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Easiness of Legal Access to Concealed Firearms Permits and Homicide Rates in the US States

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Abstract

Objectives. To examine the relation of "shall issue" laws, in which permits must be issued if requisite criteria are met, "may issue" laws, which give law enforcement officials wide discretion over whether to issue concealed firearm carry permits or not, and homicide rates.

Methods. We compared homicide rates in "shall issue" and "may issue" states and total, firearm, non-firearm, handgun, and long gun homicide rates in all 50 states during the 25-year period 1991-2015. We included year and state fixed effects and numerous state-level factors in the analysis.

Results. "Shall issue" laws were significantly associated with 6.5% higher total homicide rates, 8.6% higher firearm homicide rates, and 10.6% higher handgun homicide rates, but were not significantly associated with long gun or non-firearm homicide.

Conclusions. "Shall issue" laws are associated with significantly higher rates of total, firearm-related, and handgun-related homicide.

Firearm violence is a major public health problem. In 2015, there were approximately 36,000 firearm-related deaths in the United States; 13,463 were homicides, 22,018 were suicides, and 489 were unintentional injuries.[1] During the same year, 72.9% of homicides were firearm homicides[1] and of these, approximately 90% were committed using a handgun. A central question in the debate about public policies to reduce firearm violence is whether easier access to concealed handguns increases or decreases the rate of firearm-related homicides.[2] Some have argued that the feared or actual presence of armed citizens may deter violent crime.[3] Others have suggested that a higher prevalence of people carrying guns will increase the likelihood that an altercation results in a fatality.[4] Thus, having a clear understanding of the impact of concealed carry laws on firearm-related homicide would help guide policy makers aiming to reduce firearm violence.

As of the end of 2015, all states allowed certain persons to carry concealed handguns, but there were three major variations in permitting policy[5] (Table 1). In nine states, law enforcement officials have wide discretion over whether to issue concealed carry permits; these are referred to as "may issue" states. In 32 states, there is little or no discretion; these are referred to as "shall issue" states because permits must be issued if requisite criteria are met. In an additional nine states, there is no permit necessary to carry a concealed handgun; these are referred to as "permitless carry" states. The wide variation in these policies between states and over time presents the opportunity to compare homicide rates between states with varying concealed carry permitting policies to examine the impact of concealed carry laws on homicide.

The critical difference between "may issue" and "shall issue" laws is that in "may issue" states, law enforcement officials may use their judgment in making decisions about

whether to approve or deny a permit application, while in "shall issue" states, no judgment is involved—the application must be approved unless the applicant is categorically prohibited from concealed handgun possession. In "may issue" states, the element of discretion allotted to law enforcement is typically a judgment regarding the "suitability" or "need" of a person to carry a concealed weapon (Table 2). Law enforcement officials have a wide degree of latitude in making these judgments. In "shall issue" states, the categorical prohibitions consist of a list of specific criminal convictions.

Unfortunately, the existing literature on the impact of concealed carry laws is inconsistent. At least 10 national studies have examined the relationship between "shall issue" concealed carry laws and firearm-related or total homicide rates at the state level (Supplemental Table 1).[6-15] In two studies, "shall issue" laws were found to decrease homicide rates.[6,7] In two studies, these laws were found to increase homicide rates.[8,9] Six studies reported no clear impact of "shall issue" laws on homicide rates.[10-15] The inconsistency of these results has understandably created some confusion about what approach is most effective to address the firearm violence problem.

Most of the published literature on this topic includes data that are more than a decade old: the most recent year of data analyzed was 2010, and only three of the 10 studies examined data past the year 1998 (Supplemental Table 1). Since 1998, eleven additional states have enacted "shall-issue" laws.[5] This provides more variation over time and a longer follow-up period to examine this research question. Moreover, Ayres and Donohue[16] and Hepburn et al.[12] have suggested that the relationship between concealed carry laws and homicide rates may have been different during the period before and after the early 1990s. In addition, studies that included homicide rates from before 1994 were examining a trend that

was increasing, while studies examining homicide rates after 1994 were capturing declining trends. For these reasons, a re-examination of this research question using more recent data is needed.

One limitation of the existing literature is that no previous paper has examined the specific impact of concealed carry laws on handgun vs. long gun homicide rates. This is important because if such laws increase homicide by making it easier for people at high risk of violence to carry handguns, this effect should only be observed in relation to handgun-related homicides, not homicides committed with long guns. On the other hand, if permissive concealed carry laws deter crime by generating fear among potential perpetrators of encountering an armed individual, then all crime including handgun, long gun, and non-firearm homicide should decrease.

Another limitation of prior studies is that nearly all of them used linear models. However, homicide rates represent count data and the distribution of homicide rates across states is highly skewed[17] (Supplemental Figure 1). Plassmann and Tideman argued that a count model (such as a Poisson or negative binomial model) is the most reliable for analyzing crimes, such as homicides, with low occurrence rates.[17] Beyond the Plassmann and Tideman study, only one other study[12] used a count model.

In this paper, we examine the relationship between "shall issue" concealed carry laws and total, firearm-related, and non-firearm-related homicide rates, as well as handgun vs. long gun homicide rates across all 50 states during the 25-year time period 1991-2015 using both count and linear regression models. We examine the specificity of the relationship between concealed carry laws and homicide rates by separately modeling firearm vs. non-firearm homicide rates and then within firearm-related homicides, by modeling handgun vs.

long gun homicide rates. We analyze the relationship between "shall issue" concealed carry laws and homicide rates using both a count and a linear regression model, thus examining the robustness of results to the type of model used.

METHODS

Design Overview

The study used a quasi-experimental, panel design, taking advantage of changes in state concealed carry permitting laws over time in order to explore the relationship between these laws and total, firearm-related, and non-firearm-related homicide rates in the 50 states over a 25-year period, 1991-2015. We modeled homicide rates in two ways: (1) using a negative binomial regression with homicide rates as the outcome variable; and (2) using linear regression with log-transformed homicide rates as the outcome variable. In both cases, we included year and state fixed effects and controlled for a range of time-varying, state-level factors.

Variables and Data Sources

Outcome variables

Annual state-specific, age-adjusted firearm, non-firearm, and total homicide rates. The main outcome variable was the age-adjusted firearm homicide rate in each year analyzed. For example, Missouri's "shall issue" law went into effect in 2003; thus, homicide rates associated with Missouri's "shall issue" law were analyzed for the years 2004-2015. Homicide rates were obtained from the Centers for Disease Control and Prevention's Web-Based Injury Statistics Query and Reporting Systems database.[1] This is the ideal source for

homicide data because there is complete annual reporting from all 50 states and because the data are extracted from the vital statistics death registry maintained by the National Center for Health Statistics (NCHS), which is based on standardized death certificates. The completeness of reporting is approximately 99%.[18] Rates were age-adjusted to the 2000 standard population.

Annual state-specific handgun and long gun homicide rates. The second outcome variable was the handgun or long gun homicide rate, obtained from the Federal Bureau of Investigation's Uniform Crime Reports, Supplemental Homicide Reports (SHR).[19] While WISQARS does provide mortality data from ICD-9 and ICD-10 codes that can list handgun and long gun as the cause of death, unfortunately, most death certificates involving a firearm homicide do not specify the type of weapon used. Therefore, most firearm homicide deaths in WISQARS are classified as "other and unspecified" firearm, and it is not possible to use these data to disaggregate handgun and long gun homicides.[20] In contrast, the SHR is missing data on the type of weapon used in firearm homicides in just 13.4% of cases. Thus, the SHR is the best, if not only source for state-specific, firearm type-specific homicide data.

The SHR disaggregates firearm homicides into handgun, rifle, shotgun, and other (and unknown). We used the handgun deaths to generate handgun homicide rates and the sum of rifle, shotgun, and other gun deaths to generate long gun homicide rates for each state and year. While SHR data may include listing of multiple weapons in an incident, only one weapon may be associated with a homicide death.[21] Because of missing data on weapon type, we excluded 13.4% of firearm homicide cases in estimating handgun homicide rates. Nevertheless, there was little discrepancy between the firearm homicide totals from WISQARS and the SHR, which were correlated at r=0.98.

Because not all local law enforcement agencies complete the supplemental reports, the SHR data set excludes approximately 10% of all homicides.[22] This problem was addressed by applying weights that adjust each state-and year-specific estimate up to the overall number of homicides reported in the Uniform Crime Report for that state and year. Fox kindly provided us with updated SHR files that added previously missing data for Florida and included data through 2015.[22]

Main predictor variable

Using *Thomson Reuters Westlaw* to access historical state statutes and session laws, we developed a database indicating the presence or absence of 100 provisions of firearm laws in each state over the 26-year period.[5] We coded laws by the year they went into effect, regardless of the month of the effective date. However, in the analytic models, we lagged the state laws by one year, which ensured that all laws were in effect during the year in which their impact was being assessed. Following Lott and Mustard,[23] the impact of laws was assessed starting in the first full year they were in effect.

In this study, we examined the potential impact of "shall issue" laws, comparing them to "may issue" laws. In other words, using the "may issue" states as the reference group, we estimated the impact of "shall issue" laws on homicide rates. Since only four states had "permitless carry" laws in place during the study period, there were not enough observations to allow any meaningful analyses of these laws. Therefore, we deleted state-year observations where a "permitless carry" law was in effect.

Control variables

We controlled for 12 state-level factors that: (1) were found in the prior literature[6-15] to be significantly related to homicide rates; and (2) were significantly related to the presence of "shall issue" laws in our dataset (i.e., the regression coefficient for the variable was significant at a level of p=0.05 in a logistic regression with "shall issue" law as the dependent variable): household firearm ownership (using the standard proxy which is the percentage of all suicides committed with a firearm), proportion of Blacks, proportion of young adults (ages 18-29), proportion of males among young adults (ages 18-29), proportion of the population living in urban areas, total population, population density, per capita alcohol consumption, the non-homicide violent crime rate (aggravated assault, robbery, and forcible rape), the poverty rate, unemployment rate, median household income, per capita disposable income, incarceration rate, and per capita number of law enforcement officers. Variable definitions and data sources are provided in Supplemental Table 2. We also controlled for the following state firearm laws that could serve as alternative explanations for changes in homicide during the study period: (1) universal background checks required for all handgun purchases; (2) waiting periods required for all handgun purchases; and (3) permits required to purchase or possess firearms.

Analysis

Count models

Since homicide rates are not normally distributed but skewed and overdispersed, we modeled this outcome using a negative binomial distribution. To control for clustering in our data by year (25 levels) and by state (50 levels), we entered year and state as fixed effects in the regression models. We used robust standard errors that account for the clustering of observations, serial autocorrelation, and heteroskedasticity.[24]

Our final model was as follows:

$$(1)\ Pr(H_{st} = h_{st}) = [\ \Gamma(y_{st} + \alpha^{-1})/\Gamma((y_{st} + 1)\ \Gamma\alpha^{-1})\ ]\ [\ 1/(1 + \alpha\mu_{st})\ ]^{1/\alpha}\ [\ \mu_{st}/(\alpha^{-1} + \mu_{it}\ ]^{yst},$$

where: $Pr(H_{st} = h_{st})$ is the probability that state *s* in year *t* has a homicide rate equal to h_{st}, $E(H_{st}) = \mu_{st}$, and $Var(H_{st}) = \mu_{st + \alpha}\ \mu_{st}^2$.

The mean homicide rate was then modeled as follows:

$$(2)\ ln(\mu_{st}) = \alpha + \beta_1 CC_{st} + \beta_2 C_{st} + S + T + e,$$

where CC_{st} is a dummy variable for the presence of a "shall issue" law, *C* is a vector of control variables, *S* represents state fixed effects, and *T* represents year fixed effects.

The negative binomial regression coefficients are reported as incidence rate ratios (IRR). The IRR indicates the percentage difference in homicide rate for states with a "shall issue" concealed carry law compared to states with a "may issue" law.

Linear models

To check the robustness of our findings, we repeated the analyses using a linear regression model, with the log-transformed homicide rate as the outcome variable, again using robust standard errors.[24] As with the negative binomial models, we included year and state fixed effects, and we included the same state-level control variables.

Analytic software and significance testing

We conducted analyses using STATA version 14.1 (College Station, TX: StataCorp). The significance of regression coefficients was evaluated using a Wald test at α=0.05.

Sensitivity analyses

We checked the robustness of our results by conducting several sensitivity analyses, including: (1) restricting the analysis to the 23 states in which "shall issue" laws were adopted during the study period; (2) using raw count data instead of homicide rates; (3) restricting the analysis to states with population greater than 1,000,000; (4) restricting the analysis to the period 1991-2002; (5) restricting the analysis to the period 2003-2015; and (6) using SHR instead of WISQARS homicide data (thus avoiding the problem of missing data for some smaller states after 1998).

RESULTS

During the study period, 23 states adopted "shall issue" laws (Table 1). By 2015, 37 states had such laws. In the same year, the average firearm homicide rate in the states with "shall issue" laws was 4.11 per 100,000, compared to 3.41 per 100,000 in the "may issue" states. The number of states that had "permitless carry" laws in effect at all during the study period was small (N=4), as was the number of observations (N=46), limiting our ability to analyze the impact of these laws. Because CDC does not report homicide counts below 10 in years after 1998, we were missing outcome data for several years for six states (Hawaii, New Hampshire, North Dakota, South Dakota, Vermont, and Wyoming); a sensitivity analysis using SHR data source revealed that these omissions do not affect our findings.

In negative binomial regression models, "shall issue" concealed carry permitting laws were significantly associated with 6.5% higher total homicide rates compared to "may issue" states (IRR = 1.065; 95% confidence interval [CI], 1.032-1.099) (Table 3). The association was specific to firearm homicide rates, which were 8.6% higher in "shall issue" states (IRR = 1.086; 95% CI, 1.047-1.126). There was no significant association between "shall issue" laws and non-firearm homicide rates. Further disaggregation within firearm homicides

showed that the association between "shall issue" laws and firearm homicide rates was specific to handgun homicide. "Shall issue" states had handgun homicide rates that were 10.6% higher (IRR = 1.106; 95% CI, 1.039-1.177), but there was no significant association with long gun homicide rates.

The results of the linear regression analyses were similar. Here, "shall issue" laws were significantly associated with 6.6% higher total homicide rates compared to "may issue" states (95% CI, 3.0% to 10.4%), (data not shown). The association was specific to firearm homicide rates, which were 11.7% higher in "shall issue" states (95% CI, 6.4% to 17.2%); there was no significant association between these laws and non-firearm homicide rates. Further disaggregation within firearm homicides showed that the association between "shall issue" laws and firearm homicide rates was specific to handgun homicide. "Shall issue" states had handgun homicide rates that were 19.8% higher (95% CI, 10.3% to 30.1%), but rates of long gun homicide were not significantly different in states with "shall issue" compared to "may issue" laws.

The significant association between "shall issue" laws and higher total, firearm, and handgun-related homicide rates remained when we restricted the analysis to the 23 states in which these laws were adopted during the study period (Table 4). This pattern of results was robust to a series of additional sensitivity checks, including using raw count data, restricting the analysis to states with a population of more than 1,000,000, restricting the analysis to the period 1991-2002, restricting the analysis to the period 2003-2015, and using SHR instead of WISQARS homicide data.

DISCUSSION

To the best of our knowledge, this is the first study to examine the relationship between concealed carry permitting laws and handgun-specific homicide rates. We found that, using both count and linear models and after controlling for a range of time-varying state factors and for unobserved time-invariant state factors using a fixed effects model, "shall issue" concealed carry permitting laws were significantly associated with 6.5% higher total homicide rates, 8.6% higher firearm-related homicide rates, and 10.6% higher handgun-specific homicide rates compared to "may issue" states.

A major reason for inconsistent results in the existing literature on the effects of concealed carry laws may be that the relationship between concealed carry laws and homicide rates was different during the period before and after the early 1990s.[12,16] It is possible that despite the enactment of early "shall issue" laws in the 1970s and 1980s, the demand for handgun permits in those states was modest. There has been a striking increase in the demand for pistols, especially those designed for concealed carry, during the past decade.[25] Recently, Steidley found that the adoption of "shall issue" laws during the period 1999-2013 was associated with a persistent, long-term increase in handgun sales in all seven states studied.[26] Our analysis provides further support for the hypothesis that the relationship between "shall issue" laws and higher homicide rates increased over time, as the regression coefficients for these laws was higher for the second half of the study period (2003-2015) compared to the first half (1991-2002).

Our finding that the association between "shall issue" laws and homicide rates is specific to handgun homicides adds plausibility to the observed relationship. If the relationship between "shall issue" laws and homicide rates were spurious, one might expect to see the relationship hold for long gun as well as handgun homicide rates. Moreover, this

finding is inconsistent with the hypothesis that permissive concealed carry laws deter crime by increasing the presence of armed individuals. Were that the case, one would expect to see lower handgun, non-handgun, and non-firearm homicide rates in "shall issue" compared to "may issue" states. The lack of an association between "shall issue" laws and long gun homicide rates is also inconsistent with the hypothesis that the presence of more concealed weapons escalates the level of violence in encounters that may involve a long gun.

This study has several novel strengths, including the use of both count and linear models, the use of recent data (through 2015), and the disaggregation of homicide rates. Nevertheless, caution should be exercised in assessing causality from an ecological study such as this one. In particular, these results should be interpreted with caution because of the possibility that they reflect a reverse association. That is, it is possible that the adoption of "shall issue" concealed carry laws is associated with higher baseline homicide rates so that we are picking up not a causal effect of these laws on homicide but a systematic difference in baseline homicide rates between states that do or do not have these laws. However, our findings hold even when the analysis is restricted to states that started with "may issue" laws at the beginning of the study period and adopted "shall issue" laws during the study period.

An additional limitation of this study is that we could not consider the enforcement of concealed carry laws.[27] Enforcement of these laws may vary not only among states, but even among counties in the same state.[12] In addition, we did not have information on the number of concealed carry permits issued in each state or the number of homicides committed by concealed carry permittees.

It is also important to note that we examined only fatal firearm injuries. Further research should investigate potential effects of concealed carry laws on non-fatal firearm injuries.

Finally, we were unable to analyze the impact of "permitless carry" laws due to the small number of observations. Only four states had "permitless carry" laws in place during the study period. However, in the past two years, an additional five states have enacted such laws. Elucidating the impact of "permitless carry" laws will require follow-up of the nine states that now have such laws in effect.

Despite these limitations, this study suggests that there is a robust association between "shall issue" laws and higher rates of firearm homicides. The trend toward increasingly permissive concealed carry laws is inconsistent with public opinion, which tends to oppose the carrying of guns in public.[35] Our findings suggest that these laws may also be inconsistent with the promotion of public safety.

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Contributors

M. Siegel conceptualized the study, led the data analysis and writing, and was the principal author of this article. Z. Xuan and C. S. Ross assisted with the study design and analytical plan. All authors contributed toward the interpretation of data analyses, critical review of the manuscript, and revision of the manuscript.

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Human Participant Protection

This study made use of secondary data only and did not require institutional review board approval.

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TABLE 1—Concealed Carry Permitting Laws and Age-adjusted Firearm Homicide Rates by State, 2015 and Status of Laws During the Period 1991-2015

State	Age-adjusted Firearm Homicide Rate[a], 2015 (per 100,000)	Status of Concealed Carry Permitting Law, 2015	Effective Date of Current (as of 2015) Concealed Carry Law
Hawaii[b]	0.75	May issue	Prior to 1991
New Hampshire	0.96	Shall issue	Prior to 1991
Rhode Island	0.99	May issue	Prior to 1991
Maine	1.14	Shall issue	Prior to 1991
Massachusetts	1.26	May issue	Prior to 1991
Utah	1.39	Shall issue	1995
Idaho	1.29	Shall issue	Prior to 1991
Iowa	1.62	Shall issue	Prior to 1991
North Dakota	1.69	Shall issue	Prior to 1991
Vermont	1.76	Permitless carry	Prior to 1991
Minnesota	1.77	Shall issue	2003
South Dakota	1.97	Shall issue	Prior to 1991
New York	2.07	May issue	Prior to 1991
Wyoming	2.16	Permitless carry	2011[c]
Montana	2.17	Shall issue	Prior to 1991
Washington	2.32	Shall issue	Prior to 1991
Oregon	2.35	Shall issue	Prior to 1991
Connecticut	2.43	May issue	Prior to 1991
Colorado	2.46	Shall issue	2003

Nebraska	2.67	Shall issue	2007
West Virginia	2.89	Shall issue	Prior to 1991
Wisconsin	3.18	Shall issue	2011
New Jersey	3.22	May issue	Prior to 1991
Virginia	3.29	Shall issue	1995
Kansas	3.35	Shall issue	2007
California	3.52	May issue	Prior to 1991
Arizona	3.56	Permitless carry	2010[c]
Kentucky	3.96	Shall issue	1996
Texas	4.04	Shall issue	1995
Pennsylvania	4.34	Shall issue	Prior to 1991
Ohio	4.38	Shall issue	2004
Nevada	4.49	Shall issue	1995
North Carolina	4.54	Shall issue	1995
Indiana	4.61	Shall issue	Prior to 1991
Florida	4.66	Shall issue	Prior to 1991
Michigan	4.74	Shall issue	2001
New Mexico	4.79	Shall issue	2001
Alaska	5.22	Permitless carry	2003[c]
Arkansas	5.34	Shall issue	1995
Illinois	5.45	Shall issue	2013
Tennessee	5.51	Shall issue	1994
Georgia	5.73	Shall issue	Prior to 1991

Oklahoma	5.87	Shall issue	1995
Delaware	6.12	May issue	Prior to 1991
South Carolina	7.55	Shall issue	1996
Maryland	7.69	May issue	Prior to 1991
Missouri	7.92	Shall issue	2003
Alabama	8.43	Shall issue	2013
Mississippi	9.11	Shall issue	1991
Louisiana	9.96	Shall issue	1996

[a]From Centers for Disease Control and Prevention (CDC). *Web-based Injury Statistics Query and Reporting Systems*: Fatal Injury Reports. Available at: http://www.cdc.gov/injury/wisqars/fatal_injury_reports.html.
[b]Data for Hawaii are unavailable for the years 2010 to 2015 because CDC WISQARS does not report homicide counts less than 10. The data here are from 2009.
[c]Changed from “may issue” to “shall issue” in 1994.

Table 2—Elements of Discretion in Law Enforcement Decisions to Approve or Deny Concealed Handgun Carry Permits—"May Issue" States, 2015

State	Elements of Discretion	Citation
California	Applicant must be of "good moral character" and must have "good cause" for issuance of the license	California Penal Code § 26150, § 26155
Connecticut	Applicant must intend only to make "legal use" of the handgun and must be a "suitable person to receive such permit."	Connecticut General Statutes § 29-28
Delaware	Applicant must be "of good moral character," must desire the handgun for "personal protection" or "protection of the person's property," and must submit signed, written statements of five "respectable citizens" of the county who testify that the applicant is a person "of sobriety and good moral character" and "bears a good reputation for peace and good order in the community" and that a handgun is "necessary for the protection of the applicant or the applicant's property." The Superior Court has discretion to approve or deny the application.	Delaware Code § 1441
Hawaii	Must be "an exceptional case," the applicant must show "reason to fear injury to the applicant's person or property," the applicant must be "a suitable person" to be licensed, and the chief of police must determine that the person "is qualified to use the firearm in a safe manner."	Hawaii Revised Statutes § 134-9
Maryland	Applicant must have a "good and substantial reason to wear, carry, or transport a handgun, such as a finding that the permit is necessary as a reasonable precaution against apprehended danger," and the applicant must not have "exhibited a propensity for violence or instability that may reasonably render the person's possession of a handgun a danger to the person or to another."	Maryland Public Safety Code § 5-306
Massachusetts	Applicant must be a "suitable" person and must not be judged to potentially create a risk to public safety.	Massachusetts General Laws 140 § 131

New Jersey	Applicant must demonstrate a "justifiable need to carry a handgun" and must submit endorsements by three individuals who have known the applicant for at least three years that the applicant is "a person of good moral character and behavior."	New Jersey Statutes § 2C:58-4
New York	Applicant must be "of good moral character," must be "of good character, competency, and integrity," and there must be no "good cause" for denial of the license.	New York Penal Law § 400.00
Rhode Island	Applicant must have "good reason to fear an injury to his or her person or property" or have "any other proper reason" for carrying a handgun and must be a "suitable person to be so licensed."	General Laws of Rhode Island § 11-47-11

TABLE 3—Incidence Rate Ratios (95% Confidence Intervals) of Shall Issue vs. May Issue Laws and Total, Firearm, Non-firearm, Handgun, and Long Gun Homicide Rates in 50 US States, 1991-2015[a]

	Homicide rate				
Variable	Total	Firearm	Non-firearm	Handgun	Long gun
"Shall issue" laws	1.065* (1.032-1.099)	1.086* (1.047-1.126)	1.014 (0.963-1.068)	1.106* (1.039-1.177)	0.999 (0.915-1.090)

*p<0.05

[a]In these final negative binomial models, the reference group is states with "may issue" laws. All models include year and state fixed effects and control for the following time-varying, state-level factors: household gun ownership levels, proportion of young males, proportion of young adults, proportion of blacks, proportion living in an urban area, total population, population density, median household income, poverty rate, unemployment rate, per capita disposable income, per capital alcohol consumption, violent crime rate, incarceration rate, per capita law enforcement officers, universal background check laws for all handguns, waiting periods for all handguns, and permits required for all firearms.

Table 4—Relationship Between "Shall Issue" Concealed Carry Permitting Laws and Homicide Rates (Incidence Rate Ratio and 95% Confidence Interval): Sensitivity Analyses[a]

	Homicide Rate		
	Total	Firearm	Handgun
Analysis restricted to states that adopted "shall issue" concealed carry laws during study period	1.063* (1.028-1.099)	1.068* (1.030-1.108)	1.074* (1.002-1.150)
Analysis using raw count of homicides with population as the exposure variable	1.051* (1.020-1.083)	1.079* (1.039-1.120)	1.139* (1.067-1.217)
Analysis restricted to states with population > 1 million	1.055* (1.023-1.087)	1.067* (1.030-1.105)	1.095* (1.029-1.166)
Analysis restricted to years prior to 2003 (1991-2002)	1.058* (1.014-1.104)	1.067* (1.019-1.116)	1.107* (1.037-1.180)
Analysis restricted to years after 2002 (2003-2015)	1.064* (1.009-1.122)	1.100* (1.028-1.176)	1.274* (1.092-1.488)
Analysis using Supplemental Homicide Report data instead of Vital Statistics data	1.044* (1.006-1.083)	1.094* (1.047-1.143)	1.106* (1.039-1.177)

*p<0.05

[a]All models include year and state fixed effects and control for the following time-varying, state-level factors: household gun ownership levels, proportion of young males, proportion of young adults, proportion of blacks, proportion living in an urban area, total population, population density, median household income, poverty rate, unemployment rate, per capita disposable income, per capital alcohol consumption, violent crime rate, incarceration rate, per capita law enforcement officers, universal background check laws for all handguns, waiting periods for all handguns, and permits required for all firearms.

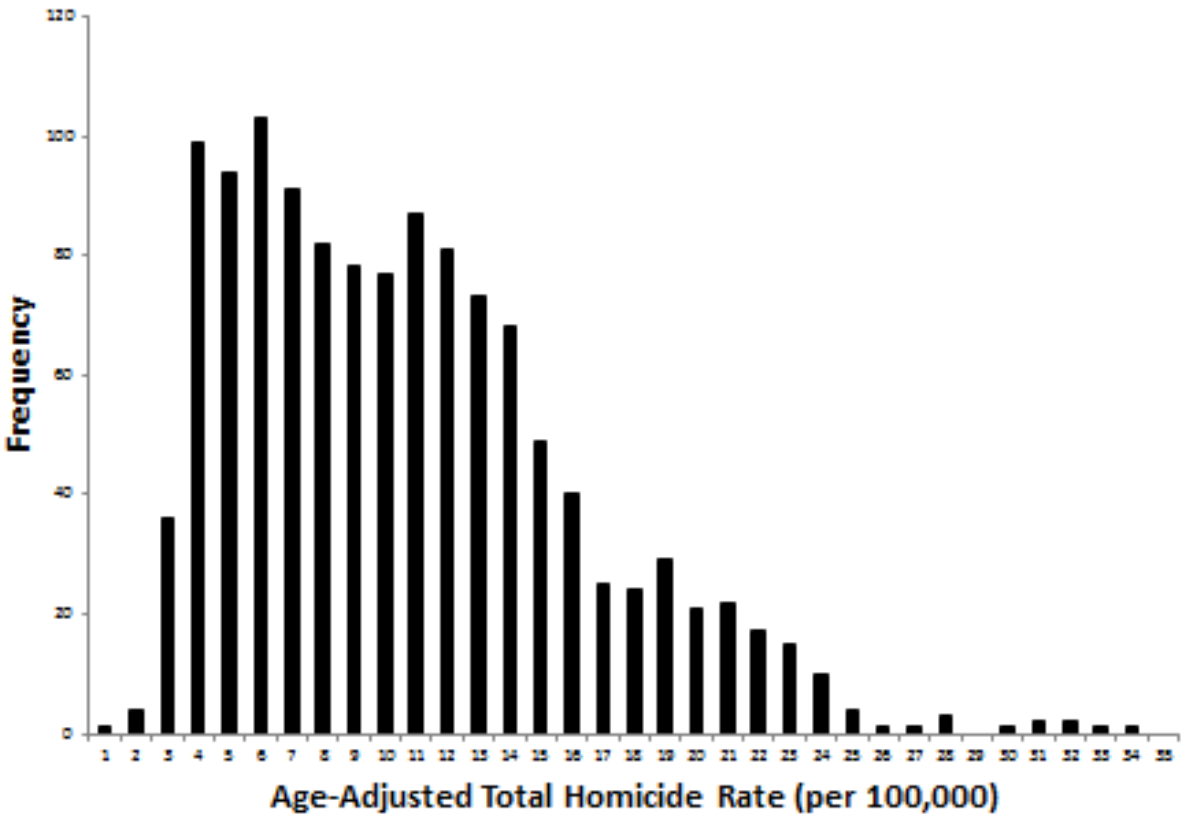
SUPPLEMENTAL TABLE 1—Previous National Studies of the Effect of State-level, Concealed Carry Permit Legislation on Total or Firearm-Related Homicide Rates at the State Level

Study and Years Covered	Law Studied	Outcome
Zimmerman, 2014 (1999-2010)	Permissive concealed carry laws ("shall issue")	Significant increase in homicide rates
Aneja et al., 2011 (1977-2006)	Permissive concealed carry laws ("shall issue")	No significant association with homicide rates
Lott, 2010 (1977-2005)	Permissive concealed carry laws ("shall issue")	Permissive concealed carry laws associated with significant decrease in homicide rates
Rosengart et al., 2005 (1979-1998)	Permissive concealed carry laws ("shall issue")	Shall issue laws associated with a non-significant increase in firearm and total homicide rates
Hepburn et al., 2004 (1979-1998)	Permissive concealed carry laws ("shall issue")	No association between concealed carry laws and homicide rates
Lott and Whitley, 2001 (1979-1996)	Permissive concealed carry laws ("shall issue")	Permissive concealed carry laws associated with significant reduction in homicide rates
Ludwig, 1998 (1977-1994)	Permissive concealed carry laws ("shall issue")	Permissive concealed carry laws associated with significantly higher adult homicide rates
Sommers, 1980 (1977)	Permissive concealed carry laws ("shall issue")	No effect on homicide rates
DeZee, 1983 (1978)	Permissive concealed carry laws ("shall issue")	No significant effect on overall homicide rates
Murray, 1975 (1970)	Permissive concealed carry laws ("shall issue")	No significant effect on overall homicide rates

SUPPLEMENTAL TABLE 2—Variables and Data Sources

Variable	Definition	Mean (standard deviation)	Source
Household firearm ownership (proxy)	Percentage of households with a firearm, using a proxy which is the proportion of all suicides committed using a firearm	55.2% (13.0%)	Centers for Disease Control and Prevention. Web-based Injury Statistics Query and Reporting Systems (WISQARS): Fatal Injury Reports[1]
Race/ethnicity - black	Percentage of population that is black	10.7% (9.5%)	Centers for Disease Control and Prevention. Web-based Injury Statistics Query and Reporting Systems (WISQARS): Fatal Injury Reports[1]
Age – young adults	Proportion of population ages 18-29	21.0% (0.04%)	U.S. Bureau of the Census[28]
Age/sex – young males	Proportion of young adults (ages 18-29) who are male	51.0% (0.02%)	U.S. Bureau of the Census[28]
Percent urban	Proportion of population living in urbanized area or urban cluster	72.4% (0.41%)	U.S. Bureau of the Census[28]
Population density	Population divided by land area in square miles	185.2 (250.1)	U.S. Bureau of the Census[28]
Population	Total population	5,771,576 (6,361,161)	U.S. Bureau of the Census[28]
Alcohol consumption	Per capita alcohol consumption among persons ages 14 and older	2.33 (0.49)	National Institute of Alcoholism and Alcohol Abuse[29]
Violent crime rate	Combined rate of aggravated assault, robbery, and forcible rape per 100,000 population	4.31 (2.13)	Federal Bureau of Investigation. Uniform Crime Reporting Statistics[30]
Poverty rate	Percentage of population living in poverty	13.0% (0.1%)	U.S. Bureau of the Census[31]
Disposable income	Per capita personal disposable income	$34,944 ($161)	U.S. Bureau of the Census[31]
Household income	Median household income (in 2010 dollars)	$50,274 ($227)	U.S. Bureau of the Census[31]
Unemployment rate	Percentage unemployed among civilian labor force, aged ≥16	5.7% (0.1%)	U.S. Bureau of Labor Statistics[32]
Incarceration rate	Prisoners with sentence >1 year per 100,000 population	369.3 (4.1)	Bureau of Justice Statistics[33]
Law	Per capita number of sworn law	2.09	Federal Bureau of Investigation[34]

enforcement capacity	enforcement officers	(0.01)



SUPPLEMENTAL FIGURE 1—Histogram showing distribution of state age-adjusted, total homicide rates, 1991-2015