13.2 to −0.3)
Webster et al,[42] 2014	• Ecologic, time series • Multivariate generalized least-squares regression models	• Intervention: Repeal of Missouri's permit-to-purchase law in 2007 • Comparison: Homicide rates after repeal of the law	• 1999-2012 • Missouri state-level firearm homicide rates	• In the postrepeal period (2008-2010), mean annual firearm homicide rate was 29% higher than prerepeal mean (*P*= .001). During the same period, mean firearm homicide rate in the United States declined

Abbreviations: ARIMA, autoregressive integrated moving average (time series analytical technique); aIRR, adjusted incidence rate ratio; ANCOVA, analysis of covariance.

[a] Studies in which a relevant point estimate is reported are included in this this table.

[b] Before-and-after design compares counts or percentages of homicides within the unit of analysis (eg, states or cities) in the years before the law to that in the years after the law.

malfunction), and requiring firearm identification technology. Also included are laws requiring mandatory reporting of lost or stolen guns by firearm owners and those imposing specific sentencing for crimes committed with a gun.[16] Seventeen studies[11-13,15,16,20-22,25,26,29,30,33,34,36,37,43] related to these laws and their effects on firearm homicide were reviewed.

Table 2. Categories of Firearm Laws Considered in the 34 Articles

| Source | Category of Firearm Laws | | | | |
	Curb Firearm Trafficking	Strengthen Background Checks	Child Safety	Ban Military-Style Assault Weapons	Restrict Firearms in Public Places
Beaver et al,[11] 1993	X				
Britt et al,[12] 1996	X				
Cummings et al,[14] 1997			X		
Fife and Abrams,[15] 1989	X				
Fleegler et al,[16] 2013	X	X	X	X	X
French and Heagerty,[17] 2008					X
Ginwalla et al,[18] 2014					X
Hepburn et al,[19] 2004					X
Irvin et al,[20] 2014	X				
Kalesan et al,[21] 2016	X	X	X	X	X
Kleck and Patterson,[22] 1993	X	X	X		X
Koper and Roth,[23] 2001				X	
La Valle and Glover,[24] 2012					X
Lester and Murrell,[25] 1982	X	X	X		X
Loftin and McDowall,[26] 1981	X				
Loftin et al,[13] 1991	X				
Lott and Mustard,[27] 1997					X
Ludwig and Cook,[28] 2000		X			
Mahler and Fielding,[29] 1977	X				
Marvell and Moody,[30] 1995	X				
Marvell,[31] 2001			X		
McDowall et al,[32] 1995					X
Murray,[33] 1975	X	X	X		X
O'Carroll et al,[34] 1991	X				
Olson and Maltz,[35] 2001					X
Price et al,[36] 2004	X	X	X	X	X
Rosengart et al,[37] 2005	X		X		X
Ruddell and Mays,[38] 2005		X			
Rudolph et al,[39] 2015		X			
Sen and Panjamarpirom,[40] 2012		X			
Sloan et al,[41] 1988					X
Sumner et al,[42] 2008		X			
Webster et al,[43] 2002	X				
Webster et al,[45] 2014		X			
Total articles	17	12	9	4	15

Review of Evidence: Effectiveness

Gun Dealer Regulations | Five studies[20-22,25,33] investigated the effects of gun dealer regulations. These laws include requiring a state license for gun dealers, record keeping and retention by dealers, records reported to and maintained by the state, mandatory theft reporting for all firearms, store security precautions, and allowing police inspections of dealers.[16] The earliest of these studies[22,25,33] concluded that these laws were not associated with an effect on firearm homicides. Another study[20] examined firearm homicide rates from 1995 to 2010 and found that states requiring firearm dealer regulations with licensing and police inspections had lower firearm homicide rates, even after controlling for sociodemographic factors. This effect was stronger in states requiring both state licensing and inspections of firearm dealers (aIRR, 0.49; 99% CI, 0.42-

0.58). A study[21] published in 2016 reported mixed results for 6 different laws in this category.

Limit Bulk Purchases | Two studies[21,37] addressed legislation limiting bulk purchases of firearms, allowing the purchase of only 1 gun a month. One study used multivariate analysis, including state-level demographic and SES variables and other firearm laws, and found no statistical association between firearm homicide rates and limiting bulk purchases.[37] Another study[21] reported an increased risk of firearm homicides with this law (aIRR, 1.81; 95% CI, 1.26-2.59).

Ban Sales of Certain Guns | Five studies[11-13,37,43] focused on legislation banning the sale of handguns (including Saturday night specials). One study looked only at the numbers of firearm-related deaths in children younger than 16 years in Maryland before and after

Table 3. Evaluation of Firearm Law Articles

Source	Appropriate Data Source/ Outcome Measure	Appropriate Time Frame Studied?	Are Appropriate Statistical Tests Used?	Robustness of Results to Changes in Variables	Do the Disaggregated Results and Results of the Control Variables Make Sense?	Overall Quality Score[a]
Beaver et al,[11] 1993[b]	1. Data source appropriate: • MD Mortality File (Bureau of Vital Statistics) • Office of the Chief Medical Examiner data 2. Outcome measure not appropriate: firearm homicide counts in children <16 y for handgun legislation	Yes: 1979-1987 (before law limiting sales of "Saturday night specials"), 1988-1992 (after the law)	No: Only Wilcoxon rank sum test	No other variables assessed	No other variables assessed	1
Britt et al,[12] 1996[c]	1. Data source appropriate: • FBI Supplementary Homicide Reports • NCHS mortality files 2. Outcome measure appropriate: firearm homicide counts in Washington, DC compared with control city Baltimore, MD	Yes: 1968-1976 (before 1976 law to register all handguns and ban sales of new handguns), 1976-1987 (after law)	Indeterminate: Used ARIMA for interrupted time series with control city. There are challenges to interpreting the results. They outlined a useful approach for modeling when laws should have an effect	Yes: General pattern of results consistent across analyses	Unable to determine based on data included in the article	1
Cummings et al,[14] 1997[d]	1. Data source appropriate: • NCHS mortality files 2. Outcome measure appropriate: Firearm homicide rates in children <15 y old	Yes: 1979-1994, Gun safe storage state laws passed over 4 y (156 state-years prelegislation, 36 state-years postlegislation)	Yes: Multivariate Poisson regression and negative binomial regression	Yes: General pattern of results consistent across analyses	Yes	3
Fife and Abrams,[15] 1989[c]	1. Data source appropriate: • NCHS mortality files 2. Outcome measure appropriate: NJ firearm homicides counts	Yes: 1974-1980 (before 1980 mandatory sentencing law), 1981-1986 (after law)	No: Frequency of homicide counts before and after law	No other variables assessed	No other variables assessed	1
Fleegler et al,[16] 2013[d]	1. Data source appropriate: • WISQARS 2. Outcome measure appropriate: US firearm homicide rates	Yes: 2007-2010, State firearm laws	Yes: Multivariate Poisson regression with clustering by state	Yes	Yes	3
French and Heagerty,[17] 2008[c]	1. Data source appropriate: • NCHS mortality files 2. Outcome measure appropriate: US firearm homicide rates	Yes: 1979-1998 State shall-issue laws	Yes: Comparison of multivariate models (GEE, GLM, random effects meta-analysis, empirical Bayes) for analyzing policy change.	Yes: General pattern of results consistent across analyses	Unable to determine based on data included in the article	2
Ginwalla et al,[18] 2014[b]	1. Data source inappropriate: • Tucson, AZ, police department for crime data, "Population at risk," defined as number of crime events and accidents. • Single hospital data 2. Outcome measure appropriate: Firearm homicide counts in southern Arizona	Yes: 2008-2010 (before 2010 repeal of concealed carry gun law), 2010-2012 (after law)	No: χ² calculated relative risk	No other variables assessed	No other variables assessed	1
Hepburn et al,[19] 2004[d]	1. Data source appropriate: • NCHS mortality files 2. Outcome measure appropriate: US firearm homicide rates	Yes: 1979-1998, State concealed firearm laws	Yes: Multivariate negative binomial regression; unit of analysis was state-year; sensitivity analysis included	Yes: General pattern of results consistent across analyses	No: Some expected associations with homicide not found for state-level predictors. Control data inconsistent.	2
Irvin et al,[20] 2014[c]	1. Data source appropriate: • WISQARS 2. Outcome measure appropriate: US firearm homicide rates	Yes: 1995-2010, State firearm dealer regulation laws	Yes: Multivariate Poisson regression, but aggregated all data across time	No other models/variables assessed	No: Unable to determine based on data included in the manuscript	2
Kalesan et al,[21] 2016[d]	1. Data source appropriate: • WISQARS 2. Outcome measure appropriate: US firearm homicide rates	Yes: 2008-2010, State firearm laws	Yes: Multivariable Poisson regression	Yes: General pattern of results consistent across analyses	Not reported	2
Kleck and Patterson,[22] 1993[d]	1. Data source appropriate: • NCHS mortality files 2. Outcome measure appropriate: Firearm homicides in 170 large cities	Yes: 1979-1981, Multiple gun control laws	No: Linear model used for rate outcome; perhaps overfitted with too many covariates	Yes: General pattern of results consistent across analyses	Mixed results	1

(continued)

Table 3. Evaluation of Firearm Law Articles (continued)

Source	Appropriate Data Source/ Outcome Measure	Appropriate Time Frame Studied?	Are Appropriate Statistical Tests Used?	Robustness of Results to Changes in Variables	Do the Disaggregated Results and Results of the Control Variables Make Sense?	Overall Quality Score[a]
Koper and Roth,[23] 2001[d]	1. Data source appropriate: • FBI UCR 2. Outcome measure appropriate: US firearm homicide rates	Yes: 1980-1995, Projections of 1995 firearm homicide rates based on 1980-1995 cross-sectional models for impact of 1994 federal assault weapon ban	No: Analytic decisions likely had an impact on results and linear model used for rate outcome	Yes: General pattern of results consistent across analyses	Mixed results	1
La Valle and Glover,[24] 2012[c]	1. Data source appropriate: • FBI UCR 2. Outcome measure appropriate: Firearm homicide rates in 57 US cities	Yes: 1980-2006, State "right to carry" laws	Unclear: Based on descriptions in article	Yes: General pattern of results consistent across analyses	Yes	2
Lester and Murrell,[25] 1982[d]	1. Data source appropriate: • NCHS (Vital Statistics of the US) 2. Outcome measure appropriate: US firearm homicide rates	Yes: 1960 and 1970 for state gun laws in 1968	No: Used unadjusted correlations with 1-tailed tests	Yes: General pattern of results consistent across analyses	No other variables assessed	1
Loftin and McDowall,[26] 1981[c]	1. Data source appropriate: • Vital and Health Statistics, MI Department of Public Health 2. Outcome measure appropriate: Detroit homicide counts	No: 1969-1978, Mandatory sentencing law enacted January 1977	Yes	No other variables assessed	No other variables assessed	1
Loftin et al,[13] 1991[c]	1. Data source appropriate: • NCHS mortality files 2. Outcome measure appropriate: Firearm homicide counts in Washington, DC, and metropolitan areas in MD and VA	Yes: 1968-1975 (before gun-licensing law enacted in 1977), 1976-1987 (after law)	Yes: However, there was no adjustment for other variables	No other variables assessed	No other variables assessed	2
Lott and Mustard,[27] 1997[c]	1. Data source appropriate: • FBI UCR Supplementary Homicide Reports 2. Outcome measure appropriate: Firearm homicide rate, counties >100 000 people	Yes: 1982-1991, State "shall issue" firearm laws	Yes: Multivariate 2-stage least-squares regression, weighted by county size	Yes: General pattern of results consistent across analyses	Not reported	2
Ludwig and Cook,[28] 2000[c]	1. Data source appropriate: • NCHS mortality files 2. Outcome measure appropriate: US firearm homicide rates	Yes: 1985-1994 before Brady Handgun Violence Prevention Act, 1994-1997 after law	Yes: Multivariate regression model	Yes: General pattern of results consistent across analyses	Not reported	2
Mahler and Fielding,[29] 1977[b]	1. Data source appropriate: • MA Department of Public Health 2. Outcome measure not appropriate: Homicide counts in Boston	No: 1974-1976 for mandatory sentencing law enacted April 1975	No	No other variables assessed	No other variables assessed	1
Marvell and Moody,[30] 1995[c]	1. Data source appropriate: • FBI UCR 2. Outcome measure appropriate: US firearm homicide rates	Yes: 1970-1993, State firearm sentence enhancement laws	Yes	Yes: General pattern of results consistent across analyses	Not reported	2
Marvell,[31] 2001[c]	1. Data source appropriate: • WISQARS 2. Outcome measure appropriate: US firearm homicide rates	Yes: 1970-1998, for 1994 federal law banning juvenile gun possession	Yes: Specifics about multiple time series regression not reported	Yes: General pattern of results consistent across analyses	Mixed results	2
McDowall et al,[32] 1995[c]	1. Data source appropriate: • NCHS mortality files 2. Outcome measure appropriate: Firearm homicide rates for selected counties in 3 states	Yes: 1973-1992 State concealed firearms laws, (specific number of months varied by county)	Yes: ARIMA interrupted time series models; compared 3 different model specifications	Yes: General pattern of results consistent across analyses	Not reported	2
Murray,[33] 1975[d]	1. Data source appropriate: • NCHS mortality files 2. Outcome measure appropriate: US firearm homicide counts	Yes: 1970 state gun control laws	Yes: Stepwise multivariable regression with social factors	Not reported.	Mixed results	2
O'Carroll et al,[34] 1991[c]	1. Data source appropriate: • Detroit City Police Department official report of homicides 2. Outcome measure appropriate: Detroit firearm homicide counts	No: 1980-1987, city ordinance requiring mandatory sentencing for carrying firearm in public effective January 1987; not enough postlegislation data	No: ARIMA interrupted time series models; modeled number of deaths, not rates	No other variables assessed	No other variables assessed	1

(continued)

Table 3. Evaluation of Firearm Law Articles (continued)

Source	Appropriate Data Source/ Outcome Measure	Appropriate Time Frame Studied?	Are Appropriate Statistical Tests Used?	Robustness of Results to Changes in Variables	Do the Disaggregated Results and Results of the Control Variables Make Sense?	Overall Quality Score[a]
Olson and Maltz,[35] 2001[c]	1. Data source appropriate: • FBI supplementary homicide report • Reanalysis of Lott and Mustard[27] data using 16% of data 2. Outcome measure appropriate: firearm homicide rates in 1977 in counties with population >100 000 people	Yes: 1977-1992 Prelegislation and postlegislation "right to carry" law periods varied by state	Yes: Multivariate weighted ordinary least-squares regression, weighted by county size	Yes: General pattern of results consistent across analyses	No: Meaning and significance level of presented coefficients difficult to interpret	2
Price et al,[36] 2004[d]	1. Data source appropriate: • WISQARS 2. Outcome measure appropriate: State firearm homicide rates	Yes: 1999 State firearm laws	No: Only used crude and adjusted Pearson (ANCOVA)[2+] correlations	Yes: General pattern of results consistent across analyses	Yes	1
Rosengart et al,[37] 2005[c]	1. Data source appropriate: • NCHS mortality files 2. Outcome measure appropriate: US firearm homicides	Yes: 1979-1998, State firearm laws	Yes: Poisson multivariate regression with state and year dummy variables and robust standard errors	Yes: General pattern of results consistent across analyses	Not reported	2
Ruddell and Mays,[38] 2005[d]	1. Data source appropriate: • CDC mortality files 2. Outcome measure appropriate: US firearm homicide rates	Yes: 1991-2001, State firearm laws	Yes: Multivariate ordinary least-squares regression	Yes: General pattern of results consistent across analyses (5 different models)	Yes	3
Rudolph et al,[39] 2015[c]	1. Data source appropriate: • CDC WONDER database 2. Outcome measure appropriate: Connecticut firearm homicide rate	Yes: 1984-1994 (before 1995 permit-to-purchase law), 1996-2005 (after law)	Yes: Synthetic control method approach with permutation-based testing	Yes: General pattern of results consistent across analyses	Not reported	2
Sen and Panjamapirom,[40] 2012[c]	1. Data source appropriate: • WISQARS 2. Outcome measure appropriate: US firearm homicide counts	Yes: 1996-2005 state background check laws	Yes: Multivariate negative binomial regression with robust standard errors	Yes: General pattern of results consistent across analyses; results robust to using aggregate vs specific background check variables	Mixed	2
Sloan et al,[41] 1988[d]	1. Data source appropriate: • City records for both firearm ownership and homicide 2. Outcome measure appropriate: Firearm homicide rates in Seattle, WA, and Vancouver, Canada	Yes: 1980-1986	Yes: Univariate comparison of rates, adjusted for age and sex	Yes: General pattern of results consistent across analyses	Not reported	2
Sumner et al,[42] 2008[d]	1. Data source appropriate: • WISQARS 2. Outcome measure appropriate: US firearm homicides	Yes: 2002-2004	Yes: Multivariate negative binomial regression	Yes: General pattern of results consistent across analyses	Not reported	2
Webster et al,[43] 2002[c]	1. Data source appropriate: • NCHS mortality files 2. Outcome measure appropriate: Firearm homicide rates in MD, VA, and PA	Yes: 1975-1998, "Saturday night special" handgun ban law enacted in 1990	Yes: ARIMA interrupted time-series models adjusting for several variables	Yes: General pattern of results consistent across analyses	Not reported	2
Webster et al,[45] 2014[c]	1. Data source appropriate: • WISQARS • WONDER 2. Outcome measure appropriate: Missouri firearm homicide rates	Yes: 1999-2007 (before 2007 repeal of Missouri's permit-purchase law, 2008-2010 (after law)	Yes: Multivariate generalized least-squares regression with robust standard errors and fixed effects of state and year	No other variables assessed	Mixed results	2

Abbreviations: ANCOVA, analysis of covariance; ARIMA, Autoregressive Integrated Moving Average; CDC, Centers for Disease Control and Prevention; FBI, Federal Bureau of Investigation; GEE, generalized estimating equations; GLM, generalized linear mixed models; NCHS, National Center for Health Statistics; UCR, Unified Crime Reports; WISQARS, Web-based Injury Statistics Query and Reporting System, Centers for Disease Control and Prevention; WONDER, Wide-ranging Online Data for Epidemiologic Research.

[a] Scored as 1 = poor, 2 = fair, 3 = good.

[b] Before-and after study design.

[c] Time series study design.

[d] Cross-sectional study design.

a law limited sales of Saturday night specials. Of all firearm injuries, the percentage due to firearm homicide increased after the law.[11] Loftin et al[13] used autoregressive, integrated, moving-average time series (ARIMA) models to evaluate the effects of restrictive licensing of handguns in Washington, DC, and found that the mean frequency of firearm homicide decreased from 13.0 per month before the law (1968-1976) to 9.7 per month after the law (1976-1987), with no change in adjacent metropolitan areas in Maryland and Virginia,

where these laws were not implemented. Britt et al[12] conducted a reanalysis of these data and claimed to refute the original findings. They stated that an inappropriate control population was used for comparison in the original analysis and that Baltimore, Maryland (with no such law), also had decreased firearm homicide rates.

Only 2 studies in this legislative category used multivariate analyses. Rosengart et al[37] used multivariate Poisson regression to evaluate US states with laws banning the sales of "junk guns" and found no decrease in firearm homicide rates. Webster et al[43] used ARIMA while considering SES factors and estimated that homicide rates were 8.6% lower (95% CI, −14.5 to −2.6) in Maryland after the law banning the sale of Saturday night specials than expected without the law.

Minimum and Mandatory Sentencing for Crimes With Firearms | Six studies[15,22,26,29,30,34] focused on the effect of mandatory or minimum sentencing for crimes committed with firearms. Four studies,[15,26,29,34] from the 1970s to the 1990s, examined the effect of these laws on firearm homicides, but due to methodologic limitations no specific conclusions can be drawn. The study by Kleck and Patterson[22] of a mandatory penalty law for illegal gun carrying and the study by Marvell et al[30] of a firearm sentence enhancement law used multivariate modeling, and neither found an effect of these laws on the rate of firearm homicides.[22]

Conclusions
The relatively large body of evidence from 17 studies about firearm trafficking has conflicting or inconclusive results. The evidence does not support a firm conclusion that gun trafficking laws are associated with decreased firearm homicide rates. Most studies lacked robust methodologies. Many did not use multivariate analysis to control for other state-level factors (eg, SES, other gun control laws). Some studies examined only firearm homicide counts and not rates over time.

Category 2. Strengthen Background Checks
Laws mandating background checks attempt to act both directly, by reducing the number of firearms sold to potential perpetrators, and indirectly, by reducing the number of secondary firearm transfers without background checks, which are often the source of firearms used in homicides.[28] In 1993, the Brady Handgun Violence Prevention Act[47] was enacted, mandating that federally licensed firearms dealers perform federal background checks and instituting a 5-day waiting period for all individuals purchasing a handgun (the waiting period provision ended in 1998). Twelve studies examined the effects of the laws strengthening background checks on firearm homicides.[16,21,22,25,28,33,36,38-40,42,45]

Review of Evidence: Effectiveness
Five studies[16,21,22,33,36] addressed background checks within their analyses of more comprehensive firearm legislation, and 2 studies[16,21] concluded these laws may be protective. One study[16] found that laws strengthening Brady Act background checks were associated with a decreased aIRR for firearm homicide (0.91; 95% CI, 0.84-0.99), which was the only category of law associated with a decreased rate of firearm homicide. Another study[21] reported that of the laws addressing background checks, universal background checks (aIRR, 0.21; 95% CI, 0.07-0.63) and ammunition background checks (aIRR, 0.07; 95% CI, 0.02-0.33) were associated with reductions in firearm homicide.

Brady Act | Ludwig and Cook[28] evaluated the effect of the Brady Handgun Violence Prevention Act on rates of firearm homicide. Their multivariate models controlled for SES as well as the overall rate of US gun violence. They concluded that the Brady Act was not associated with reduced firearm homicide rates (aIRR, −0.12; 95% CI, −1.12 to 0.88).

Background Check Requirements | Four studies[21,38,40,42] focused exclusively on background check requirements for firearm purchasers. All found that more inclusive background checks were associated with lower firearm homicide rates, especially in states with more comprehensive background check laws.[38,40]

Permit-to-Purchase Laws | Four studies[25,33,39,45] evaluated permit-to-purchase firearm laws. Two older studies[25,33] analyzed the effect of permit-to-purchase laws and concluded that there was no effect on firearm homicide. Webster et al[45] examined the effect of repealing a permit-to-purchase gun law in Missouri in 2008, eliminating the permit process and mandatory background checks for handguns, and found the mean annual firearm homicide rate was 29% higher than prerepeal (P = .001). Rudolph et al[39] analyzed the 10-year effect of Connecticut's permit-to-purchase law on firearm homicide using a synthetic control method (an estimate from a weighted combination of 39 other states represented the homicide trends that Connecticut would have experienced in the absence of the law) and concluded there was a 40% reduction in firearm homicide rates.

Conclusions
The overall evidence from 12 studies supports the conclusion that laws that strengthen background checks and that require a permit to purchase a firearm are associated with a decrease in firearm homicides.

Category 3. Improve Child Safety
Child safety laws include requiring the sale of guns with mechanical trigger locks, mandating age restrictions for gun purchases, and Child Access Prevention (CAP) laws that increase gun owner liability for improperly stored firearms that injure children or cause injuries perpetrated by children.[14,16] Nine studies[14,16,21,22,25,31,33,36,37] addressing the impact of child safety laws on firearm homicide were evaluated. Two studies[16,36] that analyzed child safety laws as part of more comprehensive gun control legislation did not find any decrease in firearm homicide rates associated with these laws.

Review of Evidence: Effectiveness

Child Access Prevention Laws | Cummings et al[14] specifically investigated the impact of safe storage laws on child firearm mortality nationally from 1979 to 1994 and found no statistically significant reduction in firearm homicide in children younger than 15 years.

Juvenile Age Restrictions | In 1994, Title XI of the Federal Crime Control and Law Enforcement Act prohibited the possession of handguns by persons younger than 18 years, with certain exceptions (eg, hunting or target shooting).[31] Five studies[21,25,31,33,37] evaluated age restrictions on firearm purchase and/or use. Only 1 study[21] found any effect of these laws on firearm homicides (aIRR, 0.83; 95% CI, 0.73-0.94).

Conclusions

The overall evidence from the 9 studies related to laws improving child safety do not support the effectiveness of child protection laws for decreasing firearm homicides.

Category 4. Ban Military-Style Assault Weapons

Fully automatic weapons have been stringently regulated in the United States since 1934; however, semiautomatic weapons, including military-style assault weapons, are widely available for civilian purchase and use.[23] For 10 years, from 1994 to 2004, the Federal Violent Crime Control and Law Enforcement Act (Federal Assault Weapons Ban) banned the production of military-style semiautomatic firearms and limited the sale of ammunition magazines holding more than 10 rounds.[23] Proponents of the regulation argued that these weapons pose specific risk owing to their ability to fire a high number of shots in rapid succession. Four studies[16,21,23,36] researched the effects of this law on firearm homicides.

Review of Evidence: Effectiveness

Following the Federal Assault Weapons Ban, Congress mandated a study on the impact of this law. Koper and Roth[23] compared prelegislation and postlegislation firearm homicide rates and found a 6.7% reduction, which was not statistically significant. The authors suggested this was due to the brief postintervention time period studied. Three studies[16,21,36] examined laws banning assault weapons in the context of other firearm-related laws; none found a decrease in firearm homicides.

Conclusions

Limited data from 4 studies on the effects of the federal assault weapons ban (in effect from 1994 to 2004) do not provide evidence that the ban was associated with a significant decrease in firearm homicides.

Category 5. Restrict Firearms in Public Places

Laws to restrict firearms in public places establish who is legally permitted to carry firearms on their person, how the firearm is carried (in plain sight or hidden from view, or "concealed"), and whether firearms can be carried in specific locations (eg, schools, bars, workplace).[16] These laws have been enacted and repealed at the national, state, and local level over the course of several decades. Fifteen studies[16-19,21,22,24,25,27,32,33,35-37,41] related to these laws and their effects on firearm homicide.

Review of Evidence: Effectiveness

Right to Concealed Carry | There are 2 primary types of concealed carry laws. *Shall issue* laws stipulate the government *must* issue a permit to carry a concealed weapon to any person who meets a set of minimum criteria (ie, passes a federal National Instant Criminal Background Check System [NICS]). The *may issue* standard, which is more restrictive than *shall issue*, stipulates that local law enforcement (ie, the local police chief) has the discretion to approve or deny a person's concealed carry application, even if the person can pass a NICS background check. Eight studies[17,19,21,24,27,32,35,37] examined change from 1 standard (eg, *may issue*) to the other (*shall issue*) on firearm homicides. Three studies—2 examining city level[24,32] and 1 analyzing state level[37] data—concluded that changes to a more permissive standard (ie, *may issue* to *shall issue*) were associated with increased firearm homicide rates. Two studies[27,35] analyzing county level data found right to carry laws (*shall issue*) were associated with decreased firearm homicides. One state-level study[21] reported a *may issue* law was associated with increased firearm homicide. The 2 other studies[17,19] did not detect a statistically significant association.

Presence of Guns in Public Spaces | Seven other studies[16,18,22,25,33,36,41] examined the laws regulating the presence of firearms in public spaces, including those concerning a permit to carry concealed firearms. Two of these studies[16,36] examined this category of laws in the context of overall state firearm laws, and 3 studies[22,25,33] examined firearm laws regulating permits for open carry along with other firearm laws. None of these studies found an association between these laws and firearm homicide rates. One study[41] compared rates of firearm homicide in Seattle, Washington, with Vancouver, British Columbia, Canada, where harsher penalties for firearm crimes were in place and concealed public gun carrying is not allowed, and found the relative risk for firearm homicide in Seattle was 5.08 (95% CI, 3.54-7.27), compared with the risk in Vancouver. No differences were found between the cities in nonfirearm homicide.[41] Another study[18] analyzed the frequency of firearm homicide in southern Arizona after repeal of a concealed weapons law and the subsequent allowance of the concealed carrying of a firearm without a permit; the study found that the proportion of firearm homicides increased.

Conclusions

From 15 studies, there is inclusive evidence for the effectiveness of laws to restrict firearms in public places in reducing firearm homicide. Some evidence suggests that permitting the concealed carrying of firearms is associated with increases in firearm homicide.[24,37,41] However, there are also methodologically sophisticated studies that failed to replicate these findings.[16,17,19]

Discussion

Compared with other high-income countries, the United States has among the lowest rates of assault, but the rates of firearm homicide far surpass those of the other industrialized nations. The annual US firearm homicide rate is 3.6 per 100 000 persons while Australia (0.2 per 100 000 persons) and the United Kingdom (0.0 per 100 000 persons) have much lower rates.[48,49] Since 1968, more American civilians have been murdered with guns than American soldiers have been killed in combat by any means.[50] Given the magnitude of the problem, it is disconcerting that relatively few evaluations of firearm laws have been published, particularly within the past decade. Researchers are not immune to the contentiousness involved in firearms issues, and the lack of funding opportunities, which have limited the number of studies in this field. This is in contrast to many other areas of injury prevention. For example, there is robust research in the field of motor vehicle traffic injury prevention, which has led to substantial decreases in traffic-related injuries and deaths over the past several decades.[51-54]

We focused on the effect of firearm laws on firearm homicide; we did not examine the effect on other outcomes of interest (eg, homicide from all methods, firearm suicides, nonfatal firearm injuries, unintentional firearm injuries, firearms and interpersonal violence, or self-protection with firearms). Although the overall quality of the evidence

varied, our review found evidence that stronger firearm laws are associated with reductions in firearm homicide rates. The strongest evidence is for laws that strengthen background checks and that require a permit to purchase a firearm. The effect of many of the other specific types of laws is uncertain, such as laws to curb gun trafficking, improve child safety, ban military-style assault weapons, and restrict firearms in public places. It is important to note that when the evidence for specific types of law is uncertain, it means that the evidence is uncertain, not that these types of laws may actually have been found to be effective or ineffective if more robust studies had been conducted. Our findings are similar, but not identical, to those that the Task Force on Community Preventive Services and the National Academy of Sciences reached about a decade ago.[9,10]

A 2015 international review of firearm laws and injuries, including homicides, also demonstrated varying efficacy of firearm laws.[55] Only the laws related to stricter gun dealer regulations, background checks, and permit-to-purchase demonstrated effectiveness in decreasing firearm homicides. This is consistent with evidence that these types of laws may prevent individuals at high risk for committing crimes from acquiring firearms.[56] A 2016 study of the effect of firearm legislation and firearm mortality in the United States also concluded that laws related to background checks were associated with decreased firearm homicide rates.[21] Both the 2004[36] and 2013[16] studies examining the effects of overall state firearm legislative strength found an associated decrease in firearm homicide rates in states with stronger laws.

The quality of the studies was highly variable. Some of this variability was due to the different time periods (ie, the earliest studies were from the 1970s), the quality of the available data over time, as well as the different methodological approaches used. For example, there is controversy about the various methodologies used in the studies of the right-to-carry laws, which have reported different results and conclusions.[17,21,27,32]

All 34 studies were ecological, 19 were time series, and 25 did not use multivariate analysis.[11,13,15,18,25,26,29,34,41] Even those studies that conducted multivariate analyses often had other substantial limitations. Among the studies in the review, some did not focus on the population for which the law was targeted.[11] In several studies,[24,28,43] small changes in the model yielded very different results, raising questions about the robustness of the overall findings. The disaggregated results were not always consistent with the main findings of the study, and the results for the control variables were too often inconsistent with what is known about the relationship between demographic and social factors and firearm violence.[22,23,31,33,40]

The dearth of high-quality studies is likely due in part to the limited federal funding for firearm-related research for the past 20 years.[57] Future research should further evaluate the actual effectiveness of these laws by studying the population for whom the laws were intended to have an impact. The effect of firearm laws must also be considered in the light of their implementation and enforcement. Incomplete adherence and/or enforcement of these laws may invalidate the assessment of a law's effectiveness on a particular outcome.

Limitations

Our review has limitations. We only included studies published in peer-reviewed journals. Because we did not include any studies from non–peer-reviewed legal journals, we did not capture this perspective; however, we searched the legal and sociological literature as well as the medical literature and included those that met the inclusion criteria. The methodologic limitations of the studies restrict the robustness of some of the reported results.

Conclusions

Given the magnitude and gravity of firearm homicides in the United States, effective legal and public health policies are essential. Adequate funding to enable high-quality research is also crucial to determine the optimal policies and strategies to decrease firearm injuries and deaths. Although the overall evidence for the effectiveness of firearm laws for reducing firearm homicides is limited, the literature suggests that laws that strengthen background checks and require a permit to purchase a firearm may be among the most effective strategies.

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