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State Intimate Partner Violence–Related Firearm Laws and Intimate Partner Homicide Rates in the United States, 1991 to 2015

Carolina Díez, BA; Rachel P. Kurland; Emily F. Rothman, ScD; Megan Bair-Merritt, MD, MSCE; Eric Fleegler, MD, MPH; Ziming Xuan, ScD, SM, MA; Sandro Galea, MD, DrPH, MPH; Craig S. Ross, PhD, MBA; Bindu Kalesan, PhD, MPH, MSc; Kristin A. Goss, PhD, MPP; and Michael Siegel, MD, MPH

Background: To prevent intimate partner homicide (IPH), some states have adopted laws restricting firearm possession by intimate partner violence (IPV) offenders. "Possession" laws prohibit the possession of firearms by these offenders. "Relinquishment" laws prohibit firearm possession and also explicitly require offenders to surrender their firearms. Few studies have assessed the effect of these policies.

Objective: To study the association between state IPV-related firearm laws and IPH rates over a 25-year period (1991 to 2015).

Design: Panel study.

Setting: United States, 1991 to 2015.

Participants: Homicides committed by intimate partners, as identified in the Federal Bureau of Investigation's Uniform Crime Reports, Supplementary Homicide Reports.

Measurements: IPV-related firearm laws (predictor) and annual, state-specific, total, and firearm-related IPH rates (outcome).

Results: State laws that prohibit persons subject to IPV-related restraining orders from possessing firearms and also require them to relinquish firearms in their possession were associated with 9.7% lower total IPH rates (95% CI, 3.4% to 15.5% reduction) and 14.0% lower firearm-related IPH rates (CI, 5.1% to 22.0% reduction) than in states without these laws. Laws that did not explicitly require relinquishment of firearms were associated with a non–statistically significant 6.6% reduction in IPH rates.

Limitations: The model did not control for variation in implementation of the laws. Causal interpretation is limited by the observational and ecological nature of the analysis.

Conclusion: Our findings suggest that state laws restricting firearm possession by persons deemed to be at risk for perpetrating intimate partner abuse may save lives. Laws requiring at-risk persons to surrender firearms already in their possession were associated with lower IPH rates.

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For author affiliations, see end of text.
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Every year, more than 1800 persons in the United States are killed by their intimate partners, and approximately 50% of these homicides are committed with firearms (1). Approximately 85% of victims of intimate partner homicide (IPH) are women, and IPH accounts for nearly 50% of all homicides involving women in the United States each year (2, 3). Several studies (4–7) have shown that in situations of intimate partner violence (IPV)—which may include physical violence, sexual violence, stalking, and/or psychological aggression—abusers' access to firearms increases the risk for IPH as much as 5-fold (5). Because of the association between firearm access and IPH, regulating the possession of firearms by IPV offenders is one approach to reducing IPH (3, 6–8).

Federal legislation enacted in the United States in 1968 prohibited firearm possession by persons convicted of an IPV-related felony (9). This legislation was augmented in 1996 to extend the prohibition to those convicted of an IPV-related misdemeanor (10). In addition, the 1994 Violence Against Women Act barred firearm possession by persons subject to permanent IPV-related restraining orders (11). However, there is limited federal capacity or willingness to enforce these restrictions. Therefore, several states have enacted their own statutes to mirror these federal laws and explicitly authorize state officials to enforce the restrictions curtailing IPV perpetrators' possession of firearms (we refer to these as "possession" laws).

However, a substantial loophole in the federal statute limits the ability of states to enforce these laws, even if they have codified the federal statute into their own laws. Although the federal statute prohibits certain IPV offenders from *possessing* firearms, it does not explicitly require them to *surrender* guns already in their possession (12, 13). In other words, in some states, a person may technically be prohibited from possessing a firearm, but it is up to the person to go to a police station to relinquish the weapon. Without statutory authorization, law enforcement cannot confiscate the firearms. This loophole has been termed the "relinquishment gap" by the Law Center to Prevent Gun Violence (14). As the Law Center stated in its recent report on this loophole, "One of the most glaring gaps in the nation's gun laws—even in states with the strongest gun laws in the country, like California—is the lack of an effective firearm relinquishment policy. Few state legislatures have taken any meaningful steps to actually enforce their criminal gun restrictions by ensuring that armed offenders give up their firearms after they are convicted of serious crimes" (14). Recently, however, some states have taken steps to enforce their gun restrictions by going beyond federal law.

See also:

Editorial comment 591

One way that some states have done this is by enacting legislation that explicitly requires persons prohibited from possessing firearms due to an IPV-related misdemeanor or restraining order to surrender firearms already in their possession (we refer to these as "relinquishment" or "surrender" laws) (14). These laws typically enhance enforcement by putting offenders on official notice that surrender of their firearms is required and by specifying a time by which the transfer must take place. For example, California law requires that when a court issues an IPV-related restraining order, it orders respondents to surrender all firearms in their possession within 24 hours by transferring them to a law enforcement official or a federally licensed gun dealer (15). As of 2016, 11 states explicitly required persons convicted of an IPV-related misdemeanor to surrender their firearms after conviction, and 15 states explicitly required persons subject to an IPV-related restraining order to surrender their firearms for as long as the order is in effect (14). A second approach that some states have used is requiring law enforcement officials to remove firearms from the scene of an IPV incident. A third approach involves extending the prohibition of firearm possession to persons convicted of stalking.

We are aware of only 3 studies that have evaluated the effect of state firearm policies on IPH rates (16–19). These studies were limited because they used data from 2003 or earlier and had little power to detect an effect of IPV-related firearm policies because so few states had enacted such policies. Most important, at the time of these studies, few states had enacted laws that required IPV offenders to surrender firearms already in their possession, although 16 states had adopted a relinquishment law by 2013. The number of state IPV-related firearm laws has increased sharply since 2003, partly in response to the reauthorization of the Violence Against Women Act in 2005. A new provision made Violence Against Women Act grants conditional on state courts' informing convicted IPV offenders of the federal and any state restrictions on firearm ownership.

This study builds on and extends previous studies in 2 key ways. First, our data include homicide rates and state laws over a much longer and more recent time frame (1991 to 2015). Second, we drew data from the most comprehensive coding of state IPV-related laws to date, paying particular attention to relinquishment provisions that might be critical to the larger policy goal of restricting firearm possession by potentially dangerous persons.

METHODS

Design Overview

We conducted a panel study to examine the association between state IPV-related firearm laws and total and firearm-related IPH rates between 1991 and 2015. The panel consisted of state-level predictor and outcome variables for each of the 50 states during each of the 25 years. The outcome variable was the state-specific IPH rate in a given year. Four categories of laws were considered: 1) prohibition of firearm possession by persons convicted of an IPV-related misdemeanor, with or without a relinquishment requirement; 2) prohibition of firearm possession by persons subject to an IPV-related restraining order, with or without a relinquishment requirement; 3) laws authorizing removal of firearms from the scene of a domestic violence incident; and 4) prohibition of firearm possession by persons convicted of stalking (Table 1). We also examined whether laws in the first 2 categories included a mechanism to ensure that persons surrender firearms already in their possession. Because we used secondary data sources without personal identifiers, the Institutional Review Board of Boston University Medical Center deemed this not to be human subjects research.

Measures and Data Sources

Outcome Variables

Annual Firearm, Nonfirearm, and Total IPH Rates, by State. The only national data source that records homicide victim–offender relationships is the Supplementary

Table 1. Differences in IPH Rates Associated With 4 Categories of IPV-Related Firearm Laws Considered Individually*

Category	Total IPH		Firearm-Related IPH	
	Difference in Rate (95% CI), %	*P* Value	Difference in Rate (95% CI), %	*P* Value
Prohibition of firearm possession by persons convicted of an IPV-related misdemeanor				
Relinquishment of firearms not required	−2.9 (−13.3 to 8.7)	0.61	−6.6 (−13.9 to 1.5)	0.107
Relinquishment of firearms required	−3.9 (−10.4 to 3.2)	0.28	−7.3 (−15.7 to 2.0)	0.118
Prohibition of firearm possession by persons subject to an IPV-related restraining order				
Relinquishment of firearms not required	−6.6 (−13.2 to 0.5)	0.068	−6.4 (−15.0 to 3.0)	0.176
Relinquishment of firearms required	−10.8 (−16.8 to −4.4)†	0.001	−15.0 (−23.3 to −5.9)†	0.002
Removal of firearms from the scene of an IPV incident	−1.9 (−8.2 to 4.9)	0.58	−1.1 (−9.2 to 7.9)	0.81
Prohibition of firearm possession by persons convicted of stalking	−2.6 (−7.5 to 2.5)	0.31	−4.0 (−10.9 to 3.5)	0.29

IPH = intimate partner homicide; IPV = intimate partner violence.
* Negative binomial regression models included year fixed effects and controlled for region, lagged IPH rate, stranger homicide rate, household gun ownership, proportion of the population that is African American, violent crime rate, and divorce rate. The reference group was states with no law in the given category.
† Statistically significant ($P < 0.05$).

Homicide Reports (SHR) of the Federal Bureau of Investigation's Uniform Crime Reports (20–23). State and local law enforcement agencies report homicides to the Federal Bureau of Investigation on a monthly basis. Data were provided for each of the 50 states for the entire study period, with the exception of missing data for 23 state-year combinations. Thus, the final sample size was 1227 out of 1250 possible observations.

The SHR victim–offender relationship categories include spouses, common-law spouses, former spouses, and dating partners, but former dating partners are not specifically categorized (24). This prevented us from assessing the effect of IPV-related firearm laws on abuse of noncohabiting dating partners, which is underreported in the SHR because these cases are often not classified as IPH (24).

Missing Data on Victim–Offender Relationship. The SHR is limited by missing data on the victim–offender relationship in approximately one third of homicides. Fox and Swatt developed a multiple imputation approach for these missing data that is generally viewed as the strategy of choice (25). The imputation procedure attempts to ascertain the likely victim–offender relationship using known variables about the case and the observed association of those variables with the victim–offender relationship in cases where this relationship is clear. Fox provided us with multiply imputed files covering 1990 to 2015 (26). In our prior work, we showed that regression results obtained using the imputed data are similar to those obtained using only cases in which the victim–offender relationship is known (27). Nevertheless, we conducted analyses using both the imputed and nonimputed data to ensure that the imputation process did not alter the findings. The correlation between imputed and nonimputed IPH rates was 0.93.

Main Predictor Variable

Using searches conducted with the WestlawNext and HeinOnline legal resources, with laws then collected from state legislature Web sites, Everytown for Gun Safety developed a database of state IPV-related firearm laws over time (28). Using this database, we coded 4 categories of laws and their operative provisions (a total of 6 variables) as present or absent for each state during each of the 25 years from 1991 through 2015 (**Appendix Table 1**, available at Annals.org). Data on these provisions for all 50 states for 2015 are shown in **Appendix Tables 2** and **3** (available at Annals.org). State laws on IPV-related felonies were not included in our analyses because most states have procedures in place for the surrender of firearms by persons convicted of felonies.

Control Variables

We accounted for secular trends in homicide rates by including year fixed effects. To account for dynamic effects and to address the potential problem of omitted-variables bias, we included the lagged IPH rate (that is, the rate in the previous year). We also controlled for state-level household firearm ownership, using a proxy (a variable that serves in place of an unmeasurable variable) that we developed in earlier research (29). This proxy is necessary because no survey assessed household firearm ownership at the state level throughout the study period (29). We also considered the following factors, retaining in the model only those that were significantly related to the outcome: population distribution by age, sex, and race/ethnicity; region (East, South, West, and Midwest); degree of urbanization; rates of education, poverty, unemployment, divorce, and self-reported depression; levels of household income and income inequality; population density; per capita gross domestic product, personal disposable income, and alcohol consumption; rates of nonhomicide violent crime (aggravated assault, robbery, and forcible rape), stranger homicide (homicide committed by a person unknown to the victim), and property crime (burglary, larceny-theft, and motor vehicle theft); incarceration rate; and per capita number of law enforcement officers (**Appendix Table 4**, available at Annals.org). We lagged the state laws by 1 year; for example, we used laws in 1991 to predict homicide rates starting in 1992. Thus, the law data used in our analyses covered 1990 through 2014.

Statistical Analysis

Because homicide rates are skewed and overdispersed rather than normally distributed, we modeled this outcome using a negative binomial model following the approach in our previous studies (27, 30–33). To account for clustering of observations among states, we used a generalized estimating equations approach (34–38). We used SEs that are robust to the presence of serial autocorrelation and heteroscedasticity (39). Model fit was assessed using the quasi-information criterion, indicated by Pan as the criterion of choice for generalized estimating equations models (40). This test indicated that an exchangeable working correlation matrix produced the best fit for the data.

To develop a parsimonious model and to avoid overfitting the model, we conducted a stepwise variable selection procedure. Both a forward and a backward selection procedure resulted in the inclusion of 3 covariates: proportion of the population that was African American, violent crime rate, and divorce rate. Five variables were automatically included in all models: year fixed effects, region fixed effects, stranger homicide rate, household firearm ownership, and lagged IPH rate.

Analyses were conducted using Stata, version 14 (StataCorp).

Role of the Funding Source

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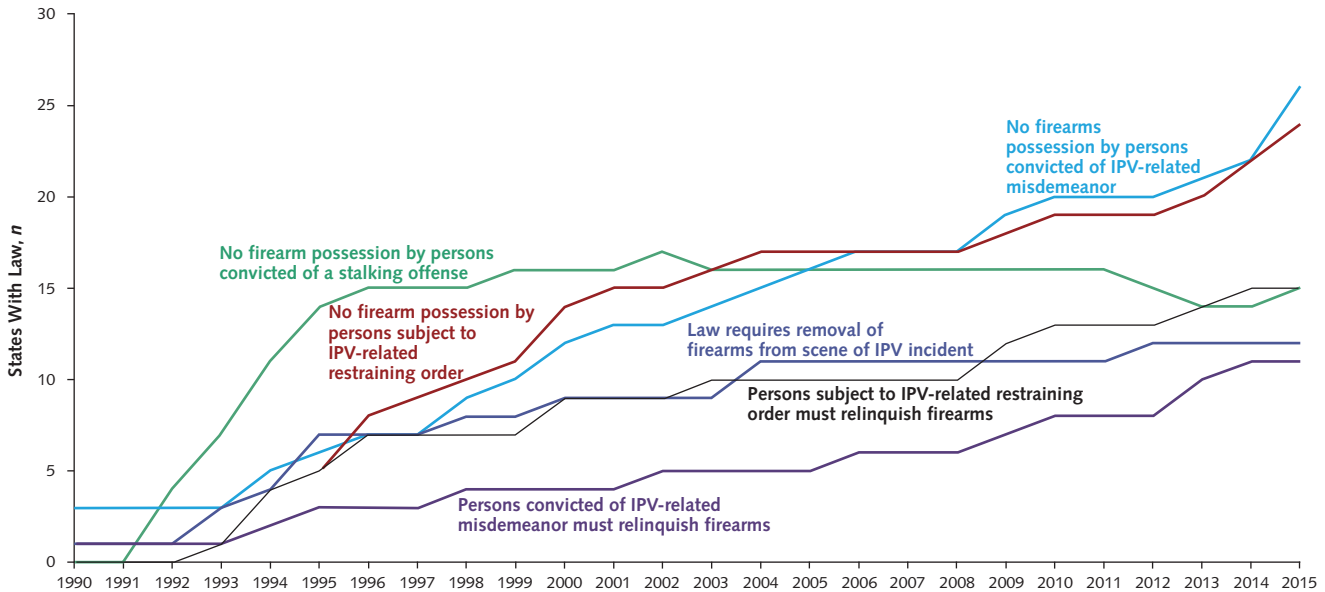
Figure 1. Number of states with selected IPV-related firearm laws, by year, 1990 to 2014.



A map showing states with and without these laws in 2015 is provided in the **Appendix Figure** (available at Annals.org). IPV = intimate partner violence.

RESULTS

The number of states with IPV-related firearm laws increased substantially between 1990 and 2015, but very few states enacted laws requiring IPV offenders to surrender firearms they already had (**Figure 1**). For example, by 2015, 26 states prohibited firearm possession by persons convicted of an IPV-related misdemeanor, but only 11 of those states also explicitly required relinquishment of weapons. Similarly, 24 states prohibited firearm possession by persons subject to an IPV-related restraining order, but only 15 of those states also explicitly required relinquishment of firearms. By 2015, 2 states (California and Illinois) had enacted all of the laws, but 16 states had enacted none. During the study period, 3 states (Washington, Alabama, and Arkansas) repealed a law that was already in place.

Nationally, the total IPH rate decreased from 1.19 per 100 000 persons in 1991 to 0.60 per 100 000 persons in 2015, and the firearm-related IPH rate decreased from 0.68 to 0.36 per 100 000 persons. There was a nearly 5-fold range in average IPH rates across states in 2015, with a low of 0.36 per 100 000 persons in Minnesota and a high of 1.67 per 100 000 persons in Louisiana. The mean IPH rate across all states decreased from 1.18 per 100 000 persons in 1991 to 0.67 per 100 000 persons in 2015.

We first examined models that included each of the laws one at a time (**Table 1**). Laws that prohibited firearm possession by persons subject to an IPV-related restraining order and required them to surrender firearms they already had were associated with 10.8% lower total IPH rates (95% CI, −16.8% to −4.4%) and 15.0% lower firearm-related IPH rates (CI, −23.3% to −5.9%) compared with the absence of both laws. Laws prohibiting firearm possession by persons subject to IPV-related restraining orders that did not also require offenders to surrender firearms they already had were not significantly associated with total or firearm-related IPH rates. The 3 other categories of laws were not significantly associated with total or firearm-related IPH rates.

We next developed a final model that included only the presence or absence of an IPV-related restraining order firearm relinquishment law but did not include restraining order firearm possession laws (states with these laws were in the reference group). These laws were significantly associated with 9.7% lower total IPH rates and 14.0% lower firearm-related IPH rates but were not significantly associated with non–firearm-related IPH rates (**Table 2**).

To ensure that imputation of the victim–offender relationship in some cases did not affect the results, we repeated the analysis using only nonimputed data (that is, including only confirmed IPHs). The results were essentially unchanged: restraining order relinquishment laws were associated with 8.4% lower IPH rates (CI, −16.0% to −0.04%) (**Appendix Table 5**, available at Annals.org).

We then estimated a model in which the relationship between restraining order relinquishment laws and IPH rates was allowed to vary by state. In this model, these laws were associated with significantly lower IPH rates in 9 states, nonsignificantly lower rates in 3 states, and nonsignificantly higher rates in 2 states (**Figure 2**; **Appendix Table 6**, available at Annals.org).

Table 2. Results of Final Model for Law Prohibiting Firearm Possession by Persons Subject to an IPV-Related Restraining Order and Requiring Them to Surrender Firearms They Already Have*

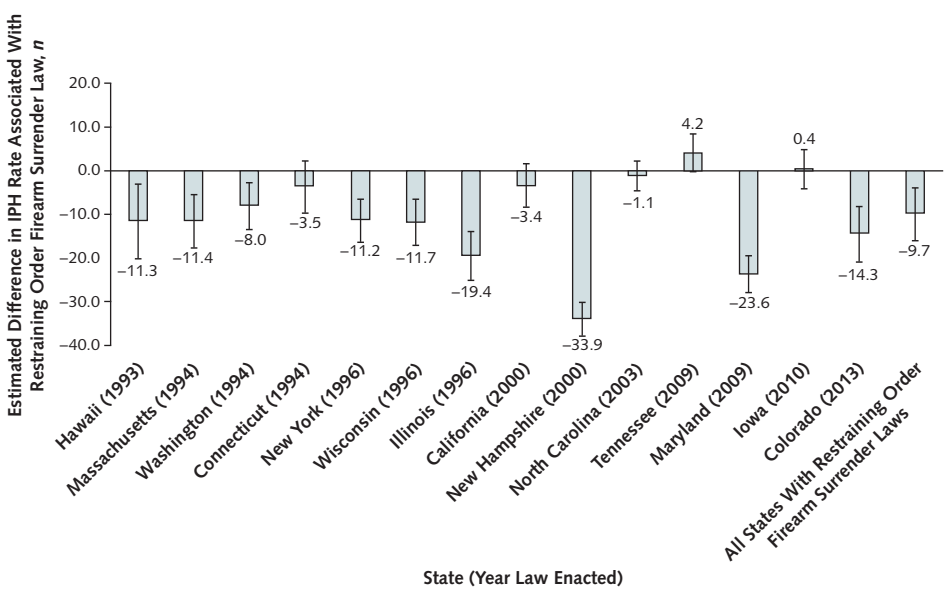
Variable	Total IPH		Firearm-Related IPH		Non-Firearm-Related IPH	
	Difference in Rate (95% CI), %	*P* Value	Difference in Rate (95% CI), %	*P* Value	Difference in Rate (95% CI), %	*P* Value
IPV-related restraining order firearm possession and surrender law	−9.7 (−15.5 to −3.4)†	0.003	−14.0 (−22.0 to −5.1)†	0.003	−5.5 (−12.8 to 2.5)	0.175
Control variables‡						
Region						
Northeast	−6.6 (−16.8 to 4.9)	0.25	−11.2 (−25.9 to 6.5)	0.20	−4.3 (−15.4 to 8.4)	0.49
South	17.5 (5.3 to 31.2)†	0.004	32.7 (13.3 to 55.4)†	<0.001	2.7 (−7.9 to 14.5)	0.64
West	7.1 (−3.3 to 18.7)	0.189	11.1 (−3.9 to 28.5)	0.154	2.8 (−10.4 to 17.8)	0.70
Firearm ownership (SD = 13.4%)	9.2 (5.3 to 13.3)†	<0.001	17.5 (11.9 to 23.4)†	<0.001	1.1 (−6.2 to 8.9)	0.78
Stranger homicide rate (SD = 0.83 per 100 000 persons)	6.3 (2.9 to 9.8)†	<0.001	10.2 (5.6 to 15.1)†	<0.001	2.2 (−1.5 to 6.0)	0.26
Lagged IPH rate (SD = 0.45 per 100 000 persons)	7.6 (3.8 to 11.6)†	<0.001	3.8 (−0.2 to 7.9)	0.061	6.6 (2.0 to 11.4)†	0.004
Proportion of population that is African American (SD = 9.5%)	12.1 (7.9 to 16.5)†	<0.001	14.3 (9.2 to 19.6)†	<0.001	12.0 (6.1 to 18.2)†	<0.001
Violent crime rate (SD = 2.13 per 100 000 persons)	11.9 (7.8 to 16.2)†	<0.001	7.9 (3.1 to 12.9)†	0.001	18.5 (12.8 to 24.4)†	<0.001
Divorce rate (SD = 1.2 per 1000 persons)	7.5 (5.0 to 10.0)†	<0.001	9.9 (6.2 to 13.7)†	<0.001	5.8 (2.4 to 9.3)†	0.001

IPH = intimate partner homicide; IPV = intimate partner violence.
* Models included year fixed effects, region, household gun ownership, stranger homicide rate, lagged IPH rate, proportion of the population that is African American, violent crime rate, and divorce rate. The reference group was states with no law requiring surrender of firearms by persons subject to an IPV-related restraining order.
† Statistically significant ($P < 0.05$).
‡ All variables are standardized such that the percentage shown is the percentage difference in IPH rates associated with a 1-SD increase in the listed factor.

In 10 of 14 states that enacted these laws, the percentage change in IPH rates from before to after the law was greater than that for other states without such a law during the same period (**Appendix Table 7**, available at Annals.org). The regression model estimated lower IPH rates associated with implementation of the law for all of these states.

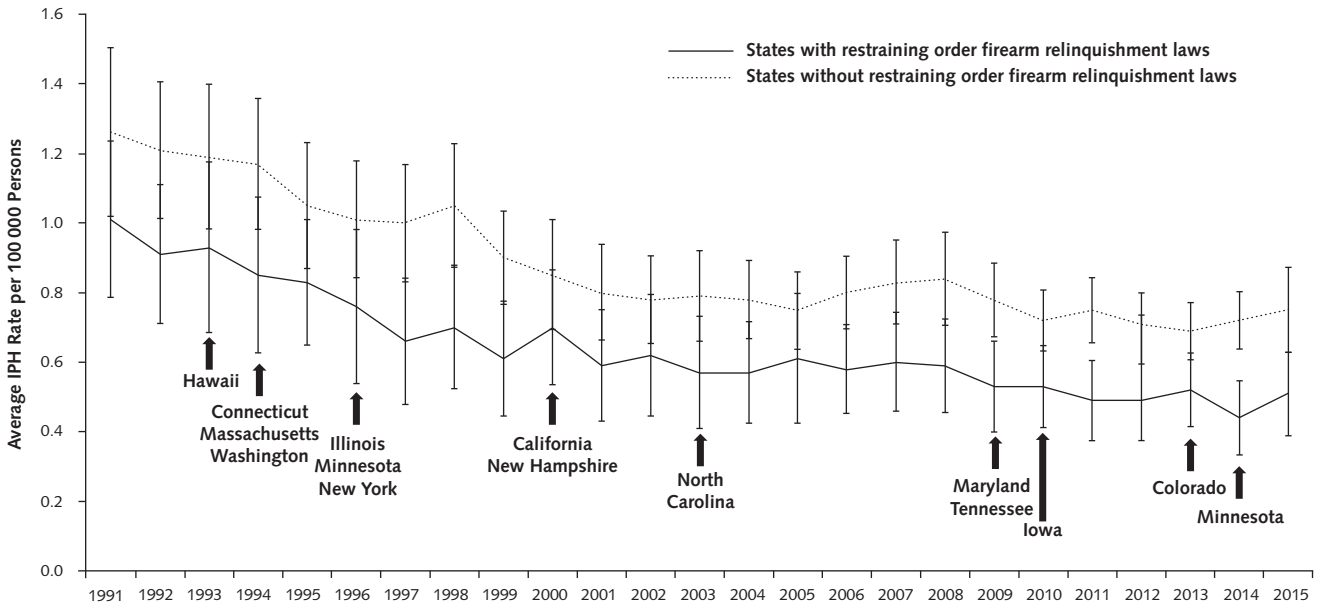
To check the validity of our findings, we investigated whether laws requiring persons subject to IPV-related restraining orders to surrender their firearms were associated with other crime-related outcomes not expected to be affected by these laws. We found no significant relationship between these laws and stranger homicide rates, violent crime rates, or prop-

Figure 2. Difference in IPH rate between states with and without IPV-related restraining order firearm relinquishment laws, estimated from negative binomial regression model.



IPH = intimate partner homicide; IPV = intimate partner violence.

Figure 3. Trends in IPH among states with and without IPV-related restraining order firearm relinquishment laws, 1991 to 2015.



IPH = intimate partner homicide; IPV = intimate partner violence.

erty crime rates. We also confirmed that the relationship between restraining order relinquishment laws and IPH rates remained significant when we included region-specific time trends and state fixed effects in the model. We also reran the analysis using the traditional proxy for household gun ownership (the percentage of suicides committed with a firearm) used in other studies (41), and the results were unchanged. Finally, the results remained unchanged when we controlled for state laws requiring universal background checks, permits to purchase handguns, or waiting periods for the purchase of handguns.

We saw a clear trend of gradually decreasing IPH rates in states without restraining order relinquishment laws, but the rate of decrease slowed after 2005 and the average IPH rate actually increased from 2013 to 2015 (**Figure 3**). In contrast, IPH rates in states with restraining order relinquishment laws continued to decrease at their previous rate after 2005 and dropped slightly from 2013 to 2015. Differences in IPH rates in 2015 between states with and without restraining order relinquishment laws are shown in the **Appendix Figure** (available at Annals.org).

If one assumes a causal relationship, our final model (**Table 2**) suggested that there were 75 fewer IPHs in 2015 among states with restraining order relinquishment laws than would have been expected without these laws. The model also suggested that if all 50 states had such laws in place, there would have been an additional 120 fewer IPH deaths across the nation in 2015 than would have been expected without these laws.

DISCUSSION

We examined the association of state IPV-related firearm laws with IPH rates using data subsequent to 2003, a period in which many states enacted such laws. We found that state laws that both prohibited the possession of firearms by persons subject to an IPV-related restraining order and required these persons to surrender their firearms were associated with firearm-related IPH rates that were 14.0% lower than in states without these laws. Laws that prohibited the possession of firearms by persons subject to a restraining order but did not require them to surrender firearms already in their possession were not significantly associated with IPH rates.

A basic implication of these findings is that laws that identify firearm owners who are at high risk for using their weapons against their partners and require the relinquishment of those weapons may save lives. Women who obtain restraining orders are at particularly high risk for partner violence, given that fear of violence (often created by threatened or actual violence) typically motivates the desire for a protective order. These findings seem to demonstrate the value of identifying high-risk situations based on known episodes of past violence and removing firearms from such situations to prevent future violence.

Although our study did not find a statistically significant association between laws prohibiting IPV misdemeanants or convicted stalkers from owning guns and rates of IPH, current data do not allow us to assess the extent to which implementation might mediate their effect. Such laws may be effective only if law enforcement

has the authority or mandate to seize firearms from offenders. At this time, there are not enough states with such provisions to assess their effect.

Other state-level variables that were related to IPH in our models were residence in the South, the prevalence of household firearm ownership, the stranger homicide rate, the lagged IPH rate, the proportion of the population that was African American, the violent crime rate, and the divorce rate. Data from a national survey conducted by the Centers for Disease Control and Prevention show that physical (excluding sexual) IPV is approximately 35% higher among African American women than white women (42). Thus, it may be that the significant coefficient for this variable reflects a higher rate of IPH among African Americans.

The chief potential threat to the validity of our findings is that states that have enacted laws requiring subjects of IPV-related restraining orders to surrender their firearms may differ from those that have not in ways that were not measured. Another important limitation of this research is that even if laws are written similarly, their enforcement may vary by county, city, or town within a given state. There may also be differences in how the judicial system in each state adjudicates IPV cases and in how state law handles protective orders in general. Our findings may also reflect the effect of laws other than IPV-specific ones. Finally, to avoid the ecological fallacy, caution must be used in drawing inferences from this study with regard to the relationship between both the main exposure variable (state laws) and the covariates and IPH risk at the individual level.

Despite these limitations, the results of this study suggest that laws prohibiting firearm possession by persons subject to IPV-related restraining orders may be associated with lower rates of firearm-related IPH, but only if the law includes an explicit requirement that these persons relinquish their firearms.

From Boston University School of Public Health, Boston University School of Medicine, Boston Children's Hospital, and Harvard Medical School, Boston, Massachusetts, and Sanford School of Public Policy, Duke University, Durham, North Carolina.

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Reproducible Research Statement: *Study protocol and data set:* Available from Dr. Siegel (e-mail, mbsiegel@bu.edu). *Statistical code:* See Appendix Table 8 (available at Annals.org).

Requests for Single Reprints: Michael Siegel, MPH, Department of Community Health Sciences, Boston University School of Public Health, 801 Massachusetts Avenue, 4th Floor, Boston, MA 02118; e-mail, mbsiegel@bu.edu.

Current author addresses and author contributions are available at Annals.org.

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Current Author Addresses: Ms. Díez; Ms. Kurland; and Drs. Rothman, Xuan, and Siegel: Department of Community Health Sciences, Boston University School of Public Health, 801 Massachusetts Avenue, 4th Floor, Boston, MA 02118.
Dr. Bair-Merritt: Department of Pediatrics, Boston Medical Center, 88 East Newton Street, Vose Hall, Boston, MA 02118.
Dr. Fleegler: Division of Emergency Medicine, Boston Children's Hospital, 300 Longwood Avenue, Main South, 0120, Boston, MA 02115.
Dr. Galea: Office of the Dean, Boston University School of Public Health, 715 Albany Street, TC3, Boston, MA 02118.
Dr. Ross: Department of Epidemiology, Boston University School of Public Health, 715 Albany Street, TE3, Boston, MA 02118.
Dr. Kalesan: Division of Preventive Medicine and Epidemiology, Department of Medicine, Boston University School of Medicine, 801 Massachusetts Avenue, 4th Floor, Boston, MA 02118.
Dr. Goss: Sanford School of Public Policy, Duke University, 234 Sanford School Building, Durham, NC 27708.

Author Contributions: Conception and design: C. Díez, R.P. Kurland, M. Bair-Merritt, E. Fleegler, S. Galea, C.S. Ross, M. Siegel.
Analysis and interpretation of the data: C. Díez, R.P. Kurland, E.F. Rothman, E. Fleegler, Z. Xuan, S. Galea, C.S. Ross, B. Kalesan, M. Siegel.
Drafting of the article: C. Díez, R.P. Kurland, E.F. Rothman, S. Galea, C.S. Ross, M. Siegel.
Critical revision of the article for important intellectual content: C. Díez, M. Bair-Merritt, E. Fleegler, Z. Xuan, B. Kalesan, K.A. Goss, M. Siegel.
Final approval of the article: C. Díez, R.P. Kurland, E.F. Rothman, M. Bair-Merritt, E. Fleegler, Z. Xuan, S. Galea, C.S. Ross, B. Kalesan, K.A. Goss, M. Siegel.
Provision of study materials or patients: B. Kalesan.
Statistical expertise: Z. Xuan, M. Siegel.
Obtaining of funding: B. Kalesan, M. Siegel.
Administrative, technical, or logistic support: M. Siegel.
Collection and assembly of data: C. Díez, R.P. Kurland, M. Siegel.

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Appendix Table 1. IPV-Related Firearm Law Provisions Coded

Type of State Law and Provision	States With Provision in 2014, *n**	Total State–Year Observations, 1991–2015, *n*†
Prohibition of firearm possession by persons convicted of an IPV-related misdemeanor		
No provision (reference group)	28	938
Persons convicted of an IPV-related misdemeanor prohibited from possessing firearms	22	312
Persons convicted of an IPV-related misdemeanor prohibited from possessing firearms and explicitly required to surrender firearms they already have	11	121
Prohibition of firearm possession by persons subject to an IPV-related restraining order		
No provision (reference group)	28	940
Persons subject to IPV-related restraining order prohibited from possessing firearms	22	310
Persons subject to IPV-related restraining order prohibited from possessing firearms and explicitly required to surrender firearms they already have	15	205
Removal of firearms from the scene of an IPV incident		
No provision (reference group)	38	1043
Law enforcement required to remove firearms from the scene of a domestic violence incident	12	207
Prohibition of firearm possession by persons convicted of stalking		
No provision (reference group)	36	917
Persons convicted of stalking prohibited from possessing firearms	14	333

IPV = intimate partner violence.
* Number of states with each provision is shown for 2014 because we lagged the laws by 1 y in the regression models. Thus, 2014 is the most recent year of law data included in the analysis.
† Total number of state–year observations is 1227. Intimate partner homicide data were missing for 23 state–year combinations.

Appendix Table 2. Firearm-Related and Total IPH Rates in 2015 and Total Number of IPV-Related Firearm Law Provisions in 2014

State*	Firearm-Related IPH Rate in 2015 (per 100 000 persons)	Total IPH Rate in 2015 (per 100 000 persons)	Ratio of Firearm-Related to Total IPH Rate, %	Total IPV-Related Firearm Law Provisions in 2015, *n*†	Total IPH Deaths in 2015, *n*‡	Population in 2015, *n*
Alaska	0.96	1.60	60.3	0	12	738 432
South Carolina	0.87	1.33	65.7	0	65	4 896 146
Arkansas	0.84	1.30	64.5	0	39	2 978 204
Mississippi	0.81	0.97	83.2	0	29	2 992 333
Nevada	0.79	1.15	68.5	2	33	2 890 845
Georgia	0.75	0.91	82.9	0	93	10 214 860
Missouri	0.75	1.01	74.1	0	62	6 083 672
Louisiana	0.73	1.16	63.2	2	54	4 670 724
Tennessee	0.72	1.13	63.6	5	75	6 600 299
Montana	0.68	1.52	44.5	1	16	1 032 949
Virginia	0.56	0.82	68.8	0	69	8 382 993
Kentucky	0.54	0.79	68.2	0	35	4 425 092
Texas	0.50	0.79	63.0	2	218	27 469 114
North Carolina	0.49	0.81	61.0	2	81	10 042 802
Oklahoma	0.45	0.78	57.4	1	31	3 911 338
Michigan	0.44	0.82	53.8	0	82	9 922 576
Maryland	0.44	0.71	62.1	4	42	6 006 401
Arizona	0.40	0.74	54.2	2	50	6 828 065
Idaho	0.40	0.46	86.1	0	8	1 654 930
Kansas	0.40	0.66	60.4	0	19	2 911 641
Indiana	0.39	0.54	73.0	2	36	6 619 680
Pennsylvania	0.38	0.70	54.9	4	89	12 802 503
Wyoming	0.36	0.40	90.6	0	2	586 107
Washington	0.36	0.59	61.0	3	42	7 170 351
North Dakota	0.36	0.55	64.8	0	4	756 927
New Mexico	0.35	0.68	51.7	0	14	2 085 109
Ohio	0.34	0.54	61.7	1	63	11 613 423
Connecticut	0.31	0.47	66.7	5	17	3 590 886
Minnesota	0.28	0.59	47.5	5	32	5 489 594
Nebraska	0.28	0.34	81.3	2	6	1 896 190
Wisconsin	0.28	0.47	58.5	3	27	5 771 337
Colorado	0.27	0.53	50.7	5	29	5 456 574
California	0.26	0.48	54.9	6	188	39 144 818
Utah	0.26	0.30	86.7	1	9	2 995 919
Iowa	0.25	0.42	60.0	4	13	3 123 899
Illinois	0.25	0.39	64.5	6	50	12 859 995
Oregon	0.23	0.50	45.7	0	20	4 028 977
New Hampshire	0.23	0.23	100.0	2	3	1 330 608
West Virginia	0.21	0.51	42.1	3	9	1 844 128
New Jersey	0.20	0.51	38.4	4	46	8 958 013
Vermont	0.16	0.16	100.0	2	1	626 042
New York	0.15	0.38	39.6	5	76	19 795 791
Maine	0.15	0.15	100.0	2	2	1 329 328
Delaware	0.15	0.42	35.0	3	4	945 934
Massachusetts	0.10	0.33	31.3	5	23	6 794 422
Rhode Island	0.10	0.73	13.6	0	8	1 056 298
Hawaii	0.00	0.20	0.0	5	3	1 431 603
South Dakota	0.00	0.77	0.0	1	7	858 469

IPH = intimate partner homicide; IPV = intimate partner violence.
* Alabama and Florida were missing data for 2015.
† Total possible number of provisions is 6.
‡ Includes imputed data from Uniform Crime Reports, Supplementary Homicide Reports (26).

Appendix Table 3. Status of Selected IPV-Related Firearm Laws, by State, 2015

State	Prohibition of Firearm Possession by Persons Convicted of IPV-Related Misdemeanor	Persons Convicted of IPV-Related Misdemeanor Prohibited From Possessing Firearms and Required to Surrender Firearms They Already Have	Prohibition of Firearm Possession by Persons Subject to IPV-Related Restraining Order	Persons Subject to IPV-Related Restraining Order Prohibited From Possessing Firearms and Required to Surrender Firearms They Already Have	Removal of Firearms From the Scene of an IPV Incident Required	Prohibition of Firearm Possession by Persons Convicted of Stalking
Alabama						
Florida			✓			
Alaska						
South Carolina						
Arkansas						
Mississippi						
Nevada	✓					
Georgia						
Missouri						
Louisiana	✓		✓			
Tennessee	✓	✓	✓	✓	✓	
Montana					✓	
Virginia						
Kentucky						
Texas	✓		✓			
North Carolina			✓	✓		
Oklahoma					✓	
Michigan						
Maryland	✓		✓	✓		✓
Arizona	✓					✓
Idaho						
Kansas						
Indiana	✓					✓
Pennsylvania	✓	✓			✓	✓
Wyoming						
Washington	✓		✓	✓		
North Dakota						
New Mexico						
Ohio					✓	
Connecticut	✓	✓	✓	✓		✓
Minnesota	✓	✓	✓	✓		✓
Nebraska	✓				✓	
Wisconsin			✓	✓		✓
Colorado	✓	✓	✓	✓		✓
California	✓	✓	✓	✓	✓	✓
Utah					✓	
Iowa	✓	✓	✓	✓		
Illinois	✓	✓	✓	✓	✓	✓
Oregon						
New Hampshire			✓	✓		
West Virginia	✓		✓		✓	
New Jersey	✓		✓		✓	✓
Vermont	✓					
New York	✓	✓	✓	✓		✓
Maine	✓		✓			
Delaware	✓		✓			✓
Massachusetts	✓	✓	✓	✓		✓
Rhode Island						
Hawaii	✓	✓	✓	✓	✓	
South Dakota	✓					

IPV = intimate partner violence.

Appendix Table 4. Variables and Data Sources

Variable	Definition	Source	Missing Data
Outcome variables			
Intimate partner firearm, nonfirearm, and total homicide rates	Rate of firearm, nonfirearm, and total intimate partner homicides per 100 000 persons	FBI Uniform Crime Reports, Supplementary Homicide Reports; multiply imputed data set with weights to adjust for unit missingness provided by Professor James A. Fox, Northeastern University (26)	Alabama: 6 y Florida: 2 y Iowa: 1 y Kansas: 6 y Maine: 2 y Montana: 3 y New Hampshire: 1 y North Dakota: 1 y Wisconsin: 1 y
Main predictor variable			
State firearm laws	21 domestic violence–related firearm law provisions, including detailed coding of firearm relinquishment and confiscation provisions	WestlawNext annotated historical state statutes and historical session laws. Adapted from coding conducted by Everytown for Gun Safety (28).	None
Control variables			
Age	Percentage of population aged 15–29 y	CDC, WISQARS (42)	None
Sex: young males	Percentage of population aged 15–29 y that is male	WISQARS (43)	None
Race/ethnicity: African American	Percentage of population that is African American	WISQARS (43)	None
Race/ethnicity: Hispanic	Percentage of population that is Hispanic	U.S. Census Bureau. Current Population Surveys. Southern Regional Education Board: Population & Demographics (44)	None
Poverty status	Percentage of population living in poverty	U.S. Census Bureau. Current Population Surveys. U.S. Census Bureau Historical Poverty Tables	None
Unemployment	Percentage of unemployed persons among civilian labor force aged ≥16 y	U.S. Bureau of Labor Statistics. Southern Regional Education Board: Economic and Government Data (45)	None
Self-reported depression	Percentage of adults who report depression or other emotional problems during all of the previous 30 d	BRFSS surveys (46)	None
Household income	Median household income (in 2010 U.S. dollars)	U.S. Census Bureau. Current Population Surveys. Southern Regional Education Board: Economic and Government Data (47)	None
Educational attainment	Percentage of adults aged ≥25 y with college degree (bachelor's or higher)	U.S. Census Bureau. Current Population Surveys. U.S. Census Bureau Statistical Abstracts and Educational Attainment Reports	Data interpolated for 1992
Income inequality	Gini coefficient	U.S. Census Bureau. Decennial censuses: 1980, 1990, and 2000. American Community Survey: 2006–2010	Data interpolated for 1991–1998 and 2000–2005
Level of urbanization	Percentage of population living in urbanized area or urban cluster	U.S. Census Bureau. Decennial censuses: 1990, 2000, 2010; U.S. Census Bureau Statistical Abstracts	Data interpolated for 1991–1999 and 2001–2009
Population density	Population per square mile	U.S. Census Bureau	None
Per capita gross domestic product	State gross domestic product divided by population	Bureau of Economic Analysis. *Regional Data: GDP and Personal Income*. Washington, DC: U.S. Department of Commerce, Bureau of Economic Analysis.	None
Per capita disposable income	Per capita disposable income (in 2010 U.S. dollars)	Bureau of Economic Analysis. *Regional Data: GDP and Personal Income*. Washington, DC: U.S. Department of Commerce, Bureau of Economic Analysis.	None
Alcohol consumption	Per capita alcohol consumption among persons aged ≥14 y	National Institute on Alcohol Abuse and Alcoholism (48)	None
Violent crime rate	Rates of aggravated assault, robbery, and forcible rape per 100 000 persons	FBI Uniform Crime Reporting Statistics (49)	None

Continued on following page

Appendix Table 4 – Continued

Variable	Definition	Source	Missing Data
Nonviolent crime rate	Rate of property crime (burglary, larceny-theft, and motor vehicle theft) per 100 000 persons	FBI Uniform Crime Reporting Statistics (49)	None
Divorce rate	Divorces per 1000 persons	CDC, National Center for Health Statistics. CDC and U.S. Bureau of the Census Statistical Abstracts (50)	Data interpolated in some years for California, Georgia, Hawaii, Indiana, Louisiana, and Minnesota
Incarceration rate	Number of prisoners with sentences >1 y per 100 000 persons	Department of Justice, Bureau of Justice Statistics, National Prisoner Statistics, Prisoner Series (51)	Data interpolated for 1992
Capacity for firearm law enforcement	Number of sworn police officers per 1000 persons	FBI Uniform Crime Reports (49)	None
Lagged intimate partner homicide rate	Intimate partner homicide rate in prior year	FBI Uniform Crime Reports, Supplementary Homicide Reports (20)	Same as for intimate partner homicide rate
Region	Census region	U.S. Census Bureau	None
Stranger homicide rate	Homicides committed by a stranger (not an acquaintance) per 100 000 persons	FBI Uniform Crime Reports, Supplementary Homicide Reports (20)	Same as for intimate partner homicide rate
Household gun ownership	Proportion of households in which someone owns a gun	Validated proxy derived from standard measure (firearm suicides divided by total suicides [FS/S]) but adjusted for hunting license rate (HL) (29); calculated as follows: proxy = (0.62 × FS/S) + (0.92 × HL) − 4.478	None
Hunting licenses	Proportion of population aged ≥15 y with hunting license	U.S. Fish and Wildlife Service (52)	None

BRFSS = Behavioral Risk Factor Surveillance System; CDC = Centers for Disease Control and Prevention; FBI = Federal Bureau of Investigation; WISQARS = Web-based Injury Statistics Query and Reporting System.

Appendix Table 5. Model Results When Analysis Was Restricted to Nonimputed Data on IPHs*

Variable	Difference in IPH Rate (95% CI), %	*P* Value
IPV-related restraining order firearm possession and surrender law	−8.4 (−16.0 to −0.04)†	0.049
Control variables‡		
Region		
Northeast	−3.7 (−15.4 to 9.6)	0.56
South	22.4 (6.5 to 40.7)†	0.004
West	18.8 (5.2 to 34.1)†	0.005
Firearm ownership (SD = 13.4%)	12.8 (7.1 to 18.9)†	<0.001
Stranger homicide rate (SD = 0.83 per 100 000 persons)	1.9 (−1.7 to 5.7)†	0.31
Lagged IPH rate (SD = 0.45 per 100 000 persons)	11.4 (7.4 to 15.6)†	<0.001
Proportion of population that is African American (SD = 9.5%)	9.0 (3.2 to 15.1)†	0.002
Violent crime rate (SD = 2.13 per 100 000 persons)	8.5 (3.8 to 13.5)†	<0.001
Divorce rate (SD = 1.2 per 1000 persons)	4.1 (1.0 to 7.2)†	0.008

IPH = intimate partner homicide; IPV = intimate partner violence.
* The law being tested prohibits persons who are subject to IPV-related restraining orders from possessing firearms and requires them to surrender firearms they already have. The models included year fixed effects, region, household gun ownership, stranger homicide rate, lagged IPH rate, proportion of the population that is African American, violent crime rate, and divorce rate. The reference group is states with no law requiring surrender of firearms by persons subject to an IPV-related restraining order.
† Statistically significant ($P < 0.05$).
‡ All variables are standardized such that the percentage shown is the percentage difference in IPH rates associated with a 1-SD increase in the listed factor.

Appendix Table 6. Results of Final Model for IPV-Related Restraining Order Firearm Possession and Surrender Laws, Allowing for Different Effects of Law in Each State*

Variable	Difference in IPH Rate (95% CI), %	*P* Value
State (effective date)		
Hawaii (1993)	−11.3 (−19.5 to −2.2)†	0.016
Massachusetts (1994)	−11.4 (−17.3 to −5.0)†	0.001
Washington (1994)	−8.0 (−13.3 to −2.5)†	0.005
Connecticut (1994)	−3.5 (−9.3 to 2.7)	0.26
New York (1996)	−11.2 (−15.9 to −6.1)†	<0.001
Wisconsin (1996)	−11.7 (−16.8 to −6.4)†	<0.001
Illinois (1996)	−19.4 (−24.8 to −13.6)†	<0.001
California (2000)	−3.4 (−8.3 to 1.6)	0.180
New Hampshire (2000)	−33.9 (−37.7 to −29.9)†	<0.001
North Carolina (2003)	−1.1 (−4.4 to 2.4)	0.54
Tennessee (2009)	4.2 (−0.1 to 8.6)	0.056
Maryland (2009)	−23.6 (−27.8 to −19.2)†	<0.001
Iowa (2010)	0.4 (−4.1 to 5.0)	0.88
Colorado (2013)	−14.3 (−20.4 to −7.8)†	<0.001
Control variables‡		
Region		
Northeast	−6.0 (−17.1 to 6.6)	0.33
South	16.6 (3.9 to 30.7)†	0.009
West	6.2 (−4.9 to 18.6)	0.29
Firearm ownership (SD = 13.4%)	9.2 (4.8 to 13.7)†	<0.001
Stranger homicide rate (SD = 0.83 per 100 000 persons)	6.5 (3.1 to 10.1)†	<0.001
Lagged IPH rate (SD = 0.45 per 100 000 persons)	7.4 (3.6 to 11.4)†	<0.001
Proportion of population that is African American (SD = 9.5%)	12.1 (7.9 to 16.7)†	<0.001
Violent crime rate (SD = 2.13 per 100 000 persons)	11.9 (7.6 to 16.3)†	<0.001
Divorce rate (SD = 1.2 per 1000 persons)	7.7 (5.3 to 10.2)†	<0.001

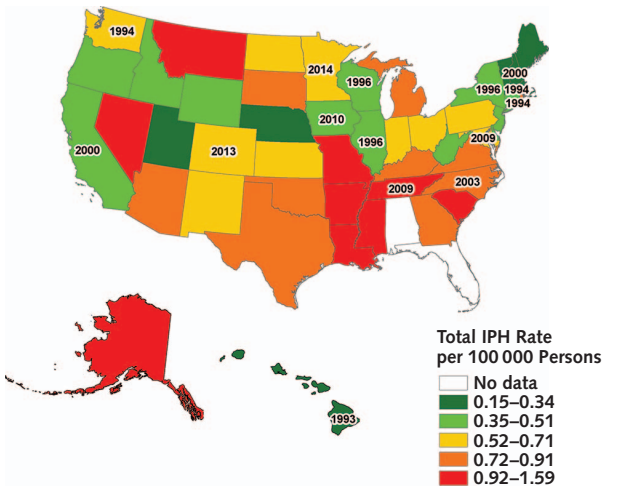
IPH = intimate partner homicide; IPV = intimate partner violence.
* The law being tested prohibits persons who are subject to IPV-related restraining orders from possessing firearms and requires them to surrender firearms they already have. The models included year fixed effects, region, household gun ownership, stranger homicide rate, lagged IPH rate, proportion of the population that is African American, violent crime rate, and divorce rate. The reference group is states with no law requiring surrender of firearms by persons subject to an IPV-related restraining order. Results for Minnesota are not reported because there was only 1 y of data after implementation of the law, so the estimate is highly unstable.
† Statistically significant ($P < 0.05$).
‡ All variables are standardized such that the percentage shown is the percentage difference in IPH rates associated with a 1-SD increase in the listed factor.

Appendix Table 7. Change in IPH Rates Before and After Implementation of IPV-Related Restraining Order Possession and Surrender Laws*

State (Year Enacted)	Average IPH Rate (per 100 000 Persons)		Change, %
	Before Law	After Law	
Hawaii (1993)	0.86	0.42	−51.2
Other states	1.16	0.83	−28.4
Massachusetts (1994)	0.47	0.37	−20.8
Other states	1.16	0.82	−29.3
Washington (1994)	0.81	0.53	−35.0
Other states	1.15	0.82	−28.7
Connecticut (1994)	0.71	0.49	−31.0
Other states	1.15	0.82	−28.7
New York (1996)	1.21	0.53	−56.2
Other states	1.11	0.79	−28.8
Wisconsin (1996)	0.52	0.41	−22.0
Other states	1.12	0.79	−29.8
Illinois (1996)	1.14	0.52	−54.4
Other states	1.11	0.79	−28.8
California (2000)	0.95	0.61	−35.8
Other states	1.05	0.76	−27.6
New Hampshire (2000)	0.54	0.28	−48.1
Other states	1.06	0.76	−28.3
North Carolina (2003)	1.42	0.94	−33.8
Other states	0.98	0.75	−23.5
Tennessee (2009)	1.20	0.99	−17.5
Other states	0.92	0.71	−22.8
Maryland (2009)	1.21	0.66	−45.5
Other states	0.92	0.71	−22.8
Iowa (2010)	0.37	0.36	−2.7
Other states	0.93	0.71	−23.7
Colorado (2013)	0.77	0.53	−30.7
Other states	0.90	0.73	−18.9

IPH = intimate partner homicide; IPV = intimate partner violence.
* For each state that enacted an IPV-related restraining order possession and surrender law during the study period, this table shows the average IPH rate before and after the year of implementation of the law, compared with the average IPH rates during the same years in all other states combined (excluding any states that had a similar law in effect). Results for Minnesota are not reported because there was only 1 y of data after implementation of the law, so the estimate is highly unstable.

Appendix Figure. Status of state IPV-related restraining order firearm relinquishment laws in 2014 and IPH rates in 2015.



The year in which the law was implemented is shown. IPH = intimate partner homicide; IPV = intimate partner violence.

Appendix Table 8. Statistical Code for Models in Stata

Main analysis negative binomial GEE model

xtnbreg intimaterate lagintimaterate i.year i.regions proxy strangerrate pctblack crime divorce lagdvrosurrender, pa i(states) robust irr

(intimaterate = current year intimate partner homicide rate; lagintimaterate = past year intimate partner homicide rate; i.year = year fixed effects; i.regions = region fixed effects; proxy = estimated household gun ownership; strangerrate = rate of stranger homicide; pctblack = percent of population that is African-American; crime = violent crime rate; divorce = divorce rate; lagdvrosurrender = lagged presence of absence of domestic violence restraining order firearm relinquishment law)

Random slopes model (allowing effect of laws to vary by state)

xtnbreg intimaterate lagintimaterate i.year i.regions proxy strangerrate pctblack crime divorce i.stateeffects, pa i(states) robust irr

(i.stateeffects = interaction between state and lagdvrosurrender; that is, numeric state code multiplied by presence (1) or absence (0) of domestic violence restraining order firearm relinquishment law in previous year)

GEE = generalized estimating equation.