

SPECIAL ISSUE ARTICLE

COUNTERING MASS VIOLENCE IN THE UNITED STATES

Evidence concerning the regulation of firearms design, sale, and carrying on fatal mass shootings in the United States

Daniel W. Webster | Alexander D. McCourt  | Cassandra K. Crifasi | Marisa D. Booty | Elizabeth A. Stuart

Johns Hopkins University

Correspondence

Daniel W. Webster, Johns Hopkins University
Bloomberg School of Public Health, Center for
Gun Policy and Research, 624 N. Broadway,
Room 580, Baltimore, MD 21205-2103.
Email: dwebster@jhu.edu.

Funding information

The Joyce Foundation; Bloomberg American
Health Initiative

Research Summary: We used data from the FBI's Supplemental Homicide Reports and other publicly available databases to calculate state-level annual incidence of fatal mass shootings for 1984–2017. Negative binomial regression models were used to estimate the associations between changes in key gun laws and fatal mass shootings. Handgun purchaser licensing laws and bans of large-capacity magazines (LCMs) were associated with significant reductions in the incidence of fatal mass shootings. Other laws commonly advocated as solutions to mass shootings—comprehensive background checks, assault weapons bans, and de-regulation of civilian concealed carry of firearms—were unrelated to fatal mass shootings.

Policy Implications: Our findings suggest that laws requiring firearm purchasers to be licensed through a background check process supported by fingerprints and laws banning LCMs are the most effective gun policies for reducing fatal mass shootings.

KEYWORDS

mass shooting, gun regulation, EVALUATION

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2020 The Authors. *Criminology & Public Policy* published by Wiley Periodicals, Inc. on behalf of American Society of Criminology

High-profile public mass shootings (e.g., incidents that gain significant media attention as a result of high victim count and/or unique characteristic such as location or motive) prompt what have become predictable responses across the political spectrum. One side points to easy firearm access as the key cause of mass shootings and calls for stronger gun laws including comprehensive background checks, bans on assault weapons and large-capacity magazines (if those were used), and more recently, Extreme Risk Protection Order (ERPO) laws to disarm persons planning violent acts. The other side sees unarmed victims being shot in mass shootings and focuses on the hypothetical question, “What if one of the victims or a bystander used a firearm to stop the attack?” The solutions to mass shootings that stem from this perspective include eliminating so-called “gun free zones” and reducing or eliminating restrictions on civilian carrying of concealed firearms in public places.

In a study of fatal mass shootings in the United States during 2014–2017 with several online data sources, Zeoli and Paruk (2020, issue) determined that 46% of the shootings were committed by someone who was prohibited or likely prohibited from possessing a firearm. But the breadth of disqualifying conditions for firearm possession—e.g., whether convictions for violent misdemeanors, domestic violence restraining orders (DVROs) involving dating partners, and younger than 21 years of age disqualify someone from purchasing or possessing a firearm—vary significantly across states and determine the size of the pool of persons at increased risk for perpetrating firearm violence who are legally prohibited from purchasing or possessing firearms (Vittes, Vernick, & Webster, 2012). Indeed, the breadth of disqualifying conditions for persons with a history of violence was consistently associated with reductions in rates of intimate partner homicides (Zeoli et al., 2018). Because many mass shootings are committed in the context of domestic violence or involve perpetrators with a history of domestic violence (Zeoli & Paruk, 2020), broader firearm restrictions for DVROs and violent misdemeanors could potentially reduce mass shootings.

Broad firearm prohibitions for violent or other criminal actions may not keep those individuals from accessing firearms without strong background check systems. State laws requiring comprehensive background checks (CBCs) and purchaser licensing could also potentially influence firearm availability to individuals at risk of perpetrating a mass shooting by making it harder for prohibited persons to obtain firearms. The typical CBC law requires prospective purchasers in private transfers of firearms to pass a background check that is facilitated through a licensed firearm dealer. In contrast, most purchaser licensing laws require prospective purchasers to apply directly at public safety agencies where they are fingerprinted for thorough background checks that include more complete records of prohibiting incidents and greater time available to conduct those checks than is the case for background checks absent licensing. Some licensing laws also require gun safety training, and a few provide officials the ability to use their discretion to deny an applicant if there is good reason to believe he or she might be dangerous (e.g., some history of violence). Rigorous studies of the impact of state CBC laws have not shown that these laws reduce homicides (Castillo-Carniglia et al., 2018; Kagawa et al., 2018; Zeoli et al., 2018); however, there has been consistent evidence that licensing laws reduce homicides (Crifasi et al., 2018; Hasegawa, Webster, & Small, 2019; Rudolph, Stuart, Vernick, & Webster, 2015) and suicides (Crifasi, Meyers, Vernick, & Webster, 2015). Licensing laws could potentially suppress fatal mass shootings, but there are no rigorous studies examining this question.

The research literature on the effects of firearm policies on mass shootings is sparse and has important limitations. A recent study found that that higher rates of gun ownership and greater permissiveness of gun laws were associated with higher rates of fatal mass shootings for incidents connected to domestic violence and other types of mass shootings (Reeping et al., 2019). Unfortunately, the gun law permissiveness scale used in the study has not been fully described, evaluated, or validated, and it does not allow for estimates of the effects of specific firearm laws on mass shootings.¹ Furthermore, the data to identify fatal mass shootings in this study—the FBI’s Supplemental Homicide Reports (SHR)—did

not include major fatal mass shootings, including shootings at Sandy Hook Elementary School in Newtown, Connecticut, in 2012 (26 deaths); a movie theatre in Aurora, Colorado, in 2012 (12 deaths and 58 individuals with nonfatal gunshot wounds); or a church in Southerland Springs, Texas (26 deaths and 20 nonfatally wounded). The data for this study also counted the Virginia Tech mass shooting (32 deaths and 23 victims with nonfatal wounds) as three incidents as a result of the way that the SHR limits the number of victims to 11 in any given homicide incident. Another recent state-level study used an open-source database compiled by the publication *Mother Jones* and found no association between measures of gun ownership and gun law permissiveness and fatal mass shootings in public places (Lin, Fei, Barzman, & Hossain, 2018). The generally undescribed gun law permissiveness measure, however, seemed to be limited to concealed carry restrictions, and the *Mother Jones* database has been criticized for inconsistent application of inclusion/exclusion criteria and for missing some cases (Fox & Fridel, 2016).

Luca and colleagues estimated the effects of several state gun laws—CBC laws that extend background check requirements to private transfers, purchaser licensing laws, regulations over civilians carrying concealed weapons, bans of assault weapons or large-capacity magazines (LCMs)—and the probability that a four-fatality mass shooting occurred in a given state and year during 1989–2014 (Luca, Malhotra, & Poliquin, 2019). Unfortunately, the authors used linear regression models that violated model assumptions for binary outcomes and thus made the findings difficult to interpret.

Two recent studies, each using different data sources and different outcome measures for fatal mass shootings, drew different conclusions regarding the association between the federal ban of assault weapons and LCMs. Fox and Fridel (2016) used the SHR data to examine cases involving four or more firearm homicide victims and found no association between the incidence of fatal mass shootings and the presence of the federal ban of assault weapons and LCMs. It is curious that these researchers did not examine whether the ban influenced the number of persons shot in mass shootings because the characteristics of the banned products are relevant to how many shots can be fired in a short span of time. Indeed, recent studies have documented that fatal mass shootings committed with assault weapons and/or LCMs result in significantly more victims shot than is the case in such shootings which involved no assault weapons or LCMs (Klarevas, 2016; Koper, 2020, this issue; Koper, Johnson, Nichols, Ayers, & Mullins, 2018). DiMaggio and colleagues (2019) published a study in which they reported that during the period when the federal ban of assault weapons and LCMs was in place (1994–2004), fatal mass shootings were 70% less likely to occur. But this study had major limitations based on the data used and the lack of statistical controls for other law changes or social trends that might explain variation in mass shootings. The study used data on fatal public mass shootings with four or more fatalities for the years 1981 through 2017 that were collected by three open-source databases—*Mother Jones*, *Los Angeles Times*, and Stanford University. Inexplicably, the researchers only included cases in their analyses that appeared in all three sources and thereby excluded many incidents of fatal mass shootings. This limited their data to only 51 public mass shootings that presumably were the most widely publicized. The study did not examine variation by state and thus did not consider state gun laws nor did it control for other covariates other than linear trend. Gius (2015) estimated the effects of federal and state bans of assault weapons and LCMs with annual data from the SHR for the years 1982–2011 and found evidence that such bans were linked to lower rates of fatalities in mass shootings. Klarevas, Conner, and Hemenway (2019) found that LCM bans were associated with significantly fewer incidents of high-fatality (six or more victims) mass shootings and lower fatality rates for such shootings during the period 1990–2017. An important limitation of this study was that it did not consider the effects of any other type of firearm laws.

In-depth studies of the circumstances surrounding public mass shootings in the United States during 2000–2017 have found that armed civilians with concealed carry permits played a role in stopping mass

shootings while they are in progress in 5% of the incidents (ALERT & FBI, 2018; Blair & Schweit, 2014). The presence of armed civilians could also potentially deter some attacks in public places. Conversely, because some mass shootings result from spontaneous responses to conflict, having more people with immediate access to a firearm could spur more mass shootings. The Violence Policy Center (2019) identified 33 incidents between May 2007 and January 2019 in which someone with a permit to carry a concealed firearm shot and killed three or more people in an incident. Prior studies designed to estimate the impact of reducing legal restrictions on civilian concealed gun carrying in public places have been plagued by methodological limitations and have found inconsistent relationships between the adoption of such laws and homicides (Crifasi et al., 2018; Donohue, Aneja, & Weber, 2019; Morral, 2017). As a result, there is great uncertainty about the impact of laws that reduce barriers to civilian gun carrying on fatal mass shootings.

1 | METHOD

1.1 | Data

This research relied on data obtained from the FBI's SHR, which includes information on the number of victims, the demographics of the offender(s) and victim(s), the weapon(s) used, some circumstances or perpetrator motives, and the relationship between the offender and the first victim. We limited our data set to incidents of homicide that occurred between 1984 and 2017, involved four or more victims (excluding any offender death), and involved a firearm of any type. We excluded any case that was coded as having a connection to gang or narcotic activity because one of our supplemental data sets excludes gang- or narcotic-related events. Other studies that have examined mass shooting frequency have excluded gang and narcotic incidents, so we excluded these incidents to adhere to the current literature (Klarevas, 2016; Lankford, 2016). We also created a variable that indicated whether a shooting involved a domestic relationship because some laws restrict firearm access based on history of domestic violence. We defined domestic relationships broadly, including any offender–victim family relationship, boyfriend/girlfriend, or ex-spouse. Importantly, the offender–victim relationship data in SHR is based on the relationship between the offender and the first victim recorded in the homicide report.

Because SHR data rely on voluntary law enforcement reporting, some homicide data is missing. In particular, exploratory analysis revealed that the SHR did not include several high-profile, high-casualty mass shootings including the 2012 Newtown, CT, school shooting; the 2012 Aurora, CO, movie theater shooting; and the 2017 Sutherland Springs, TX, church shooting. To remedy these and other omissions, we compared the SHR data with data on mass shootings collected by Stanford University (*Stanford Mass Shootings in America, courtesy of the Stanford Geospatial Center and Stanford Libraries*, n.d.) for the years 1984–2017 and the Gun Violence Archive for the years 2014–2017 (*Mass Shootings in 2017*, n.d.) and added any missing incidents to our data set.² We followed Zeoli et al. (2018) in excluding Florida, Kansas, Kentucky, Nebraska, and Montana from our analysis because of systemic Uniform Crime Reports (UCR)–SHR reporting issues over multiple years.

Data on gun laws were collected and coded using traditional legal research methods. We included several state-level statutes: concealed carry laws, handgun purchaser licensing laws that require either in-person application or fingerprinting, laws requiring point-of-sale background checks only, firearm prohibitions for subjects of domestic violence restraining orders that include ex parte orders, firearm prohibitions for subjects of domestic violence restraining orders that include dating partners in the

definition of domestic violence, firearm prohibitions for subjects of domestic violence restraining orders that do not include ex parte orders or dating partners, laws requiring surrender of all firearms by subjects of domestic violence restraining orders, firearm prohibitions for violent misdemeanants, assault weapon bans, and large-capacity magazine bans. Some of the legal data was obtained from prior work (Zeoli et al., 2018). We obtained any missing legal data from the Thomson Reuters Westlaw database. Using Westlaw, Hein Online, and Lexis Nexis, we tracked each state's statutory history to determine when each law was enacted. Each collected law was compared with existing publicly available databases of state gun laws (Everytown; Giffords; *State Firearm Laws*). Any conflicts between our data set and the databases was resolved by reevaluating the statutory or legislative text. Specific laws and the states and time periods in which they were in effect are presented in Table 1. For our analysis, we coded the laws using a binary 0–1 variable that was only equal to 1 in a year in which a given state law was in effect for at least half of the year.

Our demographic control variables included a commonly used proxy measurement of gun ownership (proportion of all suicides where the chosen method was a firearm), state unemployment rate, poverty rate, percent population identified as male, percent population identified as Black, percent married, percent divorced, percent military veteran, percent living in an Metropolitan Statistical Area, ethanol consumption per capita, religious adherence, percent with a high school diploma, the drug overdose rate (estimated by the rate of nonsuicide overdose deaths), and the proportion of the population aged 15–24 years. These variables were gathered from the U.S. Census Bureau (Census), the Centers for Disease Control and Prevention (CDC), the Bureau of Labor Statistics (BLS), the Religion and Congregation Membership Survey (ARDA), and the National Institute on Alcohol Abuse and Alcoholism (NIAAA, 2017). Missing years of demographic data were interpolated. These control variables were selected based on prior research on firearm homicide and suicide (Crifasi et al., 2015; Rudolph et al., 2015; Zeoli et al., 2018).

1.2 | Analysis

We used generalized linear models with a negative binomial distribution to conduct pooled time-series analyses of three dependent variables measured at the state-year level: domestic-linked mass shootings, non-domestic-linked mass shootings, and all mass shootings. All three are overdispersed count variables. In addition to analyzing incidents of fatal mass shootings, we also analyzed the number of victim fatalities in fatal mass shootings as an outcome variable. The models included state fixed effects, the law variables, and the sociodemographic covariates as well as linear and quadratic trend terms to control for unmeasured conditions that may have influenced fatal mass shootings during the study period. In addition to the full models with all covariates, we examined parsimonious models that limited the sociodemographic control variables with coefficients in the full model that had p values less than .10. All models used a negative binomial distribution with robust standard errors accounting for clustering by state and with overall state population as the exposure variable.

We also performed several sensitivity analyses. To provide a more flexible control for unmeasured national trends, we substituted year fixed effects for the linear and quadratic trend terms in our models. Prior work has suggested that LCM and assault weapon bans might phase in gradually because of pre-ban spikes in purchasing and production (Koper, Woods, & Roth, 2004). To examine this, we ran our models with state LCM bans and state and federal assault weapon bans coded to phase in gradually, starting with .2 in year 1 and increasing .2 per year until hitting 1 in year 5. To evaluate whether specific, high-profile mass shooting incidents might be leading to policy adoption, we ran our models without specific observations for the years just prior to policy implementation.

TABLE 1 Federal and state laws examined and dates those laws went into in effect or were repealed

State	Private Transfer Laws				Prohibitions Related to Domestic Violence Restraining Orders (DVROs)			
	Assault Weapon Ban	Large-Capacity Magazine Ban	Purchaser licensing with in-person or fingerprinting	Point-of-sale background check only	Final DVRO only	Includes ex parte orders	Includes dating partners	Includes surrender provision
Alabama					9/1/15			
Alaska							7/1/96	7/1/96
Arizona					7/20/96–7/21/97	7/21/97	9/30/09	7/20/96
Arkansas								
California	12/31/91	1/1/00		1/1/91		1/1/95	1/1/91	1/1/95
Colorado		7/1/13		7/1/13	7/1/13		2/26/94– 11/30/98	7/1/13
Connecticut	7/1/94	4/4/13	10/1/95		10/1/94–10/1/99	10/1/16	10/1/99	10/1/94
Delaware				7/1/13		1/16/94	9/18/07	1/16/94
Georgia								
Hawaii			pre-1984		6/10/93–7/1/94	7/1/94	6/7/00	6/10/93
Idaho								
Illinois						1/1/10	1/1/96	1/1/96
Indiana				pre-1984– 11/30/98			7/1/02	7/1/02
Iowa			pre-1984		7/1/10			7/1/10
Louisiana							8/1/14	
Maine					9/19/97–9/13/03	9/13/03		9/13/03
Maryland	10/1/13	8/1/94	10/1/13	10/1/96–10/1/13	10/1/96–10/1/09	10/1/09	10/1/15	10/1/96
Massachusetts	10/21/98	10/21/98	pre-1984			7/1/94	7/1/94	7/1/94
Michigan			pre-1984– 12/18/12				4/1/96	
Minnesota							8/1/14	8/1/14

(Continues)

TABLE 1 (Continued)

State	Private Transfer Laws				Prohibitions Related to Domestic Violence Restraining Orders (DVROs)			
	Assault Weapon Ban	Large-Capacity Magazine Ban	Purchaser licensing with in-person or fingerprinting	Point-of-sale background check only	Final DVRO only	Includes ex parte orders	Includes dating partners	Includes surrender provision
Mississippi								
Missouri			pre-1984– 8/28/07					
Nevada				1/1/17			10/1/07	10/1/07
New Hampshire					1/1/00		1/1/00	1/1/00
New Jersey	5/1/90	5/1/90	pre-1984		11/11/91		8/11/94	8/11/94
New Mexico								
New York	11/1/00	11/1/00	pre-1984		11/1/96		7/21/08	11/1/96
North Carolina					12/1/03		12/1/97	12/1/03
North Dakota								
Ohio								
Oklahoma								
Oregon				8/9/15	1/1/16			
Pennsylvania				10/11/95	5/9/06		12/5/94	12/5/94
Rhode Island				pre-1984	7/1/17		7/1/05	7/1/05
South Carolina								
South Dakota				6/4/15				
Tennessee				5/10/94–11/1/98	7/1/09			7/1/09
Texas					1/1/08		9/1/01	
Utah					7/1/95			
Vermont							2/2/01	
Virginia					7/1/94			

(Continues)

TABLE 1 (Continued)

State	Private Transfer Laws			Prohibitions Related to Domestic Violence Restraining Orders (DVROs)				
	Assault Weapon Ban	Large-Capacity Magazine Ban	Purchaser licensing with in-person or fingerprinting	Point-of-sale background check only	Final DVRO only	Includes ex parte orders	Includes dating partners	Includes surrender provision
Washington				12/4/14		7/1/94	7/23/95	7/1/94
West Virginia						4/14/01	6/2/98	
Wisconsin					4/1/96-7/30/02		7/30/02	4/1/96
Wyoming								
Concealed Carry Permitting Laws								
State	No issue	May issue	Shall issue with discretion	Strict shall issue	Permitless carry	Violent Misdemeanor Prohibition		
Alabama		pre-1984-8/1/13	8/1/13			9/1/15		
Alaska	pre-1984-10/1/94			10/1/94-9/9/03	9/9/03			
Arizona	pre-1984-7/16/94			7/16/94-7/28/10	7/28/10			
Arkansas	pre-1984-7/27/94		7/27/94					
California		pre-1984				1/1/91		
Colorado		pre-1984-5/17/03	5/17/03					
Connecticut		pre-1984				10/1/94		
Delaware		pre-1984						
Georgia		pre-1984-8/25/89	8/25/89					
Hawaii		pre-1984				6/13/88		
Idaho		pre-1984-7/1/90		7/1/90-7/1/16	7/1/16			
Illinois	pre-1984-1/5/14		1/5/14			1/1/96		

(Continues)

TABLE 1 (Continued)

State	Concealed Carry Permitting Laws				Violent Misdemeanor Prohibition
	No issue	May issue	Shall issue with discretion	Strict shall issue	
Indiana			pre-1984		
Iowa		pre-1984-1/1/11	1/1/11		
Louisiana	pre-1984- 4/19/96			4/19/96	
Maine				pre-1984- 10/15/15	10/15/15
Maryland		pre-1984			10/1/96
Massachusetts		pre-1984			
Michigan		pre-1984-7/1/01		7/1/01	
Minnesota		pre-1984- 5/28/03	5/28/03		8/1/03
Mississippi		pre-1984-7/1/91		7/1/91-4/15/16	4/15/16
Missouri	pre-1984- 2/26/04		2/26/04-1/1/17		1/1/17
Nevada		pre-1984- 10/1/95		10/1/95	
New Hampshire			pre-1984- 2/22/17		2/22/17
New Jersey		pre-1984			
New Mexico		pre-1984-1/1/04		1/1/04	
New York		pre-1984			pre-1984
North Carolina	pre-1984- 12/1/95			12/1/95	

(Continues)

TABLE 1 (Continued)

State	Concealed Carry Permitting Laws				Violent Misdemeanor Prohibition
	No issue	May issue	Shall issue with discretion	Permitless carry	
North Dakota	pre-1984-8/1/85			8/1/85-8/1/17	4/15/85
Ohio	pre-1984-4/8/04			4/8/04	
Oklahoma	pre-1984-9/1/95			9/1/95	
Oregon		pre-1984-1/1/90	1/1/90		
Pennsylvania		pre-1984- 6/17/89	6/17/89		
Rhode Island			pre-1984		
South Carolina		pre-1984- 8/23/96		8/23/96	
South Dakota		pre-1984-7/1/85		7/1/85	
Tennessee	pre-1984- 11/1/89	11/1/89-10/1/96		10/1/96	
Texas	pre-1984-1/1/96			1/1/96	
Utah		pre-1984-5/1/95	5/1/95		
Vermont				pre-1984	7/1/15
Virginia		pre-1984-7/1/95	7/1/95		
Washington			pre-1984		
West Virginia		pre-1984-7/7/89		7/7/89-5/24/16	5/24/16
Wisconsin	pre-1984- 11/1/11			11/1/11	
Wyoming		pre-1984- 10/1/94	10/1/94-7/1/11		7/1/11

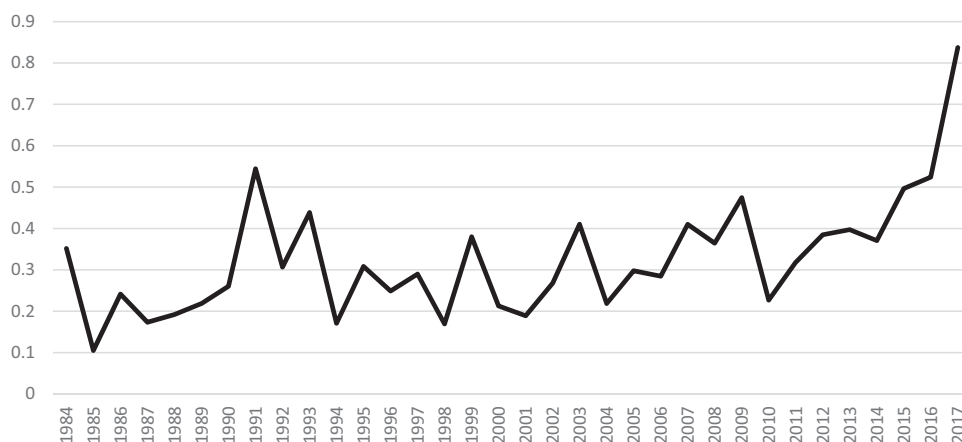


FIGURE 1 Victims in fatal mass shootings per 1 million population per year, 1984–2017

We also examined whether our findings changed when the cutoff for defining a fatal mass shooting was five or more victims and six or more victims. All models were estimated in Stata/IC 15.1 (StataCorp).

2 | RESULTS

We identified 604 mass shooting incidents involving four or more murdered victims that met our inclusion criteria (no gang- or drug-related shootings) during the 1984–2017 study period. There were 2,976 victims murdered in these incidents, 842 (28.3%) in domestic-related shootings, 2,057 (69.1%) victims in non-domestic-related shootings, and 77 victims in all shootings in which it was unclear whether the shooting was domestic related. The annual rate of mass shooting fatalities per 1 million population nationwide was .36 per 100,000 population and ranged from 0 in Delaware and Rhode Island to .88 in South Carolina (see Table A1 in the Appendix). This rate was stable through most of the study period, drifted upward during 2007–2014, before accelerating between 2014 and 2017 (Figure 1). The mean number of victim fatalities by gunfire per incident during the study period was 4.93; victim fatalities were somewhat higher during the years after the federal ban of assault weapons and LCMs expired compared with the decade during which the ban was in place (5.85 during 2005–2017 vs. 4.59 during 1995–2004; Figure 2). Most shootings had four to six victims (Figure 3). A list of descriptive statistics for independent variables can be found in Table 2.

The estimates from the full negative binomial models (Table 3) indicate that handgun purchaser licensing laws requiring in-person application with law enforcement or fingerprinting were associated with incidents of fatal mass shootings 56% lower than that of other states (internal rate of return [IRR] = 0.44, 95% confidence interval [CI] 0.26, 0.73). For LCM bans, the IRR estimate (0.52, 95% CI = 0.27, 0.98) indicates a 48% lower risk of fatal mass shootings associated with the policy. We found no evidence that concealed carry laws, assault weapons bans, prohibitions for domestic abusers and violent misdemeanants, or point-of-sale CBC laws were associated with the incidence of fatal mass shootings. In models in which the number of mass shooting victim fatalities was the outcome, handgun purchaser licensing was protective (IRR = 0.44, 95% CI 0.24, 0.82) and the point estimate for LCM bans suggests a large protective effect albeit with a wide confidence interval (IRR = 0.30, 95% CI .08, 1.10) that make inferences less certain.

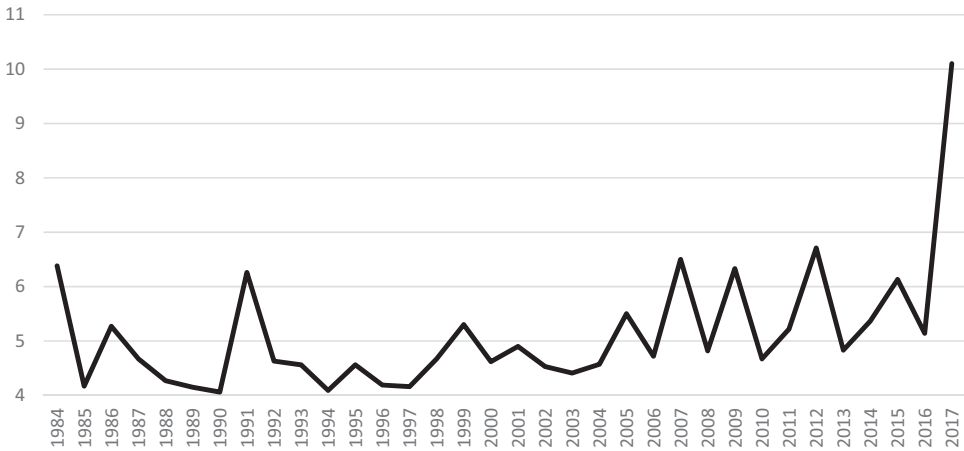


FIGURE 2 Mean number of victims murdered per incident in shootings involving 4+ victim fatalities, 1984–2017

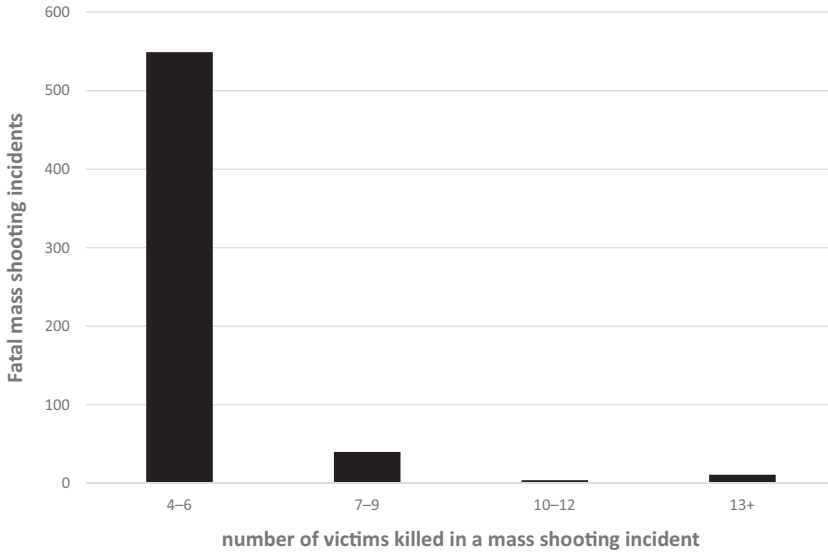


FIGURE 3 Number of incidents of fatal mass shootings by the number of victims killed, United States, 1984–2017

Models for the incidence of mass shootings with domestic or intimate partner violence links revealed no significant associations with laws prohibiting firearms for domestic violence abusers or violent misdemeanants, or purchaser licensing laws (Table 4). LCM bans, however, were associated with a 61% lower rate of domestic mass shootings (IRR = 0.39, 95% CI 0.21, 0.73). The association for LCM bans was somewhat stronger in models for the number of victim fatalities in mass shootings (IRR = 0.25, 95% CI 0.11, 0.59). CBC laws were associated with large increases in domestic mass shooting victim counts (IRR = 2.23, 95% CI 1.10, 4.51).

Purchaser licensing laws were associated with a 62% lower incidence of non-domestic-linked fatal mass shootings (IRR = 0.38, 95% CI 0.20, 0.70) in the full model (Table 5). If the proxy for gun ownership is left out of the model, the IRR is similar (IRR = 0.39, 95% CI 0.22, 0.67). LCM bans were

TABLE 2 Descriptive statistics for independent variables used in the analyses

Variable	Mean	Min	Max	SD
Concealed carry permits—May issue as reference No issue	.14	0	1	.35
Shall issue with discretion	.21	0	1	.41
Strict shall issue	.28	0	1	.45
Permitless	.05	0	1	.21
Purchaser licensing with discretion	.07	0	1	.25
Purchaser licensing in-person application/fingerprint required	.17	0	1	.37
Comprehensive background check—point of sale	.09	0	1	.28
DVRO firearm prohibition w/ final order, no dating partners	.04	0	1	.20
DVRO firearm prohibition includes ex parte	.22	0	1	.41
DVRO firearm prohibition includes dating partners	.27	0	1	.44
DVRO firearm prohibition surrender provision	.28	0	1	.45
Violent misdemeanor	.13	0	1	.34
Federal assault weapon ban	.29	0	1	.46
State assault weapon ban	.08	0	1	.26
Large-capacity magazine ban	.08	0	1	.27
Gun ownership (firearm suicides/all suicides)	.56	.13	.87	.14
Unemployment (%)	5.76	2.3	14.8	1.91
Percent in poverty	12.84	2.9	27.2	3.79
Percent male	49.16	47.63	52.71	.87
Percent Black	10.91	.28	38.29	9.77
Percent married	54.81	42.26	67.64	4.93
Percent divorced	10.31	4.78	16.54	2.03
Percent veteran	13.10	4.00	21.88	3.87
Percent living in MSA	70.09	14.94	100	19.94
Ethanol consumption per capita	2.40	1.23	5.10	.54
Religious adherence (%)	50.62	22.43	83.97	11.57
Percent Completed high school	83.30	62.59	92.8	5.87
Drug overdose rate	7.30	.14	55.26	6.55
Log proportion aged 15–24	−1.93	−2.15	−1.61	.09

Note. DVRO = domestic violence restraining order; MSA = Metropolitan Statistical Area; SD = standard deviation. Models also include state fixed effects, linear and quadratic time trend terms.

* $p = .05$.

linked with a lower incidence of non-domestic-linked fatal mass shootings in the parsimonious model (IRR = .34, 95% CI .14, .81); however, the IRR estimate for LCM bans of .65 and was not statistically significant in the full model. None of the other firearm laws were associated with the incidence of non-domestic-linked fatal mass shootings.

2.1 | Sensitivity Analyses

The models that assumed gradual effects for bans of assault weapons and large capacity magazines produced somewhat different results (Tables A2–A4). The negative association between LCM bans

TABLE 3 Estimates for incident rate ratio for the incidence of fatal mass shootings

Variable	Incidents (<i>n</i> = 604)		Victim Deaths (<i>n</i> = 2,976)	
	IRR	95% CI	IRR	95% CI
Concealed carry permits—May issue as reference No issue	.93	[.55, 1.58]	1.53	[.82, 2.85]
Shall issue with discretion	.91	[.51, 1.60]	1.14	[.60, 2.19]
Strict shall issue	1.28	[.72, 2.27]	1.44	[.70, 2.94]
Permitless	1.29	[.50, 3.29]	1.02	[.32, 3.28]
Purchaser licensing in-person application/fingerprint required	.44*	[.26, .73]	.43*	[.26, .73]
Comprehensive background check—point of sale	1.10	[.77, 1.58]	1.43	[.74, 2.77]
DVRO firearm prohibition w/ final order, no dating partners	.86	[.42, 1.77]	.72	[.33, 1.59]
DVRO firearm prohibition includes ex parte	1.10	[.76, 1.58]	1.13	[.71, 1.77]
DVRO firearm prohibition includes dating partners	.89	[.56, 1.42]	.91	[.50, 1.65]
DVRO firearm prohibition surrender provision	.76	[.50, 1.16]	.75	[.44, 1.27]
Violent misdemeanor	1.51	[.79, 2.89]	1.25	[.63, 2.46]
Federal assault weapon ban	.92	[.67, 1.26]	.96	[.63, 1.46]
State assault weapon ban	.71	[.34, 1.48]	1.11	[.30, 4.16]
Large-capacity magazine ban	.52*	[.27, .98]	.30	[.08, 1.10]
Gun ownership	.15	[.00, 4.76]	.96	[.93, 1.00]
Unemployment	1.03	[.95, 1.10]	1.02	[.92, 1.13]
Percent in poverty	1.01	[.95, 1.07]	1.00	[.93, 1.07]
Percent male	.80	[.37, 1.70]	.84	[.36, 1.94]
Percent Black	1.07	[.91, 1.26]	1.18	[.96, 1.45]
Percent married	1.03	[.94, 1.13]	1.00	[.89, 1.11]
Percent divorced	1.03	[.80, 1.32]	.99	[.74, 1.32]
Percent veteran	.86*	[.75, .99]	.92	[.78, 1.09]
Percent living in MSA	1.00	[.98, 1.03]	1.00	[.97, 1.02]
Ethanol consumption per capita	1.10	[.40, 3.03]	.80	[.24, 2.69]
Religious adherence	1.01	[.97, 1.06]	.99	[.93, 1.04]
Percent completed high school	1.05	[.98, 1.13]	1.06	[.97, 1.16]
Drug overdose rate	1.01	[.97, 1.05]	.99	[.95, 1.03]
Log proportion aged 15–24	.06*	[.00, .99]	.99	[.95, 1.03]

Note. CI = confidence interval; DVRO = domestic violence restraining order; IRR = incident rate ratio; MSA = Metropolitan Statistical Area; SD = standard deviation. Models also include state fixed effects, linear and quadratic time trend terms.

**p* = .05.

and total fatal mass shootings (IRR = 0.74, 95% CI 0.42, 1.31) and the number of victims killed in mass shootings (IRR = 0.38, 95% CI 0.10, 1.44) was no longer statistically significant in the full model, but it was associated with lower incidence in the parsimonious model for all fatal mass shootings (IRR = 0.54, 95% CI 0.29, 1.00). For domestic-linked mass shootings, LCM bans were associated with lower incidence in the parsimonious model for (IRR = 0.58, 95% CI 0.36, 0.94) and with fewer victim fatalities in the full model (IRR = 0.31, 95% CI 0.11, 0.86). Purchaser licensing laws were associated with lower incidence of total fatal mass shootings (IRR = 0.46, 95% CI 0.27, 0.77) and lower incidence rates for non-domestic-linked fatal mass shootings (IRR = 0.42, 95% CI 0.22, 0.77).

TABLE 4 Estimates for incident rate ratio for domestic-linked mass shootings

Variable	Incidents (<i>n</i> = 182)		Victim Deaths (<i>n</i> = 842)	
	IRR	95% CI	IRR	95% CI
Concealed Carry Permit—May issue reference No issue	.66	[.26, 1.68]	.74	[.27, 2.08]
Shall issue w/discretion	.98	[.41, 2.34]	.81	[.33, 2.00]
Strict shall issue	.90	[.33, 2.46]	.78	[.25, 2.48]
Permitless	2.33	[.35, 15.70]	1.43	[.16, 13.21]
Purchaser licensing in-person application or fingerprint required	.93	[.39, 2.19]	1.43	[.60, 3.39]
Comprehensive background checks—point of sale	1.88	[.92, 3.85]	2.22*	[1.10, 4.50]
DVRO prohibition—final orders, dating partner excluded	.89	[.31, 2.56]	.69	[.22, 2.13]
DVRO prohibition ex parte included	1.51	[.84, 2.71]	1.42	[.74, 2.74]
DVRO includes dating partners	.91	[.57, 1.43]	.80	[.50, 1.30]
DVRO surrender required	.85	[.45, 1.64]	.82	[.40, 1.67]
Violent misdemeanor prohibition	1.86	[.45, 7.69]	2.08	[.57, 7.60]
Federal assault weapons/LCM ban	.87	[.50, 1.51]	.84	[.46, 1.55]
State assault weapons ban	.40	[.14, 1.19]	.42	[.13, 1.32]
Large-capacity magazine ban	.39*	[.21, .73]	.25*	[.11, .59]
Gun ownership	.06	[.00, 8.9]	.96	[.89, 1.04]
Unemployment	1.05	[.91, 1.21]	1.09	[.92, 1.29]
Percent in poverty	1.01	[.89, 1.15]	1.00	[.87, 1.14]
Percent male	1.02	[.28, 3.68]	1.08	[.23, 5.03]
Percent Black	1.00	[.81, 1.24]	1.03	[.81, 1.30]
Percent married	.96	[.82, 1.13]	.97	[.82, 1.16]
Percent divorced	.90	[.61, 1.32]	.91	[.58, 1.43]
Percent veteran	1.00	[.83, 1.22]	1.08	[.89, 1.31]
Percent living in MSA	1.00	[.95, 1.05]	.98	[.93, 1.03]
Ethanol consumption per capita	.91	[.14, 6.00]	.79	[.11, 5.78]
Religious adherence	1.02	[.94, 1.10]	1.00	[.92, 1.08]
Percent completed high school	1.02	[.91, 1.14]	.99	[.88, 1.12]
Drug overdose rate	.98	[.92, 1.04]	.97	[.91, 1.04]
Log proportion aged 15–24	1.26	[.02, 95.3]	1.02	[.78, 1.34]

Note. CI = confidence interval; DVRO = domestic violence restraining order; IRR = incident rate ratio; MSA = Metropolitan Statistical Area; SD = standard deviation. Models also include state fixed effects, linear and quadratic time trend terms.

**p* = .05.

When we used year fixed effects to account for unmeasured national trends in mass shootings, our point estimates for the gun law variables were similar to those in our primary models with linear and quadratic trend terms; however, the confidence intervals for the estimates expanded and the association between LCM bans and the incidence (.56, 95% CI .27, 1.16) and fatalities for all mass shootings (IRR = .37, 95% CI .11, 1.31) were no longer statistically significant at the .05 level (Table A5). Negative associations for LCM bans and the incidence and number of fatalities for domestic-linked mass shootings and negative associations between purchaser licensing and non-domestic-linked mass

TABLE 5 Estimates for models for mass shooting incidents not linked to domestic violence

Variable	Incidents (<i>n</i> = 401)		Victim Deaths (<i>n</i> = 2,057)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	1.02	[.51, 2.05]	1.82	[.85, 3.90]
Shall issue with discretion	.84	[.38, 1.86]	1.19	[.50, 2.79]
Strict shall issue	1.52	[.86, 2.70]	1.83	[.89, 3.79]
Permitless	.68	[.26, 1.79]	1.10	[.25, 4.81]
Purchaser licensing in-person or fingerprint required	.38*	[.21, .70]	.35*	[.19, .63]
Comprehensive background check—point of sale	.84	[.48, 1.47]	1.09	[.44, 2.70]
DVRO prohibition—final orders, dating partner excluded	.88	[.32, 2.44]	.72	[.24, 2.19]
DVRO prohibition includes Ex Parte	1.02	[.53, 1.96]	1.17	[.59, 2.30]
DVRO prohibition Inc. Dating Partners	.88	[.44, 1.77]	.94	[.40, 2.19]
DVRO prohibition with Surrender Provision	.75	[.35, 1.60]	.84	[.35, 1.99]
Violent misdemeanor prohibition	1.32	[.65, 2.68]	.94	[.46, 1.91]
Federal assault weapon ban	.98	[.65, 1.46]	1.11	[.67, 1.85]
State assault weapon ban	.73	[.31, 1.72]	1.01	[.25, 4.11]
Large capacity magazine ban	.65	[.26, 1.63]	.43	[.10, 1.81]
Gun ownership	.77	[.01, 47.8]	.97	[.93, 1.02]
Unemployment	1.04	[.97, 1.11]	1.02	[.93, 1.12]
Percent in poverty	1.00	[.93, 1.07]	.98	[.90, 1.07]
Percent male	.67	[.26, 1.68]	.66	[.24, 1.81]
Percent Black	1.08	[.87, 1.33]	1.26	[.93, 1.69]
Percent married	1.06	[.92, 1.22]	.98	[.84, 1.14]
Percent divorced	1.10	[.77, 1.56]	.94	[.64, 1.38]
Percent Veteran	.79*	[.66, .96]	.89	[.70, 1.13]
Percent living in MSA	1.01	[.98, 1.05]	1.01	[.97, 1.06]
Ethanol consumption per capita	1.20	[.26, 5.50]	.93	[.15, 5.78]
Religious adherence	1.01	[.95, 1.08]	.99	[.91, 1.07]
Percent completed high school	1.05	[.94, 1.18]	1.09	[.96, 1.23]
Drug overdose rate	1.03	[.99, 1.08]	1.01	[.96, 1.06]
Log proportion aged 15–24	.02	[.00, 1.46]	.78	[.53, 1.15]

Note. CI = confidence interval; DVRO = domestic violence restraining order; IRR = incident rate ratio; MSA = Metropolitan Statistical Area; SD = standard deviation. Models also include state fixed effects, linear and quadratic time trend terms.

**p* = .05.

shootings were consistent with our primary models (Tables A6–A7). When we used Poisson fixed-effects regression models, our estimates for the association between the firearm laws of interest and fatal mass shootings were consistent with the estimates in our primary models (Tables A8–A10).

To evaluate whether particularly fatal mass shootings led to passage of the policies at interest, we conducted an analysis that omitted certain observations. We determined that, after a mass shooting with 10 or more fatalities, only two states adopted a law that showed a statistically significant effect in our main models: Connecticut and Colorado both adopted LCM bans after major mass shootings in 2012. We omitted the 2012 observations for these two states and repeated our analysis. When these

observations were omitted, the point estimate for purchaser licensing was similar to our main model of all mass shooting incidents (IRR = .40, 95% CI .23, .69; Table A11) and fatalities (IRR = .33, 95% CI .19, .59). Similarly purchaser licensing was associated with reductions in non-domestic-linked mass shootings (IRR = .38, 95% CI .20, .70; Table A13) and fatalities (IRR = .34, 95% CI .18, .62). For all mass shootings, LCM bans estimates were similar to our primary models but no longer statistically significant for incidents (IRR = .56, 95% CI .30, 1.03; Table A11) and fatalities (IRR = .40, 95% CI .14, 1.14). LCM bans were statistically significant and protective for domestic-linked mass shooting incidents (IRR = .46, 95% CI .23, .89; Table A12) and fatalities (IRR = .45, 95% CI .22, .91).

In the models using different victim fatality thresholds for mass-shootings (five and six victims), the data were too sparse to stratify by domestic violence link. When mass shootings were limited to those with five or more victims ($n = 198$ shootings), LCM bans were associated with an 80% lower incidence in the full model (IRR = .20, 95% CI .06, .67; Table A14). Although the point estimate for purchaser licensing laws was similar to that for the models with four victim fatality thresholds, it was not statistically significant (IRR = .52, 95% CI .15, 1.83). The estimate for No Issue concealed carry permit laws did change dramatically with the five-fatality threshold and was associated with much higher incidence of fatal mass shootings (IRR = 4.14, 95% CI 1.57, 10.87; Table A14). No Issue concealed carry laws no longer exist, however, as every state now allows for some form of civilian concealed carry. Similarly, when mass shootings were limited to those with six or more victims (Table A15), LCM bans were associated with an 87% lower incidence in the full model (IRR = .14, 95% CI .03, .70) and purchaser licensing laws were not associated with any change.

3 | DISCUSSION

The rate at which Americans are murdered in mass shootings has increased in recent years. For decades, horrific mass shootings have prompted intense political debates about whether such incidents can be prevented and what would be the most effective policy responses. Prior research on the effects of firearm policies on fatal mass shootings has important limitations, leaving questions about the effectiveness of strengthened gun regulations such as comprehensive background checks or policies that have been implemented to encourage more civilian gun carrying in public places.

The findings of this study suggest that the most common policy prescriptions offered by advocates on each side of the debate over gun control—comprehensive background checks and assault weapons bans on one side and so-called “Right to Carry” laws reducing restrictions on civilian concealed carry of firearms on the other side—do not seem to be associated with the incidence of fatal mass shootings. Twenty-eight percent of the shootings in this study had some connection to domestic violence, yet we found no evidence that laws designed to keep firearms from perpetrators of domestic violence have affected mass shootings connected to domestic violence. This is somewhat surprising given prior research demonstrating that laws prohibiting persons under domestic violence restraining orders from possessing firearms or with prior convictions for violent misdemeanors were associated with reduced intimate partner homicides (Zeoli et al., 2018).

This study identified two policies associated with reductions in fatal mass shootings—laws requiring firearm purchasers or owners to acquire a license that involves in-person application and/or fingerprinting of applicants and state laws banning the purchase of LCMs or ammunition-feeding devices for semiautomatic firearms. The size of the estimated protective effects of these two policies are striking, although there are large confidence intervals. Firearm purchaser or owner licensing laws have been shown to reduce firearm homicides (Crifasi et al., 2018; Hasegawa, Small, & Webster, 2019; Rudolph et al., 2015; Webster, Crifasi, & Vernick, 2014) and suicides (Crifasi et al., 2015); thus, it

is plausible that these laws reduce firearm availability to individuals who are at risk of committing many forms of lethal violence including multivictim fatal shootings. States with licensing requirements for firearm purchasers typically review broader types of data to identify conditions that prohibit firearm possession and use fingerprints to identify individuals with criminal histories rather than rely solely on biographical information provided by the applicant. In addition, rigorous firearm purchaser licensing may also reduce illegal straw sales and other types of diversion of guns for criminal use (Crifasi, Buggs, Choksy, & Webster, 2017).

Assault rifles are commonly used in mass shootings with the most casualties, and certain design features of these weapons plausibly facilitate the ability of an assailant to rapidly shoot many rounds (e.g., barrel shrouds and pistol grips). But the capacity of the ammunition-feeding device and the ability to quickly reload may be the most relevant feature of firearms that influence the incidence and outcomes of mass shootings. Furthermore, most mass shootings do not involve assault rifles, but many involve the use of LCMs. This may explain why we found that LCM bans were associated with significant reductions in the incidence of fatal mass shootings but that bans on assault weapons had no clear effects on either the incidence of mass shootings or on the incidence of victim fatalities from mass shootings. Studies that have collected detailed data on the specific firearms used in fatal mass shootings show that firearms with LCMs are used roughly twice as frequently as firearms identified as assault weapons. In the Koper et al. (2018) study of mass shootings with four or more victim fatalities during 2009–2016, 19% involved firearms with an LCM and 10% involved firearm models classified as assault weapons. Additionally, Klarevas (2016) found that, during 2006–2015 (after the federal ban expired), 67% of mass shootings with six or more victim fatalities involved the use of an LCM versus 26% with an assault weapon model. Based on the data from Koper (2020), Koper et al. (2018), and Klarevas (2016), our point estimates may be somewhat higher than would be plausible based on the prevalence of LCM use in fatal public mass shootings, although the confidence intervals for these estimates are wide and encompass the estimates of the prevalence of use of LCMs in fatal mass shootings. Also, Koper (2013) found no evidence of decreased use of LCMs in the years after the federal ban in data from four cities that collected such data. This suggests that the supply of pre-ban LCMs was plentiful and that LCMs bans may take years to sufficiently reduce their availability for criminal misuse. Yet our models estimating gradual effects of state LCM bans showed weaker law effects than did the models assuming immediate effects. Passage of LCM bans may coincide with unmeasured factors related to protection against fatal mass shootings other than the comprehensive list of firearm laws examined here. Regardless, there is a clear functional link between LCMs and the ability of a shooter to take more lives. Our estimates of LCM ban impacts show the largest protective effects on high-fatality count shootings and on the number of victims murdered in mass shootings, and the point estimates are large in all model specifications.

It should be noted that the federal assault weapons ban and some state bans of assault weapons have resulted in gun manufacturers making slight alterations in the characteristics of weapon models that are banned. These newer models, assault weapons that were grandfathered by the bans, and the ability to purchase components of assault weapons online provide substitutes for the banned firearms for individuals considering carrying out acts of mass violence. LCM bans may be less likely to result in acquisition of equivalent substitutes as is the case for assault weapon bans.

There are limitations to this study that relate to the lack of systematic data at the state level on determinants of mass shootings that would aid in the modeling of state-level trends of rare events. We drew from prior research on factors associated with state-level rates of homicides and suicides. Mass shootings involve a very small proportion of such events, however, and the conditions that facilitate or suppress lethal violence overall may not explain rare and especially lethal mass shooting events. In addition, this study was not designed to fully explore the relationship between assault weapon bans and their

impact on fatal mass shootings. We did not examine, for example, whether the bans influenced the incidence of assault weapons being used in mass shootings because such data are not available for all fatal mass shootings. We also only examined fatal mass shootings, in which the number of fatalities rather than casualties determined whether an incident was included in the analysis. Booty, O'Dwyer, Webster, McCourt, and Crifasi (2019) have raised the issue of inconsistencies in mass shooting databases that define "mass shooting" differently, and we acknowledge that our results are influenced by the definition that we have chosen.

Despite these limitations, our estimates of the effects of state and federal gun laws on fatal mass shootings are mainly robust to different modeling assumptions and consistent with other research findings. Firearm purchaser licensing requirements are likely to reduce overall firearm availability within a state as well as reduce firearm availability to high-risk individuals. This study provides evidence that firearm purchaser or ownership licensing with fingerprinting reduce the risk of fatal mass shootings in addition to firearm homicides more broadly. LCM bans also seem to reduce the incidence of fatal mass shootings and the number of fatalities in mass shootings. Policy makers should consider these findings when crafting proposals to reduce deaths from mass shootings.

ACKNOWLEDGMENTS

This research was supported by a grant from The Joyce Foundation and Dr. Webster's professorship supported by the Bloomberg American Health Initiative.

ENDNOTES

¹ The researchers used *Traveler's Guide to the Firearms Laws of the Fifty States* that provides annual ratings for the restrictiveness–permissiveness scale of U.S. gun laws for each state based on assessments of legal professionals who represent gun owners in legal cases. This publication gives a rating between 0 (completely restrictive) and 100 (completely permissive).

² *Stanford Mass Shootings in America* collected data on incidents with three or more shooting casualties in a public place, excluding incidents related to gang or narcotic involvement; this data source ceased data collection in early 2016. The Gun Violence Archive (GVA) is a publicly available data source that collects information on incidents that had four or more shooting casualties, but a search query can restrict information to four or more fatalities. Twenty-three incidents were added from Stanford, and 10 incidents were added from GVA.

ORCID

Alexander D. McCourt  <https://orcid.org/0000-0002-3524-3454>

REFERENCES

- ALERT & FBI. (2018). *Active shooter incidents in the United States in 2018*. Retrieved from <https://www.csuohio.edu/sites/default/files/Active%20Shooter%20Incidents%202018%20Report%20April%202019.pdf>
- ARDA. (n.d.). *Churches and Church membership in the United States*. Retrieved from <http://www.thearda.com/Archive/ChState.asp>
- Blair, J. P., & Schweit, K. W. (2014). *A study of active shooter incidents, 2000–2013*. Washington: Texas State University and Federal Bureau of Investigation, U.S. Department of Justice.
- BLS. (n.d.). Databases, tables & calculators by subject. Retrieved from <https://www.bls.gov/data/>
- Booty, M., O'Dwyer, J., Webster, D., McCourt, A., & Crifasi, C. (2019). Describing a "mass shooting": The role of databases in understanding burden. *Injury Epidemiology*, 6, 1, 47. <https://doi.org/10.1186/s40621-019-0226-7>

- Castillo-Carniglia, A., Kagawa, R. M., Cerdá, M., Crifasi, C. K., Vernick, J. S., Webster, D. W., & Wintemute, G. J. (2018). California's comprehensive background check and misdemeanor violence prohibition policies, and firearm mortality. *Annals of Epidemiology, 30*, 50–56.
- CDC. (n.d.). Wide-ranging ONline Data for Epidemiologic Research (WONDER). Retrieved from <https://wonder.cdc.gov/>
- Census. (n.d.). United States Census Bureau. Retrieved from <https://www.census.gov/#>
- Crifasi, C. K., Buggs, S. A., Choksy, S., & Webster, D. W. (2017). The initial impact of Maryland's Firearm Safety Act of 2013 on the supply of crime handguns in Baltimore. *RSF: The Russell Sage Foundation Journal of the Social Sciences, 3*(5), 128–140.
- Crifasi, C. K., Merrill-Francis, M., McCourt, A., Vernick, J. S., Wintemute, G. J., & Webster, D. W. (2018). Association between firearm laws and homicide in urban counties. *Journal of urban health, 95*(3), 383–390.
- Crifasi, C. K., Meyers, J. S., Vernick, J. S., & Webster, D. W. (2015). Effects of changes in permit-to-purchase handgun laws in Connecticut and Missouri on suicide rates. *Preventive Medicine, 79*, 43–49.
- DiMaggio, C., Avraham, J., Berry, C., Bukur, M., Feldman, J., Klein, M., ... Frangos, S. (2018). Changes in US mass shooting deaths associated with the 1994–2004 federal assault weapons ban: Analysis of open-source data. *Journal of Trauma and Acute Care Surgery, 86*(1), 11–17.
- Donohue, J. J., Aneja, A., & Weber, K. D. (2019). Right-to-carry laws and violent crime: A comprehensive assessment using panel data and a state-level synthetic control analysis. *Journal of Empirical Legal Studies, 16*(2), 198–247.
- Everytown. Gun Law Navigator. (n.d.). Retrieved from <https://everytownresearch.org/navigator/index.html>
- Fox, J. A., & Fridel, E. E. (2016). The tenuous connections involving mass shootings, mental illness, and gun laws. *Violence and Gender, 3*(1), 14–19. <https://doi.org/10.1089/vio.2015.0054>
- Giffords. (n.d.). Retrieved from <https://lawcenter.giffords.org/>
- Gius, M. (2015). The impact of state and federal assault weapons bans on public mass shootings. *Applied Economics Letters, 22*(4), 281–284.
- Hasegawa, R. B., Small, D. S., & Webster, D. W. (2019). Bracketing in the comparative interrupted time-series design to address concerns about history interacting with group: Evaluating Missouri Handgun Purchaser Law. *arXiv preprint arXiv:1904.11430*.
- Hasegawa, R. B., Webster, D. W., & Small, D. S. (2019). Evaluating Missouri's Handgun Purchaser Law: A bracketing method for addressing concerns about history interacting with group. *Epidemiology, 30*(3), 371–379.
- Kagawa, R. M., Castillo-Carniglia, A., Vernick, J. S., Webster, D., Crifasi, C., Rudolph, K. E., ... Wintemute, G. J. (2018). Repeal of comprehensive background check policies and firearm homicide and suicide. *Epidemiology, 29*(4), 494–502.
- Klarevas, L. (2016). *Rampage nation: Securing America from mass shootings*. Amherst: Prometheus Books.
- Klarevas, L., Conner, A., & Hemenway, D. (2019). The Effect of Large-Capacity Magazine Bans on High-Fatality Mass Shootings, 1990–2017. *American Journal of Public Health, 109*(12), 1754–1761.
- Koper, C. S., Woods, D. J., & Roth, J. A. (2004). *An updated assessment of the Federal Assault Weapons Ban: Impacts on gun markets and gun violence, 1994–2003* (Report to the National Institute of Justice). Philadelphia: Jerry Lee Center of Criminology, University of Pennsylvania.
- Koper, C. S. (2013). America's experience with the federal assault weapons ban, 1994–2004: Key findings and implications. Pp.in *Reducing Gun Violence in America: Informing Policy with Evidence and Analysis* (pp. 157–171). In Daniel W. Webster & Jon S. Vernick (Eds.), Baltimore, Maryland: Johns Hopkins University Press.
- Koper, C. S. (2020). Assessing the potential to reduce deaths and injuries from mass shootings through restrictions on assault weapons and other high-capacity semiautomatic firearms. *Criminology & Public Policy, 19*(1), 147–170.
- Koper, C. S., Johnson, W. D., Nichols, J. L., Ayers, A., & Mullins, N. (2018). Criminal use of assault weapons and high capacity semiautomatic firearms: An updated examination of local and national sources. *Journal of Urban Health, 95*(3), 313–321.
- Lankford, A. (2016). Public mass shootings and firearms: A cross-national study of 171 countries. *Violence & Victims, 31*(2), 187–199.
- Lin, P., Fei, L., Barzman, D., & Hossain, M. (2018). What have we learned from the time trend of mass shootings in the U.S.? *PLoS ONE, 13*(10), e0204722. Retrieved from <https://doi.org/10.1371/journal.pone.0204722>.
- Luca, M., Malhotra, D. K., & Poliquin, C. (2019). *The impact of mass shootings on gun policy* (Working Paper No. 16–126). Cambridge: Harvard Business School NOM Unit.
- Mass Shootings in 2017. (n.d.). Retrieved from <http://www.gunviolencearchive.org/reports/mass-shooting?year=2017>

- Morrall, A. (2017). The impact of concealed carry laws on mass shootings. In *Gun policy in America*. Santa Monica: RAND.
- NIAAA. (2017). *Surveillance report #108: Apparent per capita alcohol consumption - national, state, and regional trends, 1977–2015*. Washington: National Institute on Alcohol Abuse and Alcoholism. Retrieved from <https://pubs.niaaa.nih.gov/publications/surveillance108/pcyr1970-2015.txt>
- Reeping, P. M., Cerdá, M., Kalesan, B., Wiebe, D. J., Galea, S., & Branas, C. C. (2019). State gun laws, gun ownership, and mass shootings in the US: Cross sectional time series. *BMJ*, *364*, 1542.
- Rudolph, K. E., Stuart, E. A., Vernick, J. S., & Webster, D. W. (2015). Association between Connecticut's permit-to-purchase handgun law and homicides. *American Journal of Public Health*, *105*(8), e49–e54.
- Stanford Mass Shootings in America, courtesy of the Stanford Geospatial Center and Stanford Libraries*. (n.d.). Retrieved from <https://library.stanford.edu/projects/mass-shootings-america>
- StataCorp. (n.d.). *Stata statistical software: Release 15*. College Station: StataCorp LLC.
- State Firearm Laws*. (n.d.). Retrieved from <https://www.statefirearmlaws.org/>
- Vittes, K. A., Vernick, J. S., & Webster, D. W. (2012). Legal status and source of offenders' firearms in states with the least stringent criteria for gun ownership. *Injury Prevention*, Epub ahead of print. <https://doi.org/10.1136/injuryprev-2011-040290>
- Violence Policy Center. (2019). *Mass shootings involving concealed handgun permit holders* Retrieved from <http://concealedcarrykillers.org/wp-content/uploads/2015/04/FACTSHEET-CCW-Mass-Shooters.pdf>
- Webster, D. W., Crifasi, C. K., & Vernick, J. S. (2014). Effects of the repeal of Missouri's Handgun Purchaser Licensing Law on homicides. *Journal of Urban Health*, *9*, 293–302. <https://doi.org/10.1007/s11524-014-9865-8>
- Zeoli, A. M., McCourt, A., Buggs, S., Frattaroli, S., Lilley, D., & Webster, D. W. (2018). Analysis of the strength of legal firearms restrictions for perpetrators of domestic violence and their associations with intimate partner homicide. *American Journal of Epidemiology*, *187*(11), 2365–2371. <https://doi.org/10.1093/aje/kwx362>
- Zeoli, A. M., & Paruk, J. K. (2020). Potential to prevent mass shootings through domestic violence firearm restrictions. *Criminology & Public Policy*, *19*(1), 129–145.

AUTHOR BIOGRAPHIES

Daniel W. Webster, ScD, MPH is Bloomberg Professor of American Health at the Johns Hopkins Bloomberg School of Public Health and directs the Johns Hopkins Center for Gun Policy and Research. His research focuses on interventions to reduce gun violence, underground gun markets, intimate partner violence, suicide, and substance abuse. He is the lead editor and contributor to *Reducing Gun Violence in America: Informing Policy with Evidence and Analysis* (Johns Hopkins University Press, 2013) and lead instructor for an open online course “Reducing Gun Violence in America: Evidence for Change.”

Alexander McCourt, JD, MPH, PhD is an Assistant Scientist in the Department of Health Policy and Management at the Johns Hopkins Bloomberg School of Public Health. He is affiliated with the Center for Gun Policy and Research and the Center for Law and the Public's Health. Dr. McCourt is a public health lawyer whose research focuses on gun violence and policy, opioid policy, and other areas of public health law.

Cassandra K. Crifasi, PhD, MPH is an Assistant Professor of Health Policy and Management at the Johns Hopkins Bloomberg School of Public Health. She serves as the Deputy Director of the Center for Gun Policy and Research and is a core faculty member in the Center for Injury Research and Policy. Dr. Crifasi's research focuses broadly on public safety including injury epidemiology and prevention, gun violence and policy, attitudes and behaviors of gun owners, and underground gun markets.

Marisa D. Booty, MHS is a Senior Research Data Analyst for the Center and Gun Policy and Research at the Johns Hopkins Bloomberg School of Public Health. She received her M.H.S. in Mental Health from Johns Hopkins in 2017. Ms. Booty has published papers on the Crisis Intervention Training program and mass shooting statistics, and she is generally interested in violence prevention and criminal justice interactions with vulnerable populations.

Elizabeth A. Stuart, PhD is Associate Dean for Education and Professor in the Departments of Mental Health, Biostatistics, and Health Policy and Management at the Johns Hopkins Bloomberg School of Public Health. She received her Ph.D. in statistics in 2004 from Harvard University. Dr. Stuart has published influential papers on propensity score methods and generalizing treatment effect estimate to target populations and teaches courses on causal inference to a wide range of audiences. She works in areas that include gun violence prevention, mental health, substance use, and education. Dr. Stuart is a Fellow of the American Statistical Association.

How to cite this article: Webster DW, McCourt AD, Crifasi CK, Booty MD, Stuart EA. Evidence concerning the regulation of firearms design, sale, and carrying on fatal mass shootings in the United States. *Criminol Public Policy*. 2020;19:171–212. <https://doi.org/10.1111/1745-9133.12487>

APPENDIX

TABLE A1 Mean annual mass shooting rate and fatality rate by state

State	All Fatal Mass Shootings			Domestic-Linked Mass Shootings			Non-Domestic-Linked Mass Shootings		
	Mean Annual Rate of Mass Shootings per 1 Million Population	Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population	Population	Mean Annual Rate of Mass Shootings per 1 Million Population	Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population	Population	Mean Annual Rate of Mass Shootings per 1 Million Population	Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population	Population
Alabama	.04	.21	.01	.09	.08	.02	.06	.40	
Alaska	.06	.40	.00	.00	.40	.06	.06	.40	
Arizona	.11	.53	.03	.13	.33	.07	.07	.33	
Arkansas	.13	.69	.02	.15	.54	.11	.11	.54	
California	.06	.32	.03	.13	.19	.03	.03	.19	
Colorado	.07	.39	.01	.05	.31	.05	.05	.31	
Connecticut	.06	.48	.02	.26	.22	.04	.04	.22	
Delaware	.00	.00	.00	.00	.00	.00	.00	.00	
Georgia	.06	.28	.02	.08	.20	.04	.04	.20	
Hawaii	.05	.25	.03	.10	.15	.02	.02	.15	
Idaho	.09	.40	.03	.12	.28	.06	.06	.28	
Illinois	.05	.22	.01	.03	.17	.03	.03	.17	
Indiana	.09	.40	.04	.16	.24	.06	.06	.24	
Iowa	.02	.10	.01	.05	.00	.00	.00	.00	
Louisiana	.11	.46	.02	.09	.37	.09	.09	.37	
Maine	.08	.30	.05	.20	.10	.02	.02	.10	
Maryland	.04	.17	.02	.09	.09	.02	.02	.09	
Massachusetts	.02	.09	.005	.02	.07	.01	.01	.07	

(Continues)

TABLE A1 (Continued)

State	All Fatal Mass Shootings			Domestic-Linked Mass Shootings			Non-Domestic-Linked Mass Shootings		
	Mean Annual Rate of Mass Shootings per 1 Million Population	Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population		Mean Annual Rate of Mass Shootings per 1 Million Population	Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population		Mean Annual Rate of Mass Shootings per 1 Million Population	Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population	
		Population	Population		Population	Population		Population	Population
Michigan	.11	.46	.03	.14	.07	.32	.07	.07	.32
Minnesota	.03	.15	.01	.02	.02	.08	.02	.02	.08
Mississippi	.09	.43	.00	.00	.07	.43	.07	.07	.43
Missouri	.08	.35	.02	.07	.06	.28	.06	.06	.28
Nevada	.08	.86	.03	.13	.05	.73	.05	.05	.73
New Hampshire	.03	.12	.00	.00	.03	.12	.03	.03	.12
New Jersey	.03	.11	.01	.03	.02	.08	.02	.02	.08
New Mexico	.12	.59	.06	.29	.06	.30	.06	.06	.30
New York	.05	.24	.01	.03	.04	.21	.04	.04	.21
North Carolina	.11	.46	.01	.03	.10	.43	.10	.10	.43
North Dakota	.14	.54	.14	.54	.00	.00	.00	.00	.00
Ohio	.07	.29	.02	.08	.05	.21	.05	.05	.21
Oklahoma	.08	.42	.03	.16	.04	.26	.04	.04	.26
Oregon	.06	.30	.04	.17	.01	.03	.01	.01	.03
Pennsylvania	.04	.19	.02	.07	.02	.12	.02	.02	.12
Rhode Island	.00	.00	.00	.00	.00	.00	.00	.00	.00

(Continues)

TABLE A1 (Continued)

State	All Fatal Mass Shootings			Domestic-Linked Mass Shootings			Non-Domestic-Linked Mass Shootings		
	Mean Annual Rate of Mass Shootings per 1 Million Population	Mass Shootings per 1 Million Population	Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population	Mean Annual Rate of Mass Shootings per 1 Million Population	Mass Shootings per 1 Million Population	Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population	Mean Annual Rate of Mass Shootings per 1 Million Population	Mass Shootings per 1 Million Population	Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population
South Carolina	.18	.88	.05	.20	.68	.14	.00	.20	.34
South Dakota	.08	.34	.08	.34	.00	.00	.00	.00	.00
Tennessee	.07	.29	.02	.07	.20	.05	.05	.07	.20
Texas	.09	.47	.02	.11	.34	.06	.06	.11	.34
Utah	.07	.40	.04	.19	.21	.04	.04	.19	.21
Vermont	.10	.38	.00	.00	.38	.10	.10	.00	.38
Virginia	.08	.48	.03	.13	.35	.06	.06	.13	.35
Washington	.08	.38	.03	.12	.26	.05	.05	.12	.26
West Virginia	.14	.64	.08	.34	.30	.06	.06	.34	.30
Wisconsin	.04	.24	.01	.06	.15	.03	.03	.06	.15
Wyoming	.12	.47	.12	.47	.00	.00	.00	.47	.00
Overall	.07	.36	.03	.12	.23	.04	.04	.12	.23

TABLE A2 Estimates for incident rate ratios for all fatal mass shootings using gradual assault weapon and LCM ban variables

Variable	All Fatal Mass Shooting Incidents (<i>n</i> = 604 shootings)		Fatalities in All Fatal Mass Shootings (<i>n</i> = 2,976 fatalities)	
	IRR (IRR ^a)	95% CI (95% CI ^a)	IRR (IRR)	95% CI (95% CI)
Concealed carry permits—may issue as reference	.94	[.55, 1.59]	1.53	[.83, 2.84]
No issue	(.97)	(.58, 1.63)	(1.45)	(.78, 2.68)
Shall issue with discretion	.95	[.54, 1.69]	1.15	[.59, 2.22]
	(.88)	(.50, 1.55)	(1.08)	(.54, 2.18)
Strict shall issue	1.34	[.75, 2.39]	1.46	[.71, 2.98]
	(1.20)	(.72, 1.99)]	(1.36)	(.75, 2.47)
Permitless	1.35	[.52, 3.51]	1.02	[.31, 3.36]
	(1.24)	(.50, 3.03)	(.95)	(.30, 3.07)
Purchaser licensing ^b	.46*	[.27, .77]	.44*	[.24, .82]
	(.50)	(.34, .73)	(.62)	(.35, 1.07)
Comprehensive background check—point of sale	1.08	[.75, 1.55]	1.42	[.73, 2.79]
	(1.12)	(.78, 1.62)	(1.57)	(.72, 3.43)
DVRO firearm prohibition no dating partners	.83	[.40, 1.72]	.70	[.31, 1.62]
	(.94)	(.43, 2.04)	(.65)	(.30, 1.42)
DVRO firearm prohibition includes ex parte	1.08	[.74, 1.57]	1.10	[.69, 1.76]
	(1.04)	(.68, 1.57)	(.98)	(.59, 1.63)
DVRO firearm prohibition Includes dating partners	.93	[.58, 1.50]	.94	[.51, 1.70]
	(.89)	(.55, 1.42)	(.90)	(.50, 1.63)
DVRO firearm prohibition surrender provision	.75	[.48, 1.15]	.74	[.43, 1.25]
	(.77)	(.48, 1.25)	(.84)	(.48, 1.46)
Violent misdemeanor	1.50	[.82, 2.73]	1.30	[.67, 2.54]
	(1.48)	(.77, 2.84)	(1.30)	(.59, 2.87)
Federal assault weapon ban (gradual)	.95	[.70, 1.29]	1.02	[.65, 1.60]
	(.96)	(.70, 1.32)	(1.06)	(.70, 1.60)
State assault weapon ban (gradual)	.64	[.35, 1.18]	1.01	[.29, 3.47]
	(.66)	(.30, 1.48)	(.90)	(.21, 3.76)
Large-capacity magazine ban (gradual)	.74	[.42, 1.31]	.38	[.10, 1.44]
	(.54)	(.29, 1.00)	(.40)	(.10, 1.60)
Gun ownership	.98	[.95, 1.02]	.96	[.93, 1.00]
Unemployment	1.02	[.95, 1.10]	1.02	[.92, 1.13]
Percent in poverty	1.01	[.95, 1.07]	1.00	[.93, 1.07]
Percent male	.84	[.39, 1.78]	.85	[.37, 1.95]
Percent Black	1.07	[.91, 1.26]	1.19	[.96, 1.46]
Percent married	1.02	[.93, 1.13]	.99	[.88, 1.11]
Percent divorced	1.04	[.80, 1.33]	.99	[.74, 1.32]

(Continues)

TABLE A2 (Continued)

Variable	All Fatal Mass Shooting Incidents (<i>n</i> = 604 shootings)		Fatalities in All Fatal Mass Shootings (<i>n</i> = 2,976 fatalities)	
	IRR (IRR ^a)	95% CI (95% CI ^a)	IRR (IRR)	95% CI (95% CI)
Percent veteran	.87*	[.76, .99]	.94	[.79, 1.10]
Percent living in MSA	1.00	[.98, 1.03]	1.00	[.97, 1.03]
Ethanol consumption per capita	1.13	[.42, 3.02]	.82	[.26, 2.64]
Religious adherence	1.02	[.97, 1.06]	.99	[.93, 1.04]
Percent completed high school	1.06	[.98, 1.14]	1.06	[.98, 1.16]
Drug overdose rate (per 100,000)	1.01	[.97, 1.05]	.99	[.95, 1.03]
Percent aged 15–24	.84	[.69, 1.02]	.88	[.71, 1.09]
Linear time trend	.91	[.80, 1.04]	.90	[.77, 1.04]
Quadratic time trend	1.00	[1.00, 1.00]	1.00	[1.00, 1.00]

^aParsimonious model results.

^bHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

**p* = .05.

TABLE A3 Estimates for incident rate ratios for domestic-linked fatal mass shootings using gradual assault weapon and LCM ban variables

Variable	Domestic-Linked Fatal Mass Shooting incidents (<i>n</i> = 182 shootings)		Fatalities in Domestic-Linked Mass Shootings (<i>n</i> = 842 fatalities)	
	IRR (IRR ^a)	95% CI (95% CI ^a)	IRR (IRR)	95% CI (95% CI)
Concealed carry permit—may issue reference	.69	[.28, 1.74]	.80	[.29, 2.16]
No issue	(.67)	(.30, 1.51)	(.76)	(.31, 1.87)
Shall issue w/ discretion	1.02	[.42, 2.48]	.83	[.33, 2.07]
	(1.04)	(.46, 2.37)	(.89)	(.37, 2.14)
Strict shall issue	.94	[.35, 2.55]	.82	[.27, 2.55]
	(.96)	(.40, 2.28)	(.91)	(.33, 2.49)
Permitless	2.32	[.34, 15.75]	1.45	[.16, 13.37]
	(1.98)	(.33, 12.01)	(1.37)	(.16, 12.03)
Purchaser licensing ^b	.89	[.34, 2.37]	1.23	[.44, 3.42]
	(.80)	(.33, 1.93)	(1.53)	(.63, 3.77)
Comprehensive background checks—point of sale	1.79	[.89, 3.59]	2.07*	[1.03, 4.17]
	(1.77)	(.90, 3.48)	(2.20)*	(1.12, 4.32)
DVRO prohibition—final orders, dating partner excluded	.84	[.29, 2.45]	.66	[.21, 2.11]
	(.79)	(.33, 1.88)	(.49)	(.20, 1.22)
DVRO prohibition ex parte included	1.46	[.83, 2.58]	1.36	[.71, 2.61]
	(1.47)	(.85, 2.57)	(1.24)	(.63, 2.41)
DVRO includes dating partners	.93	[.59, 1.47]	.83	[.52, 1.33]
	(.89)	(.55, 1.45)	(.79)	(.46, 1.35)
DVRO surrender required	.82	[.42, 1.60]	.77	[.37, 1.60]
	(.85)	(.46, 1.58)	(.90)	(.45, 1.81)
Violent misdemeanor prohibition	1.61	[.45, 5.83]	1.87	[.57, 6.12]
	(1.89)	(.56, 6.37)	(2.15)	(.65, 7.14)
Federal assault weapons/LCM ban (gradual)	1.28	[.66, 2.48]	1.25	[.60, 2.59]
	(.93)	(.58, 1.51)	(.85)	(.49, 1.48)
State assault weapons ban (gradual)	.50	[.17, 1.43]	.62	[.19, 2.04]
	(.51)	(.19, 1.36)	(.68)	(.20, 2.33)
Large-capacity magazine ban (gradual)	.52	[.26, 1.02]	.31*	[.11, .86]
	(.58)*	(.36, .94)	(.37)	(.13, 1.11)
Gun ownership	.97	[.90, 1.02]	.97	[.89, 1.04]
Unemployment	1.05	[.91, 1.22]	1.10	[.93, 1.30]
Percent in poverty	1.01	[.89, 1.15]	1.00	[.88, 1.14]
Percent male	.96	[.27, 3.48]	1.01	[.22, 4.67]
Percent Black	1.02	[.82, 1.28]	1.06	[.83, 1.34]
Percent married	.91	[.77, 1.08]	.92	[.76, 1.11]

(Continues)

TABLE A3 (Continued)

Variable	Domestic-Linked Fatal Mass Shooting incidents (<i>n</i> = 182 shootings)		Fatalities in Domestic-Linked Mass Shootings (<i>n</i> = 842 fatalities)	
	IRR (IRR ^a)	95% CI (95% CI ^a)	IRR (IRR)	95% CI (95% CI)
Percent divorced	.86	[.59, 1.27]	.88	[.56, 1.38]
Percent veteran	1.05	[.88, 1.24]	1.13	[.94, 1.36]
Percent living in MSA	1.00	[.95, 1.05]	.98	[.93, 1.03]
Ethanol consumption per capita	1.24	[.20, 7.88]	1.12	[.16, 7.90]
Religious adherence	1.02	[.94, 1.10]	1.00	[.93, 1.08]
Percent completed high school	1.01	[.91, 1.13]	.98	[.87, 1.10]
Drug overdose rate	.98	[.92, 1.04]	.97	[.91, 1.04]
Percent aged 15–24	1.00	[.74, 1.34]	1.01	[.75, 1.34]
Linear time trend	.97	[.77, 1.21]	1.00	[.79, 1.26]
Quadratic time trend	1.00	[1.00, 1.01]	1.00	[1.00, 1.01]

^aParsimonious model results.

^bHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

* *p* = .05.

TABLE A4 Estimates for incident rate ratios for non-domestic-linked fatal mass shootings using gradual assault weapon And LCM ban variables

Variable	Non-Domestic-Linked Fatal Mass Shooting incidents (<i>n</i> = 401 shootings)		Fatalities in Non- Domestic-Linked Mass Shootings (<i>n</i> = 2,057 fatalities)	
	IRR (IRR ^a)	95% CI (95% CI ^a)	IRR (IRR)	95% CI (95% CI)
Concealed carry permit—may issue reference	1.01	[.50, 2.01]	1.78	[.84, 3.80]
No issue	(1.12)	(.55, 2.30)	(1.74)	(.82, 3.68)
Shall issue w/ discretion	.91	[.41, 2.02]	1.20	[.50, 2.89]
	(.81)	(.36, 1.83)	(1.00)	(.41, 2.43)
Strict shall issue	1.66	[.95, 2.92]	1.85	[.90, 3.83]
	(1.43)	(.87, 2.35)	(1.60)	(.88, 2.93)
Permitless	.75	[.28, 2.04]	1.12	[.25, 5.09]
	(.71)	(.27, 1.87)	(1.02)	(.22, 4.73)
Purchaser licensing ^b	.42*	[.22, .77]	.38*	[.20, .73]
	(.43)*	(.25, .72)	(.48)*	(.26, .91)
Comprehensive background checks—point of sale	.81	[.46, 1.45]	1.07	[.43, 2.68]
	(.86)	(.48, 1.54)	(1.27)	(.42, 3.87)
DVRO prohibition—final orders, dating partner excluded	.84	[.30, 2.39]	.71	[.23, 2.22]
	(1.07)	(.34, 3.37)	(.78)	(.24, 2.57)
DVRO prohibition ex parte included	1.01	[.53, 1.94]	1.16	[.59, 2.30]
	(.94)	(.43, 2.03)	(1.09)	(.50, 2.35)
DVRO includes dating partners	.94	[.47, 1.89]	.97	[.41, 2.29]
	(.86)	(.43, 1.72)	(.91)	(.40, 2.08)
DVRO surrender required	.75	[.35, 1.60]	.83	[.35, 1.98]
	(.78)	(.33, 1.86)	(.91)	(.37, 2.26)
Violent misdemeanor prohibition	1.35	[.69, 2.67]	1.02	[.50, 2.07]
	(1.18)	(.57, 2.46)	(.90)	(.38, 2.15)
Federal assault weapons/LCM ban (gradual)	.86	[.59, 1.27]	1.08	[.62, 1.87]
	(.95)	(.66, 1.38)	(1.15)	(.71, 1.86)
State assault weapons ban (gradual)	.58	[.25, 1.33]	.67	[.17, 2.70]
	(.69)	(.27, 1.78)	(.67)	(.15, 2.90)
Large-capacity magazine ban (gradual)	1.10	[.47, 2.56]	.67	[.16, 2.76]
	(.50)	(.23, 1.09)	(.44)	(.11, 1.75)
Gun ownership	1.00	[.96, 1.04]	.97	[.93, 1.02]
Unemployment	1.03	[.96, 1.10]	1.02	[.93, 1.11]
Percent in poverty	1.00	[.93, 1.07]	.98	[.91, 1.07]
Percent male	.74	[.29, 1.86]	.68	[.25, 1.83]
Percent Black	1.08	[.88, 1.32]	1.25	[.93, 1.69]
Percent married	1.07	[.92, 1.24]	.98	[.83, 1.15]

(Continues)

TABLE A4 (Continued)

Variable	Non-Domestic-Linked Fatal Mass Shooting incidents (<i>n</i> = 401 shootings)		Fatalities in Non-Domestic-Linked Mass Shootings (<i>n</i> = 2,057 fatalities)	
	IRR (IRR ^a)	95% CI (95% CI ^a)	IRR (IRR)	95% CI (95% CI)
Percent divorced	1.13	[.79, 1.60]	.94	[.64, 1.38]
Percent veteran	.79*	[.66, .95]	.89	[.70, 1.12]
Percent living in MSA	1.02	[.98, 1.05]	1.01	[.97, 1.06]
Ethanol consumption per capita	1.09	[.25, 4.76]	.88	[.15, 5.13]
Religious adherence	1.02	[.96, 1.08]	.99	[.91, 1.07]
Percent completed high school	1.07	[.95, 1.19]	1.10	[.97, 1.24]
Drug overdose rate	1.04	[1.00, 1.08]	1.01	[.96, 1.06]
Percent aged 15–24	.78	[.56, 1.07]	.78	[.53, 1.15]
Linear time trend	.90	[.77, 1.05]	.88	[.73, 1.05]
Quadratic time trend	1.00	[1.00, 1.00]	1.00	[1.00, 1.01]

^aParsimonious model results.

^bHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

**p* = .05.

TABLE A5 Estimates for incident rate ratios for all fatal mass shootings (>3 victim fatalities), using year fixed effects

Variable	All Fatal Mass Shooting Incidents (<i>n</i> = 604 shootings)		Fatalities in All Fatal Mass Shootings (<i>n</i> = 2,976 fatalities)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	.88	[.52, 1.48]	1.31	[.74, 2.32]
Shall issue w/ discretion	.83	[.47, 1.47]	.98	[.49, 1.95]
Strict shall issue	1.31	[.72, 2.39]	1.38	[.67, 2.84]
Permitless	1.21	[.49, 3.01]	.86	[.27, 2.73]
Purchaser licensing ^a	.43*	[.26, .70]	.44*	[.26, .75]
Comprehensive background checks—point of sale	1.00	[.69, 1.44]	1.16	[.63, 2.12]
DVRO prohibition—final orders, dating partner excluded	.94	[.46, 1.91]	.80	[.34, 1.85]
DVRO prohibition ex parte included	1.28	[.86, 1.90]	1.38	[.84, 2.25]
DVRO includes dating partners	.91	[.54, 1.51]	.92	[.48, 1.76]
DVRO surrender required	.69	[.45, 1.04]	.65	[.38, 1.10]
Violent misdemeanor prohibition	1.54	[.81, 2.95]	1.33	[.68, 2.59]
Federal assault weapons/LCM ban (gradual)	1.00	[1.00, 1.00]	1.00	[1.00, 1.00]
State assault weapons ban (gradual)	.60	[.27, 1.35]	.84	[.23, 3.08]
Large-capacity magazine ban (gradual)	.56	[.27, 1.16]	.37	[.11, 1.31]
Gun ownership	.97	[.93, 1.01]	.96	[.92, 1.01]
Unemployment	1.08	[.96, 1.22]	1.06	[.91, 1.25]
Percent in poverty	1.01	[.94, 1.07]	.99	[.92, 1.07]
Percent male	.75	[.38, 1.48]	.63	[.28, 1.43]
Percent Black	1.04	[.88, 1.24]	1.11	[.91, 1.35]
Percent married	1.10	[.98, 1.23]	1.02	[.88, 1.19]
Percent divorced	1.18	[.89, 1.56]	1.07	[.76, 1.51]
Percent veteran	.69*	[.55, .87]	.64*	[.48, .84]
Percent living in MSA	1.00	[.98, 1.03]	.99	[.97, 1.02]
Ethanol consumption per capita	1.05	[.39, 2.87]	.86	[.26, 2.81]
Religious adherence	1.01	[.97, 1.05]	.99	[.94, 1.04]
Percent completed high school	1.11	[.98, 1.25]	1.17*	[1.02, 1.34]
Drug overdose rate	1.00	[.97, 1.03]	.98	[.94, 1.02]
Percent aged 15–24	.92	[.73, 1.15]	.88	[.70, 1.10]

^aHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

**p* = .05.

TABLE A6 Estimates for incident rate ratios for domestic-linked mass shooting (>3 victims), using year fixed effects

Variable	Domestic-Linked Fatal Mass Shooting Incidents (<i>n</i> = 182 shootings)		Fatalities in Domestic-Linked Mass Shootings (<i>n</i> = 842 fatalities)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	.64	[.26, 1.59]	.62	[.24, 1.65]
Shall issue w/ discretion	.90	[.35, 2.31]	.76	[.27, 2.09]
Strict shall issue	.85	[.31, 2.38]	.70	[.23, 2.11]
Permitless	1.92	[.30, 12.36]	1.06	[.12, 9.36]
Purchaser licensing ^a	.84	[.33, 2.16]	1.46	[.57, 3.71]
Comprehensive background checks—point of sale	1.89	[.86, 4.14]	2.25*	[1.02, 4.96]
DVRO prohibition—final orders, dating partner excluded	.94	[.34, 2.57]	.83	[.28, 2.49]
DVRO prohibition ex parte included	1.65	[.87, 3.16]	1.70	[.81, 3.57]
DVRO includes dating partners	.88	[.54, 1.45]	.83	[.50, 1.39]
DVRO surrender required	.84	[.41, 1.75]	.75	[.33, 1.70]
Violent misdemeanor prohibition	1.90	[.47, 7.77]	1.92	[.52, 7.06]
Federal assault weapons/LCM ban (gradual)	1.00	[1.00, 1.00]	1.00	[1.00, 1.00]
State assault weapons ban (gradual)	.39	[.11, 1.34]	.30	[.09, 1.02]
Large-capacity magazine ban (gradual)	.39*	[.20, .76]	.26*	[.11, .60]
Gun ownership	.96	[.89, 1.03]	.95	[.88, 1.02]
Unemployment	1.04	[.82, 1.31]	1.08	[.82, 1.41]
Percent in poverty	1.03	[.91, 1.18]	1.03	[.89, 1.18]
Percent male	1.04	[.29, 3.78]	1.05	[.22, 4.98]
Percent Black	1.00	[.78, 1.29]	1.03	[.78, 1.36]
Percent married	1.02	[.79, 1.30]	1.07	[.82, 1.40]
Percent divorced	1.10	[.65, 1.84]	1.18	[.69, 2.03]
Percent veteran	.97	[.63, 1.49]	1.04	[.64, 1.71]
Percent living in MSA	1.00	[.95, 1.06]	.98	[.93, 1.04]
Ethanol consumption per capita	.64	[.10, 4.05]	.59	[.08, 4.35]
Religious adherence	1.00	[.92, 1.07]	.98	[.90, 1.06]
Percent completed high school	.99	[.81, 1.22]	.94	[.75, 1.16]
Drug overdose rate	.97	[.92, 1.04]	.97	[.91, 1.03]
Percent aged 15–24	1.13	[.81, 1.56]	1.16	[.82, 1.63]

^aHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

**p* = .05.

TABLE A7 Estimates for incident rate ratios for non-domestic-linked mass shooting (>3 victims), using year fixed effects

Variable	Non-Domestic-Linked Fatal Mass Shooting incidents (<i>n</i> = 182 shootings)		Fatalities in Non-Domestic-Linked Mass Shootings (<i>n</i> = 2,057 fatalities)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	.92	[.46, 1.84]	1.40	[.70, 2.78]
Shall issue w/ discretion	.75	[.32, 1.74]	.98	[.38, 2.52]
Strict shall issue	1.58	[.86, 2.91]	1.68	[.82, 3.45]
Permitless	.66	[.27, 1.62]	.85	[.23, 3.13]
Purchaser licensing ^a	.37*	[.21, .67]	.35*	[.19, .65]
Comprehensive background checks—point of sale	.75	[.43, 1.31]	.83	[.38, 1.83]
DVRO prohibition—final orders, dating partner excluded	.92	[.34, 2.49]	.80	[.25, 2.52]
DVRO prohibition ex parte included	1.19	[.64, 2.22]	1.43	[.72, 2.84]
DVRO includes dating partners	.89	[.43, 1.84]	.91	[.37, 2.27]
DVRO surrender required	.66	[.34, 1.30]	.64	[.29, 1.44]
Violent misdemeanor prohibition	1.30	[.62, 2.72]	.93	[.44, 1.97]
Federal assault weapons/LCM ban (gradual)	1.00	[1.00, 1.00]	1.00	[1.00, 1.00]
State assault weapons ban (gradual)	.62	[.24, 1.61]	.81	[.21, 3.13]
Large-capacity magazine ban (gradual)	.74	[.28, 1.97]	.58	[.15, 2.32]
Gun ownership	.98	[.94, 1.03]	.97	[.92, 1.03]
Unemployment	1.12	[.99, 1.27]	1.11	[.96, 1.28]
Percent in poverty	.99	[.91, 1.08]	.96	[.88, 1.06]
Percent male	.66	[.31, 1.41]	.40*	[.17, .95]
Percent Black	1.04	[.84, 1.29]	1.15	[.88, 1.50]
Percent married	1.22*	[1.00, 1.48]	1.08	[.86, 1.36]
Percent divorced	1.26	[.86, 1.87]	1.01	[.64, 1.58]
Percent veteran	.58*	[.43, .79]	.52*	[.35, .76]
Percent living in MSA	1.01	[.98, 1.05]	1.01	[.97, 1.05]
Ethanol consumption per capita	1.09	[.26, 4.47]	.98	[.19, 5.03]
Religious adherence	1.02	[.96, 1.08]	1.00	[.92, 1.08]
Percent completed high school	1.16	[.98, 1.36]	1.27*	[1.05, 1.53]
Drug overdose rate	1.02	[.98, 1.06]	1.00	[.96, 1.05]
Percent aged 15–24	.88	[.59, 1.33]	.76	[.48, 1.21]

^aHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

**p* = .05.

Estimates Using Poisson Fixed-Effects Regression.

TABLE A8 Estimates for incident rate ratios for all fatal mass shootings (>3 victims), using fixed-effects poisson regression

Variable	All Fatal Mass Shooting Incidents (n = 604 shootings)		Fatalities in All Fatal Mass Shootings (n = 2, 976 fatalities)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	.79	[.49, 1.28]	1.07	[.61, 1.85]
Shall issue w/ discretion	.81	[.46, 1.40]	.90	[.47, 1.75]
Strict shall issue	1.11	[.67, 1.83]	1.06	[.61, 1.83]
Permitless	1.22	[.53, 2.76]	.97	[.39, 2.39]
Purchaser licensing ^a	.49*	[.30, .82]	.61	[.37, 1.01]
Comprehensive background checks—point of sale	1.11	[.79, 1.55]	1.83	[.68, 4.87]
DVRO prohibition—final orders, dating partner excluded	.93	[.44, 1.97]	.79	[.33, 1.88]
DVRO prohibition ex parte included	1.00	[.72, 1.38]	.84	[.57, 1.24]
DVRO includes dating partners	.86	[.58, 1.28]	.85	[.55, 1.32]
DVRO surrender required	.76	[.52, 1.11]	.88	[.53, 1.46]
Violent misdemeanor prohibition	1.42	[.78, 2.59]	.97	[.45, 2.07]
Federal assault weapons/LCM ban (gradual)	.92	[.70, 1.20]	.91	[.67, 1.24]
State assault weapons ban (gradual)	.74	[.45, 1.24]	.93	[.57, 1.52]
Large-capacity magazine ban (gradual)	.48*	[.28, .82]	.32*	[.17, .58]
Gun ownership	.99	[.96, 1.02]	.98	[.95, 1.01]
Unemployment	1.04	[.98, 1.10]	1.03	[.95, 1.11]
Percent in poverty	1.00	[.94, 1.05]	.98	[.93, 1.04]
Percent male	.62	[.29, 1.31]	.43*	[.19, .94]
Percent Black	1.03	[.88, 1.21]	1.12	[.88, 1.43]
Percent married	1.04	[.95, 1.14]	1.01	[.93, 1.10]
Percent divorced	1.01	[.80, 1.28]	1.01	[.76, 1.33]
Percent veteran	.84*	[.74, .96]	.95	[.80, 1.13]
Percent living in MSA	1.00	[.98, 1.03]	.99	[.97, 1.02]
Ethanol consumption per capita	1.37	[.49, 3.81]	1.06	[.33, 3.37]
Religious adherence	1.02	[.98, 1.07]	1.00	[.94, 1.06]
Percent completed high school	1.06	[.98, 1.13]	1.07	[.99, 1.16]
Drug overdose rate	1.02	[.99, 1.05]	1.01	[.98, 1.04]
Percent aged 15–24	.86	[.70, 1.05]	.95	[.76, 1.18]
Linear time trend	.96	[.84, 1.09]	.96	[.84, 1.10]
Quadratic time trend	1.00	[1.00, 1.00]	1.00	[1.00, 1.00]

^aHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

*p = .05.

TABLE A9 Estimates for incident rate ratios for domestic-linked mass shooting (>3 victims), using fixed-effects poisson regression

Variable	Domestic-Linked Fatal Mass Shooting incidents (<i>n</i> = 182 shootings)		Fatalities in Domestic-Linked Mass Shootings (<i>n</i> = 842 fatalities)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	.64	[.26, 1.58]	.73	[.29, 1.83]
Shall issue w/ discretion	1.00	[.43, 2.32]	.85	[.37, 1.95]
Strict shall issue	.98	[.38, 2.49]	.93	[.34, 2.52]
Permitless	2.94	[.51, 16.83]	2.56	[.42, 15.60]
Purchaser licensing ^a	.95	[.40, 2.22]	1.90	[.72, 4.98]
Comprehensive background checks—point of sale	1.79	[.90, 3.58]	1.92*	[1.05, 3.53]
DVRO prohibition—final orders, dating partner excluded	1.01	[.35, 2.89]	.87	[.29, 2.64]
DVRO prohibition ex parte included	1.59	[.88, 2.85]	1.51	[.81, 2.81]
DVRO includes dating partners	.90	[.57, 1.43]	.80	[.50, 1.28]
DVRO surrender required	.86	[.46, 1.61]	.84	[.45, 1.56]
Violent misdemeanor prohibition	1.60	[.44, 5.79]	1.66	[.55, 5.05]
Federal assault weapons/LCM ban (gradual)	.87	[.50, 1.50]	.89	[.51, 1.53]
State assault weapons ban (gradual)	.53	[.23, 1.20]	.68	[.32, 1.43]
Large-capacity magazine ban (gradual)	.38*	[.21, .70]	.27*	[.12, .59]
Gun ownership	.98	[.91, 1.05]	.97	[.91, 1.04]
Unemployment	1.04	[.91, 1.19]	1.09	[.94, 1.25]
Percent in poverty	1.00	[.88, 1.14]	.99	[.88, 1.12]
Percent male	.87	[.26, 2.89]	.75	[.21, 2.66]
Percent Black	1.02	[.82, 1.27]	1.06	[.85, 1.33]
Percent married	.96	[.83, 1.12]	.96	[.83, 1.11]
Percent divorced	.90	[.64, 1.27]	.95	[.68, 1.34]
Percent veteran	.99	[.82, 1.20]	1.03	[.85, 1.27]
Percent living in MSA	1.00	[.95, 1.06]	.99	[.94, 1.04]
Ethanol consumption per capita	1.10	[.16, 7.46]	1.07	[.13, 8.41]
Religious adherence	1.03	[.94, 1.12]	1.01	[.92, 1.11]
Percent completed high school	1.02	[.92, 1.14]	1.01	[.91, 1.13]
Drug overdose rate	.99	[.93, 1.05]	.98	[.92, 1.04]
Percent aged 15–24	1.07	[.79, 1.47]	1.17	[.83, 1.64]
Linear time trend	1.01	[.80, 1.27]	1.04	[.83, 1.30]
Quadratic time trend	1.00	[.99, 1.01]	1.00	[.99, 1.01]

^aHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.**p* = .05.

TABLE A10 Estimates for incident rate ratios for non-domestic-linked mass shooting (>3 victims), using fixed-effects poisson regression

Variable	Non-Domestic-Linked Fatal Mass Shooting incidents (n = 182 shootings)		Fatalities in Non-Domestic-Linked Mass Shootings (n = 2,057 fatalities)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	.88	[.46, 1.70]	1.21	[.62, 2.36]
Shall issue w/ discretion	.76	[.34, 1.71]	.92	[.38, 2.22]
Strict shall issue	1.28	[.76, 2.18]	1.20	[.66, 2.15]
Permitless	.58	[.24, 1.42]	.75	[.19, 2.92]
Purchaser licensing ^a	.42*	[.22, .80]	.45*	[.25, .83]
Comprehensive background checks—point of sale	.87	[.50, 1.51]	1.84	[.49, 6.87]
DVRO prohibition—final orders, dating partner excluded	.91	[.35, 2.38]	.75	[.25, 2.27]
DVRO prohibition ex parte included	.83	[.46, 1.50]	.68	[.38, 1.22]
DVRO includes dating partners	.84	[.46, 1.53]	.85	[.45, 1.62]
DVRO surrender required	.76	[.39, 1.49]	.99	[.45, 2.20]
Violent misdemeanor prohibition	1.22	[.60, 2.50]	.69	[.28, 1.72]
Federal assault weapons/LCM ban (gradual)	.96	[.65, 1.41]	.95	[.62, 1.45]
State assault weapons ban (gradual)	.79	[.42, 1.48]	.94	[.50, 1.76]
Large-capacity magazine ban (gradual)	.56	[.26, 1.19]	.35*	[.16, .76]
Gun ownership	1.01	[.97, 1.04]	.99	[.96, 1.03]
Unemployment	1.04	[.97, 1.11]	1.01	[.92, 1.11]
Percent in poverty	1.00	[.93, 1.07]	.98	[.92, 1.05]
Percent male	.52	[.19, 1.38]	.40*	[.16, 1.00]
Percent Black	1.02	[.83, 1.25]	1.13	[.81, 1.58]
Percent married	1.08	[.95, 1.23]	1.03	[.90, 1.18]
Percent divorced	1.10	[.79, 1.53]	.99	[.67, 1.46]
Percent veteran	.77*	[.64, .94]	.95	[.75, 1.18]
Percent living in MSA	1.01	[.98, 1.05]	1.01	[.97, 1.05]
Ethanol consumption per capita	1.32	[.30, 5.94]	1.00	[.21, 4.87]
Religious adherence	1.01	[.96, 1.08]	.99	[.92, 1.07]
Percent completed high school	1.05	[.94, 1.18]	1.09	[.97, 1.22]
Drug overdose rate	1.04*	[1.01, 1.08]	1.01	[.98, 1.05]
Percent aged 15–24	.78	[.58, 1.04]	.85	[.61, 1.17]
Linear time trend	.94	[.81, 1.09]	.94	[.80, 1.10]
Quadratic time trend	1.00	[1.00, 1.00]	1.00	[1.00, 1.01]

^aHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

*p = .05.

Estimates Omitting Major Mass Shooting Incidents From 2012 in Colorado (Aurora) and Connecticut (Newtown).

TABLE A11 Estimates for incident rate ratios for all fatal mass shootings (>3 victims), Omitting Newtown and Aurora shootings

Variable	All Fatal Mass Shooting Incidents (<i>n</i> = 602 shootings)		Fatalities in All Fatal Mass Shootings (<i>n</i> = 2, 937 fatalities)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	.93	[.55, 1.57]	1.50	[.81, 2.75]
Shall issue w/ discretion	.89	[.50, 1.60]	1.10	[.54, 2.24]
Strict shall issue	1.30	[.73, 2.30]	1.52	[.76, 3.06]
Permitless	1.31	[.51, 3.34]	1.09	[.34, 3.50]
Purchaser licensing ^a	.40*	[.23, .69]	.33*	[.19, .59]
Comprehensive background checks—point of sale	1.11	[.78, 1.59]	1.41	[.73, 2.74]
DVRO prohibition—final orders, dating partner excluded	.89	[.43, 1.85]	.77	[.34, 1.77]
DVRO prohibition ex parte included	1.13	[.77, 1.64]	1.21	[.75, 1.94]
DVRO includes dating partners	.90	[.57, 1.45]	.93	[.51, 1.70]
DVRO surrender required	.76	[.49, 1.17]	.76	[.45, 1.30]
Violent misdemeanor prohibition	1.51	[.78, 2.91]	1.27	[.63, 2.59]
Federal assault weapons/LCM ban (gradual)	.92	[.68, 1.26]	.96	[.63, 1.44]
State assault weapons ban (gradual)	.67	[.33, 1.38]	.90	[.30, 2.74]
Large-capacity magazine ban (gradual)	.56	[.30, 1.03]	.40	[.14, 1.14]
Gun ownership	.98	[.95, 1.02]	.96	[.93, 1.00]
Unemployment	1.02	[.95, 1.10]	1.01	[.91, 1.11]
Percent in poverty	1.01	[.95, 1.07]	1.00	[.93, 1.07]
Percent male	.82	[.39, 1.75]	.90	[.39, 2.08]
Percent Black	1.07	[.91, 1.25]	1.17	[.96, 1.43]
Percent married	1.03	[.94, 1.13]	.99	[.89, 1.11]
Percent divorced	1.02	[.79, 1.31]	.96	[.72, 1.28]
Percent veteran	.86*	[.75, .98]	.91	[.78, 1.07]
Percent living in MSA	1.01	[.98, 1.03]	1.01	[.98, 1.03]
Ethanol consumption per capita	1.08	[.39, 2.97]	.79	[.23, 2.66]
Religious adherence	1.01	[.97, 1.06]	.99	[.94, 1.05]
Percent completed high school	1.06	[.98, 1.14]	1.07	[.99, 1.17]
Drug overdose rate	1.01	[.97, 1.05]	.99	[.95, 1.03]
Percent aged 15–24	.83	[.68, 1.02]	.86	[.69, 1.08]
Linear time trend	.92	[.81, 1.05]	.89	[.77, 1.03]
Quadratic time trend	1.00	[1.00, 1.00]	1.00	[1.00, 1.00]

^aHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

**p* = .05.

TABLE A12 Estimates for incident rate ratios for domestic-linked mass shooting (>3 victims), Omitting Newtown and Aurora shootings

Variable	Domestic-Linked Fatal Mass Shooting Incidents (<i>n</i> = 181 shootings)		Fatalities in Domestic-Linked Mass Shootings (<i>n</i> = 815 fatalities)	
	Law Variables + Covariates		Law Variables + Covariates	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	.67	[.26, 1.70]	.75	[.28, 2.02]
Shall issue w/ discretion	.99	[.42, 2.35]	.84	[.34, 2.04]
Strict shall issue	.97	[.36, 2.66]	.93	[.30, 2.86]
Permitless	2.49	[.37, 16.69]	1.72	[.19, 15.52]
Purchaser licensing ^a	.60	[.16, 2.20]	.60	[.14, 2.53]
Comprehensive background checks—point of sale	1.90	[.91, 4.00]	2.17*	[1.05, 4.48]
DVRO prohibition—final orders, dating partner excluded	.91	[.32, 2.60]	.71	[.23, 2.20]
DVRO prohibition ex parte included	1.60	[.89, 2.87]	1.66	[.87, 3.17]
DVRO includes dating partners	.92	[.58, 1.47]	.83	[.51, 1.36]
DVRO surrender required	.84	[.44, 1.62]	.78	[.38, 1.62]
Violent misdemeanor prohibition	1.76	[.42, 7.41]	1.81	[.51, 6.47]
Federal assault weapons/LCM ban (gradual)	.87	[.50, 1.52]	.85	[.46, 1.57]
State assault weapons ban (gradual)	.34	[.10, 1.14]	.24*	[.06, .90]
Large-capacity magazine ban (gradual)	.46*	[.23, .89]	.45*	[.22, .91]
Gun ownership	.97	[.90, 1.05]	.97	[.90, 1.05]
Unemployment	1.05	[.90, 1.21]	1.08	[.91, 1.28]
Percent in poverty	1.01	[.88, 1.15]	1.00	[.87, 1.14]
Percent male	1.09	[.31, 3.90]	1.27	[.29, 5.52]
Percent Black	1.00	[.80, 1.25]	1.01	[.80, 1.27]
Percent married	.96	[.82, 1.13]	.97	[.81, 1.16]
Percent divorced	.86	[.59, 1.27]	.82	[.52, 1.27]
Percent veteran	1.00	[.83, 1.21]	1.06	[.87, 1.30]
Percent living in MSA	1.00	[.95, 1.06]	.99	[.94, 1.05]
Ethanol consumption per capita	.93	[.14, 6.29]	.83	[.11, 6.07]
Religious adherence	1.02	[.94, 1.11]	1.01	[.94, 1.10]
Percent completed high school	1.02	[.91, 1.15]	1.01	[.89, 1.13]
Drug overdose rate	.98	[.92, 1.04]	.98	[.91, 1.05]
Percent aged 15–24	1.00	[.75, 1.33]	.99	[.75, 1.30]
Linear time trend	.98	[.79, 1.23]	1.02	[.81, 1.28]
Quadratic time trend	1.00	[.99, 1.01]	1.00	[1.00, 1.01]

^aHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

**p* = .05.

TABLE A13 Estimates for incident rate ratios for non-domestic-linked mass shooting (>3 victims), Omitting Newtown and Aurora shootings

Variable	Non-Domestic-Linked Fatal Mass Shooting incidents (<i>n</i> = 181 shootings)		Fatalities in Non-Domestic-Linked Mass Shootings (<i>n</i> = 2,045 fatalities)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	1.00	[.49, 2.03]	1.72	[.79, 3.75]
Shall issue w/ discretion	.81	[.36, 1.82]	1.06	[.42, 2.68]
Strict shall issue	1.51	[.85, 2.69]	1.79	[.86, 3.72]
Permitless	.67	[.25, 1.78]	1.08	[.24, 4.76]
Purchaser licensing ^a	.38*	[.20, .70]	.34*	[.18, .62]
Comprehensive background checks—point of sale	.85	[.48, 1.51]	1.11	[.45, 2.74]
DVRO prohibition—final orders, dating partner excluded	.90	[.33, 2.52]	.75	[.25, 2.22]
DVRO prohibition ex parte included	1.04	[.54, 2.01]	1.20	[.60, 2.39]
DVRO includes dating partners	.90	[.45, 1.81]	.98	[.43, 2.26]
DVRO surrender required	.75	[.35, 1.61]	.84	[.35, 2.00]
Violent misdemeanor prohibition	1.33	[.65, 2.74]	.99	[.48, 2.06]
Federal assault weapons/LCM ban (gradual)	.98	[.65, 1.47]	1.09	[.66, 1.80]
State assault weapons ban (gradual)	.72	[.31, 1.69]	.94	[.24, 3.75]
Large-capacity magazine ban (gradual)	.67	[.27, 1.69]	.47	[.12, 1.94]
Gun ownership	1.00	[.96, 1.04]	.97	[.92, 1.02]
Unemployment	1.03	[.96, 1.11]	1.01	[.92, 1.11]
Percent in poverty	1.00	[.94, 1.07]	.98	[.91, 1.07]
Percent male	.68	[.27, 1.73]	.69	[.25, 1.93]
Percent Black	1.08	[.87, 1.33]	1.27	[.94, 1.72]
Percent married	1.06	[.92, 1.21]	.98	[.84, 1.14]
Percent divorced	1.10	[.77, 1.57]	.94	[.64, 1.37]
Percent veteran	.79*	[.65, .96]	.88	[.69, 1.11]
Percent living in MSA	1.01	[.98, 1.05]	1.02	[.97, 1.06]
Ethanol consumption per capita	1.13	[.24, 5.21]	.86	[.13, 5.51]
Religious adherence	1.01	[.95, 1.08]	.99	[.91, 1.07]
Percent completed high school	1.06	[.95, 1.19]	1.11	[.97, 1.26]
Drug overdose rate	1.04	[1.00, 1.08]	1.01	[.96, 1.06]
Percent aged 15–24	.78	[.57, 1.07]	.80	[.54, 1.18]
Linear time trend	.91	[.77, 1.07]	.86	[.72, 1.04]
Quadratic time trend	1.00	[1.00, 1.00]	1.00	[1.00, 1.01]

^aHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

**p* = .05.

Estimates Using Different Definitions of “Mass Shooting”—Shootings With Fatalities > 4 and Shootings With Fatalities > 5.

TABLE A14 Estimates for incident rate ratios for all mass shooting (>4 victims)

Variable	All Fatal Mass Shooting Incidents (n = 198 shootings)		Fatalities in All Fatal Mass Shootings (n = 1,352 fatalities)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	4.14*	[1.57, 1.87]	8.41*	[3.00, 23.57]
Shall issue w/ discretion	.96	[.31, 2.94]	1.23	[.35, 4.30]
Strict shall issue	2.24	[.91, 5.49]	2.60	[.99, 6.78]
Permitless	.91	[.14, 5.78]	1.53	[.19, 12.43]
Purchaser licensing ^a	.52	[.15, 1.83]	.44	[.09, 2.18]
Comprehensive background checks—point of sale	1.94	[.85, 4.41]	3.65	[.74, 18.05]
DVRO prohibition—final orders, dating partner excluded	.70	[.22, 2.21]	.63	[.15, 2.61]
DVRO prohibition ex parte included	.97	[.54, 1.73]	1.11	[.55, 2.26]
DVRO includes dating partners	.58	[.30, 1.13]	.61	[.24, 1.52]
DVRO surrender required	.75	[.40, 1.42]	.79	[.32, 1.95]
Violent misdemeanor prohibition	2.10	[.55, 8.02]	1.34	[.35, 5.05]
Federal assault weapons/LCM ban (gradual)	1.00	[.50, 2.02]	.92	[.42, 2.01]
State assault weapons ban (gradual)	.58	[.13, 2.62]	1.41	[.09, 2.94]
Large-capacity magazine ban (gradual)	.20*	[.06, .65]	.08*	[.01, .92]
Gun ownership	.97	[.91, 1.02]	.94	[.88, 1.00]
Unemployment	1.08	[.97, 1.21]	1.08	[.95, 1.24]
Percent in poverty	.95	[.85, 1.06]	.93	[.81, 1.06]
Percent male	.43	[.12, 1.59]	.39	[.08, 1.94]
Percent Black	.92	[.66, 1.28]	1.05	[.68, 1.61]
Percent married	.90	[.80, 1.01]	.88	[.75, 1.04]
Percent divorced	.81	[.55, 1.19]	.83	[.53, 1.29]
Percent veteran	.88	[.69, 1.12]	.94	[.70, 1.26]
Percent living in MSA	.98	[.94, 1.02]	.97	[.92, 1.02]
Ethanol consumption per capita	.86	[.13, 5.73]	.90	[.09, 9.22]
Religious adherence	.93	[.86, 1.00]	.90*	[.82, 1.00]
Percent completed high school	1.17*	[1.05, 1.30]	1.19*	[1.05, 1.34]
Drug overdose rate	1.02	[.96, 1.07]	.99	[.94, 1.04]
Percent aged 15–24	1.14	[.84, 1.55]	1.13	[.77, 1.65]
Linear time trend	.96	[.77, 1.20]	.93	[.73, 1.19]
Quadratic time trend	1.00	[.99, 1.00]	1.00	[1.00, 1.01]

^aHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

*p = .05.

TABLE A15 Estimates for incident rate ratios for all mass shooting (>5 victims)

Variable	All Fatal Mass Shooting Incidents (>5 victims) (n = 92 shootings)		Fatalities in All Fatal Mass Shootings (n = 822 fatalities)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference No issue	1.77*	[1.99, 58.31]	25.74*	[4.03, 164.2]
Shall issue w/ discretion	2.13	[.27, 16.58]	1.95	[.17, 21.93]
Strict shall issue	1.93	[.30, 12.41]	1.79	[.22, 14.29]
Permitless	3.81	[.34, 42.94]	2.99	[.22, 41.29]
Purchaser licensing ^a	.87	[.32, 2.33]	.69	[.24, 2.05]
Comprehensive background checks—point of sale	2.27	[.52, 9.84]	6.98	[.82, 59.36]
DVRO prohibition—final orders, dating partner excluded	.61	[.11, 3.35]	.36	[.05, 2.62]
DVRO prohibition ex parte included	1.16	[.48, 2.79]	1.07	[.41, 2.83]
DVRO includes dating partners	.98	[.27, 3.58]	.94	[.21, 4.24]
DVRO surrender required	.51	[.15, 1.76]	.88	[.19, 4.02]
Violent misdemeanor prohibition	.72	[.16, 3.26]	.27	[.04, 1.65]
Federal assault weapons/LCM ban (gradual)	.77	[.31, 1.96]	.69	[.21, 2.22]
State assault weapons ban (gradual)	1.04	[.17, 6.36]	1.38	[.12, 15.48]
Large-capacity magazine ban (gradual)	.14*	[.03, .70]	.05*	[.00, .51]
Gun ownership	.96	[.89, 1.04]	.92	[.84, 1.01]
Unemployment	1.16	[.98, 1.37]	1.17	[.95, 1.45]
Percent in poverty	.93	[.80, 1.10]	.88	[.72, 1.07]
Percent male	.26	[.03, 2.14]	.42	[.04, 4.62]
Percent Black	.82	[.52, 1.30]	.91	[.53, 1.57]
Percent married	1.05	[.86, 1.28]	1.03	[.79, 1.33]
Percent divorced	1.03	[.56, 1.91]	1.06	[.54, 2.08]
Percent veteran	.86	[.64, 1.18]	.92	[.63, 1.34]
Percent living in MSA	.96	[.88, 1.05]	.94	[.84, 1.04]
Ethanol consumption per capita	5.43	[.23, 126.96]	1.79	[.04, 77.79]
Religious adherence	.91	[.80, 1.03]	.88	[.75, 1.03]
Percent completed high school	1.16	[.97, 1.39]	1.19	[.97, 1.47]
Drug overdose rate	.98	[.89, 1.08]	.95	[.86, 1.05]
Percent aged 15–24	1.16	[.66, 2.04]	1.20	[.59, 2.45]
Linear time trend	1.10	[.83, 1.44]	.99	[.74, 1.33]
Quadratic time trend	1.00	[.99, 1.01]	1.00	[.99, 1.01]

^aHandgun purchaser licensing with in-person application and/or fingerprinting of applicant.

* $p = .05$.