IN THE COURT OF APPEALS OF THE STATE OF OREGON

JOSEPH ARNOLD and CLIFF ASMUSSEN, Plaintiffs-Respondents, and	Harney County Circuit Court No. 22CV41008
GUN OWNERS OF AMERICA, INC. and GUN OWNERS FOUNDATION, Plaintiffs, v. TINA KOTEK, Governor of the State of Oregon, in her official capacity; ELLEN ROSENBLUM, Attorney General of the State of Oregon, in her official capacity; and CASEY CODDING, Superintendent of the Oregon State Police, in his official capacity, Defendants-Appellants.	CA A183242

APPELLANTS' BRIEF

Appeal from the Judgment of the Circuit Court
for Harney County
Honorable ROBERT S. RASCHIO, Judge

Continued…

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APPELLANTS' BRIEF

INTRODUCTION

Amidst rising gun violence, the people of Oregon used the initiative power under Article IV, section 1(2), to enact Ballot Measure 114 (2022). The law limits magazine capacity to 10 or fewer rounds; requires a permit to purchase a firearm; and closes the so-called "Charleston Loophole," requiring the completion, not just initiation, of a background check to transfer a firearm.

Article I, section 27, of the Oregon Constitution codifies a right to "bear arms" for self-defense. The right is not absolute. It protects only the types of weapons commonly used for self-defense at statehood in 1859; and as to those weapons, the constitution permits "reasonable regulations to promote public safety as long as [an] enactment does not unduly frustrate the individual right to bear arms for the purpose of self-defense." *State v. Christian*, 354 Or 22, 33, 307 P3d 429 (2013) (citing *State v. Hirsch/Friend*, 338 Or 622, 640, 114 P3d 1104 (2005), *overruled on other grounds by Christian*, 354 Or at 40).

Here, to the extent that Measure 114 regulates protected weapons at all, the law is reasonable and therefore facially constitutional. The law seeks to prevent harms from gun violence, and Oregonians remain free to purchase and use magazines with 10 or fewer rounds, permit holders can purchase any legal firearm, and any firearm transfer may proceed once a background check clears.

The trial court ruled otherwise by turning the above legal standards on their head. The court weighed the policy merits of the measure for itself and, at the same time, refused to consider published studies and reports on the public-safety benefits of each of the law's three components. In doing so, the trial court arrogated policy-making authority that belongs to the legislature and, through the initiative process, "to the people." Or Const, Art IV, § 1.

As a result, this brief raises six assignments of error. The first assignment explains why Measure 114 is facially constitutional under controlling case law. The second addresses an evidentiary issue: The trial court excluded, as irrelevant, evidence on community harms caused by mass gun violence—evidence plainly relevant to the magnitude and scope of harm that the law was enacted to prevent.

This court could, but need not, reach the state's remaining assignments. The trial court excluded four other sets of evidence that underscore the law's reasonableness: studies, reports, and statistics on public-safety impacts of the law, which the law's preamble cites. But this court already can review public facts on a facial challenge to a statute. *Fed. Cartridge Corp. v. Helstrom*, 202 Or 557, 565, 276 P2d 720 (1954). That is, the court can review the cited public-safety evidence without reviewing the trial court's evidentiary rulings. The state includes the last four assigned errors only in case this court disagrees.

STATEMENT OF THE CASE

Nature of the Proceeding

Plaintiffs, two gun owners in Harney County, sued the Oregon Governor, Attorney General, and Superintendent of the Oregon State Police, each in their official capacity. (ER-1–5). Plaintiffs raised a single claim: that Measure 114 "is unconstitutional on its face" under Article I, section 27, of the Oregon Constitution. (ER-22–26). They sought declaratory and permanent injunctive relief. (ER-26). In doing so, they challenged the law's magazine and permit provisions, but made no reference to the closure of the Charleston Loophole.

Nature of the Judgment

After a bench trial, the trial court entered general judgment that declared any application of Measure 114 facially unconstitutional under Article I, section 27, and permanently enjoined enforcement of the law by state defendants. (ER-753). The trial court later entered a supplemental judgment awarding plaintiffs $202,269.89 in attorney fees and costs as the prevailing party. (ER-803).

Jurisdiction

This court has jurisdiction under ORS 19.205 and ORS 19.255.

Notice of Appeal

General judgment was entered on January 9, 2024. The state timely served and filed its notice of appeal on January 10, 2024. The trial court then entered a supplemental judgment for attorney fees on January 29, 2024. The state timely served and filed an amended notice of appeal on February 28, 2024.

Questions Presented

1. Whether Measure 114 is facially constitutional under Article I, section 27, of the Oregon Constitution.

2. Whether, under OEC 401, community harms from firearm-related violence are relevant to the constitutionality of Measure 114.

3. Whether, under OEC 702, epidemiological studies and related testimony about the public-safety impacts of state magazine restrictions have sufficient scientific validity.

4. Whether, under OEC 401, epidemiological studies and related testimony about the public-safety impacts of state permit requirements are relevant to the constitutionality of Measure 114.

5. Whether, under OEC 401, statistical data on firearm sales under the Charleston Loophole are relevant to the constitutionality of Measure 114.

6. Whether, under OEC 401, an investigative report by the Las Vegas Metropolitan Police Department on the largest mass shooting in the nation’s history is relevant to the constitutionality of Measure 114.

Summary of Argument

1. Measure 114 has three principal components. Each is constitutional.

Measure 114's restrictions on large-capacity magazines are facially constitutional. Large-capacity magazines are not "arms" protected by Article I, section 27, at all. They are not themselves weapons, and their functionality derives from military developments that emerged decades after the adoption of that constitutional provision in 1859. For that reason, this court has held that related semi-automatic technology does not warrant constitutional protection. *Or. State Shooting Ass'n v. Multnomah Cty. ("OSSA")*, 122 Or App 540, 548–49, 858 P2d 1315 (1993), *rev den*, 319 Or 273 (1994).

The magazine restrictions also are reasonable, which is all that case law requires. The law seeks to forestall rising gun violence, and the restrictions reasonably relate to that stated aim. The use of large-capacity magazines increases the lethality of mass shootings, while state magazine restrictions significantly reduce those harms. Nor do the restrictions unduly frustrate self-defense. Capacity-compliant magazines are widely available, and more than 10 rounds are virtually never, if ever, needed for armed self-defense.

Measure 114's permit-to-purchase requirements also are facially constitutional. The Supreme Court already has upheld a concealed-carry license requirement and process that largely mirror those under Measure 114. *Christian*, 354 Or at 40–41. The policy also is reasonable. The statute requires a background check, assessment of psychological state, and demonstration of firearm safety. Such permit programs lead to significant decreases in both homicides and mass shootings. And anyone who meets the criteria may obtain a permit, while any permit holder can acquire any legal firearm.

Closing the Charleston Loophole is facially constitutional too. The Supreme Court has held that the state may promote public safety by disarming convicted felons. *Hirsch/Friend*, 338 Or at 677. Requiring a completed background check at the point of transfer is a logical and permissible means to that constitutional end. In addition, the policy is reasonable. Previous law required only the *initiation* of a point-of-sale background check, but a completed check can identify any disqualifying conviction, including those incurred since any previous background check. Further, any purchaser whose background check has cleared is free to complete their transfer.

2. Evidence about the community impacts of gun violence is relevant to the constitutionality of Measure 114, namely, to the scope of harm sought to be addressed by the law. Relevance is a "very low threshold." *State v. Davis*, 336 Or 19, 25, 77 P3d 1111 (2003). The state proffered three witnesses: a doctor who has counseled communities shattered by mass gun violence, a survivor of the mass shooting at Umpqua Community College, and a family member of a victim of the Clackamas Town Center shooting. Each personifies the public-safety harms that the law was enacted to prevent.

3. Peer-reviewed, published epidemiological studies on state magazine restrictions, and concomitant testimony about those studies, satisfy the requirements for admission under OEC 702. "Epidemiology is at the top" of scientific methodologies on causation, and publication further underscores a study's scientific validity. *Jennings v. Baxter Healthcare Corp.*, 331 Or 285, 306–09, 14 P3d 596 (2000) (citation omitted). The studies show a decrease in mass shootings in states that restrict magazine sizes and support a causal inference between large-capacity magazines and mass-shooting harms.

4. Peer-reviewed, published epidemiological studies on state permit requirements are relevant to the constitutionality of Measure 114. The studies show a decrease in firearm-related homicides and mass-shooting events in states that require permits.

5. Statistics on firearm sales enabled by the Charleston Loophole are relevant to the constitutionality of Measure 114. In 2020 alone, at least 2,989 individuals whose criminal background disqualified them from acquiring a firearm nevertheless were able to purchase one because the background check did not complete within the short timeframe required by the loophole, which closing the loophole would prevent.

6. The Las Vegas police report on the 2017 mass shooting at a music festival on the Las Vegas Strip is relevant to the law's constitutionality, namely, to the scope of harm sought to be addressed by the law. The report documents that a single shooter used 100-round and 25-round magazines to fire more than

1,000 rounds into a crowded music festival in 11 minutes, killing 58 and injuring more than 800—magazines that Measure 114 would prohibit.

Summary of Facts

The people of Oregon enacted Measure 114, the "Reduction in Gun Violence Act," in the November 2022 general election. Measure 114 ("M114") § 2.[1] The measure sought "to enhance public health and safety" amidst "a sharp increase in gun sales, gun violence, and raised fears in Oregonians of armed intimidation." *Id.*, Preamble. The measure also sought to forestall "horrific deaths and devastating injuries due to mass shootings, homicides and suicides," viewed as "unacceptable at any level." *Id.*

To further those aims, Measure 114 has three principal components. First, the law restricts magazine capacity to 10 or fewer rounds of ammunition. *Id.* § 11(1)(d), (2). Second, it requires a permit to purchase a firearm. *Id.* §§ 3(3), 6(2), 7(3)(a), 8(2), 9(1)(a)(A). Third, it requires the completion of a point-of-sale background check to transfer a firearm, closing what is commonly referred to as the Charleston Loophole; current federal law allows a transfer to proceed if the check does not complete within three business days. *Id.* §§ 6(3)(c), 6(14), 7(3)(d)(B), 8(3)(c), 10; 18 USC 922(t)(1)(B)(ii).

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[1] The text of Measure 114 is at ER-28–39. For simplicity, the brief will refer to the provisions by their statutory section and subsection.

The measure made several findings. M114, Preamble. For one, the law found that large-capacity magazines "increase casualties by allowing a shooter to continue firing for longer periods of time before reloading," which "explain[s] their use in all 10 of the deadliest mass shootings since 2009," as well as in "the 2015 shooting at Umpqua Community College in Roseburg, Oregon in which 10 people were killed and 7 more were injured." *Id.* Further, the use of such magazines in a mass-shooting event dramatically increases both fatalities and injuries, while magazine restrictions in other states "have been found to reduce the number of fatalities and injuries in shooting incidents." *Id.* On permits, "studies have shown that permits-to-purchase reduce firearm-related injuries and deaths" by keeping firearms "out of dangerous hands." *Id.*

The week before Measure 114 was to take effect, plaintiffs sued in Harney County Circuit Court challenging the law under Article I, section 27. The trial court granted plaintiffs' emergency request to enjoin the law. The state petitioned for a writ of mandamus from the Oregon Supreme Court, which that court denied without prejudice to any future filings. *Arnold v. Brown*, No. S069923 (Or, Dec 17, 2022). The trial court held two preliminary-injunction hearings, ultimately extending its injunction pending a bench trial. The state again petitioned for mandamus, which the Supreme Court again denied without prejudice. *Arnold v. Kotek*, 370 Or 716, 524 P3d 955 (2023).

The trial court held a six-day bench trial in September 2023. Before trial, the court granted the state's motion to exclude evidence about possible future implementations of the law; the court also granted plaintiffs' motion to exclude, as irrelevant, victim-impact testimony and the efficacy of permit-to-purchase programs. (Tr-475–85). During trial, the court further excluded evidence about closing the Charleston Loophole. (Tr-1102, 1466).

Trial therefore focused on the law's magazine restrictions. Plaintiffs presented seven lay witnesses, including three members of law enforcement, and four expert witnesses on firearms self-defense, gunsmithing, sales, and artifacts and history. The state presented one lay witness and five experts witnesses on quantitative social sciences, gun-violence epidemiology, Oregon's history of material culture in the mid-1800s, firearms history and trade, and commercial sales.

After trial, the court issued an amended letter opinion. The court ruled that any application of Measure 114 would facially contravene Article I, section 27, and permanently enjoined the law's enforcement. (ER-757–800).

FIRST ASSIGNMENT OF ERROR

The trial court erred in ruling that Measure 114 is facially unconstitutional under Article I, section 27.

A. Preservation of Error

The state preserved this assigned error. Before, during, and at the close of the bench trial, the state argued that Measure 114 facially comports with Article I, section 27. The state contended that large-capacity magazines are not protected "arms" and that, even if they were, the magazine restrictions constitute reasonable and permissible policy choices for promoting public safety; the state also argued that the permit-to-purchase requirements and closure of the Charleston Loophole are similarly reasonable and permissible policy choices for seeking to prevent firearm-related violence. (Tr-1918–42; Defs' Resp to Pls' Mot for TRO 10–15 (Dec 5, 2022); Defs' Resp to Pls' Mot for Prelim Inj 13–20 (Dec 12, 2022); Defs' Hearing Memo re Charleston Loophole 9–11 (Dec 22, 2022); Defs' Resp to Pls' Mots in Limine 2–6 (Sept 6, 2023); Defs' Trial Memo & Resp to Mot for Summ J 6–15 (Sept 15, 2023); Defs' Memo of Law re *OSSA* 1–3 (Sept 24, 2023)).

B. Standard of Review

This court reviews for legal error a trial court's interpretation of a statute and ruling on the statute's facial constitutionality. *State v. Norris-Romine*, 134 Or App 204, 209, 894 P2d 1221, *rev den*, 321 Or 512 (1995). In that review, statutes are "presumed to be constitutional." *Fed. Cartridge Corp.*, 202 Or at 565 (quoting *City of Portland v. Goodwin*, 187 Or 409, 416, 210 P2d 577 (1949)). As such, the challenger to a law "has the burden of establishing its invalidity." *Milwaukie Co. of Jehovah's Witnesses v. Mullen*, 214 Or 281, 293, 330 P2d 5 (1958).

In addition, "[a] statute is presumed to be supported by facts known to the legislative body." *Fed. Cartridge Corp.*, 202 Or at 565 (quoting *City of Portland*, 187 Or at 416). Further, "[i]f a state of facts could exist which would justify legislation, it would be presumed that it did exist." *State v. Bunting*, 71 Or 259, 266, 139 P 731 (1914), *aff'd*, 243 US 426, 37 S Ct 435, 61 L Ed 830 (1917). Moreover, on a facial challenge, "the court is not limited to * * * the material presented" as to the "facts surrounding the enactment of a law." *Payless Drug Stores Nw. v. Brown*, 300 Or 243, 247, 708 P2d 1143 (1985).

ARGUMENT

Case law firmly establishes that Measure 114 is facially constitutional, and the record below confirms the law's constitutionality. To the extent that Measure 114 implicates Article I, section 27, the law reasonably seeks to promote public safety without unduly frustrating the right to armed self-defense. The state will address each of the law's three components in turn.

A. Measure 114's restrictions on large-capacity magazines are facially constitutional.

Plaintiffs challenge the law's restrictions on large-capacity magazines. But large-capacity magazines are not protected "arms" under Article I, section 27—or arms at all. Even if they were, the restrictions are reasonable and do not unduly burden armed self-defense.

1. Large-capacity magazines are not protected "arms."

Article I, section 27, provides: "The people shall have the right to bear arms for the defense of themselves, and the State, but the Military shall be kept in strict subordination to the civil power." Or Const, Art I, § 27. As noted, the right "is not an absolute right." *Christian*, 354 Or at 33. Rather, the right protects only the types of weapons commonly used for self-defense at statehood in 1859. *Hirsch/Friend*, 338 Or at 640. Put another way, the right does not extend to military weapons that postdate statehood. *State v. Kessler*, 289 Or 359, 368–69, 614 P2d 94 (1980); *OSSA*, 122 Or App at 544.

This court requires three elements for a weapon to fall within the ambit of constitutional protection: "(1) although the weapon may subsequently have been modified, it must be 'of the sort' in existence in the mid-nineteenth century; (2) the weapon must have been in common use; and (3) it must have been used for personal defense." *OSSA*, 122 Or App at 544 (citing *State v. Delgado*, 298 Or 395, 400, 692 P2d 610 (1984); *Kessler*, 289 Or at 369). Large-capacity magazines satisfy none of these required elements.

a. Firearms with large-capacity magazines were not commonly used for self-defense in 1859.

As a threshold matter, large-capacity magazines are not arms at all. Such magazines are not, by themselves, commonly used for self-defense, now or in 1859. Magazines are a component of many firearms for feeding ammunition into the firearm. (Tr-1748). But a *large-capacity* magazine is not necessary for a firearm to function. That is, the capacity of a magazine does not impact the operability of a firearm; it changes only the number of shots that can be fired without pausing to reload. (Tr-857, 1094, 1763–66, 1769, 1807).

More fundamentally, no firearm commonly used for self-defense in 1859 had a large-capacity magazine or anything like a large-capacity magazine. Instead, the practicality and functionality of such magazines derive from three separate innovations in the 1880s, two of them for military purposes. The pertinent firearms history, recounted below, was undisputed at trial.

Until the 1850s, firearms generally were single-shot and muzzle-loading; a single round was loaded from the open end of the gun barrel. (Tr-1149). The user poured gunpowder down the barrel, put a projectile ball on a grease patch, and used a rod to ram the ball to the barrel's bottom; additional gunpowder then was used with a flintlock ignition system to ignite the powder charge. (Tr-717, 1149–51). A percussion-cap ignition system enabled the development of "cap-and-ball" ammunition by the 1830s, but this system still required that each round be loaded individually. (Tr-1150–56, 1164, 1021).

By the 1850s, five types of firearms were common: the musket, military musket, rifle, shotgun, and pistol. (Tr-1146–48). Two pistol-type weapons had developed that were referred to as "repeaters" because they could store and fire more than one round of ammunition. (Tr-1157). One was the pepperbox pistol, which used a single axis with multiple barrels, typically 4-to-8. (Tr-674–75, 1158–61). The other was the revolver, popularized by Samuel Colt, which had a single barrel with multiple chambers, typically 5-to-8. (Tr-676, 1161–63).

In the 1850s, the Oregon territory was at the end of the nation's supply chain. (Tr-1353–55). As explained by Dr. Mark Tveskov—an anthropology professor and historical archeologist at Southern Oregon University who has studied Oregon's territorial period extensively—this created a culture of independence and self-reliance, with a preference for tried-and-true rather than experimental technology. (Tr-1360, 1384–86, 1391). That preference extended to firearms. Those in the territory commonly used single-shot muzzle-loading firearms for self-defense, and some even eschewed newer percussion-cap rifles for older, single-shot, flintlock rifles. (Tr-1248–49, 1371–73, 1381–86, 1391).

Only in the 1860s did the nation see its first commercially successful firearms with a capacity of more than 10 rounds: the Henry and Winchester rifles. (Tr-1169–70). Both depended on recent advancements from the Industrial Revolution. Metallic cartridges provided pre-assembled, self-contained ammunition of primer, propellant, and projectile; and breech-loading technology loaded ammunition from the back (breech) of the barrel, rather than from the front (muzzle). (Tr-1164–67). Both rifles used a lever action with a tubular magazine; the user fed ammunition one-by-one into a tube, and then manually ejected and chambered each round with a lever. (Tr-1170–72).

Henry and Winchester rifles initially were rare. By the early 1870s, they constituted at most 0.2% of firearms in the United States, as the vast majority were sold and shipped overseas. (Tr-1173–75). More to the point, there is no evidence that any firearm with a capacity of more than 10 rounds appeared in Oregon until after the Civil War. (Tr-1393–97).

In the 1880s, three innovations dramatically altered the form and functionality of firearms. First, Hiram Maxim, a British inventor, invented automatic fire for military use. (Tr-1182, 1251). He perfected a team-operated gun that sat on a tripod, harnessing the explosive power from each ignition to eject and rechamber a round automatically using ammunition fed from a crate. (Tr-1182). Second, James Paris Lee, a Canadian inventor, invented the first successful detachable magazine, also for military use; it held eight rounds that were loaded one-by-one using a lever. (Tr-1181, 1251). Third, Paul Vieille, a French chemist, invented nitrocellulose, a smokeless gunpowder three times stronger than black powder that left virtually no residue; the residue of black powder quickly fouls a barrel, rendering a firearm inoperable. (Tr-1185–86).

In the 1890s, those three innovations were combined to create semi-automatic firearms. (Tr-698, 1184–86). With semi-automatic technology, each trigger pull fires a cartridge, and the resulting energy is harnessed to eject the spent cartridge and chamber a new round automatically. (Tr-1183).

Those innovations allowed large-capacity magazines to become useful; they also would have been unforeseeable to those living in the 1850s. As explained by Dr. Brian DeLay—a history professor and scholar at UC Berkeley who has published several peer-reviewed articles and studied the international firearms trade in the 1700s and 1800s—the technologies, separately and combined, constituted "profound ruptures in the history of firearms technology." (Tr-1187). Before, a firearm user had to expend time and energy to manually remove and rechamber a spent round of ammunition; a firearm's capacity was limited by its dimensionality, where the size of the firearm dictated its capacity; and the rate of repeat fire was limited by the quick fouling of the barrel caused by black powder. (Tr-1184–89). As a result, large-capacity firearms were not practical in 1859. Unsurprisingly then, they were not common anywhere in the United States, much less commonly used for self-defense. (Tr-756–58, 1167–75, 1393–97).

Again, none of the above history is disputed. Large-capacity magazines therefore bear no relation to the rudimentary firearms commonly used for self-defense in 1859, in Oregon or anywhere else in the country. That is, firearms equipped with such magazines are not the "sort" of weapons then-common, much less commonly used for self-defense. Rather, modern-day large-capacity magazines derive utility and practicality from three innovations in the 1880s, two of them military. Military innovations that post-date statehood are "not the 'sort' of weapons for defense of self intended by the drafters to come within Article I, section 27." *OSSA*, 122 Or App at 546–49. Measure 114's magazine restrictions thus do not implicate, much less violate, Article I, section 27.

b. The trial court's ruling to the contrary was error.

The trial court ruled otherwise. (ER-780–83). In doing so, the court failed to cite, much less apply, this court's criteria for determining whether weapons constitute protected "arms." Instead, the trial court cited the general interest of gunmakers in developing the nonexistent technology to conclude that "the drive for larger capacity magazines" was enough to confer constitutional protection. (ER-782 n 12). That ruling was error.

The hopes of gunmakers in the 1800s has no legal relevance to the question of whether large-capacity magazines are akin to weapons commonly used for self-defense in 1859. *OSSA*, 122 Or App at 544. Put another way, a general historical desire for increased firearm capacity does not confer constitutional protection on later, technologically distinct weapons derived from military innovations. *Kessler*, 289 Or at 369; *OSSA*, 122 Or App at 546–47.

Separately, and incongruously, the trial court reasoned that "[l]arge capacity magazines existed in the early 1800s" and "that firearm technology at the founding of the state is the foundation for the current firearm technology." (ER-780, 782). The trial court invoked two "repeater" firearms as historical analogues: “repeating rifles of the 1850s,” as well as “Colt revolvers and pepperboxes.” (ER-782 & n 12). Neither is apposite.

As to repeating rifles, this court already held in *OSSA* that such firearms are not valid historical analogues for conferring constitutional protection under Article I, section 27, because they were not commonly used for self-defense in the 1850s. 122 Or App at 549. The trial court attempted to distinguish that legal holding factually, stating that “[t]he record in this case leads the court to very different factual conclusions” based on “several other models of multi-shot firearms pre-statehood including, but not limited to, the Lorenzoni and Girandoni rifles[.]” (ER-782 n 12). Stare decisis, and the record, preclude that reasoning.

It was undisputed below that, as *OSSA* held, repeating rifles were not common, much less commonly used for self-defense, in the 1850s. According to plaintiffs’ own expert, there is evidence of only one Lorenzoni-style firearm ever making its way to the United States. (Tr-758, 1255). And the Girandoni was not a firearm at all: Like a pellet gun, it used compressed air to expel projectiles, which the user had to manually pump. Further, plaintiffs’ expert could identify only one Girandoni that appeared in the United States, famously brought by Merriwether Lewis on the Lewis and Clark Expedition as a show gun. (Tr-734–36, 1214). Air rifles in general were so rare and obscure at the time that museums charged admission to see one. (Tr-1256–57).

As this court already explained, and as the record here confirms, repeating rifles were not commonly used for self-defense in the 1850s because the technology did not exist to make them in sufficient quantity and quality. *OSSA*, 122 Or App at 549; (Tr-1167–68). For example, the Volcanic was underpowered and prone to gas leakage, and the company ultimately filed for bankruptcy. *OSSA*, 122 Or App at 549; (Tr-1225). The Belton, meanwhile, used “superposed loads,” where all rounds would fire after a single trigger pull; there is no evidence that one was ever sold to the public, and superposed loads never became commonly used, as they lacked any control or safety; a misfire could turn the firearm into a pipe bomb and kill the user. (Tr-731, 1252–54).

With respect to pistols, Colt revolvers and pepperbox pistols indeed were commonly used for self-defense in the 1850s. But large-capacity magazines are not their modern-day equivalent. As already discussed, their capacity was limited by their dimensionality. That is, to increase capacity beyond the 4-to-8 rounds that they typically held, additional chambers or barrels would need to be added; doing so, however, was impractical, given the size and weight of each. (Tr-775, 1158–59). Moreover, reloading to fire more than 10 rounds would have been time-consuming and laborious: Each round had to be loaded manually—primer, propellant, and projectile—and the barrel required frequent cleaning due to gunpowder fouling. (Tr-1160–64). Reloading a single firearm once would have taken at least a minute and a half. (Tr-1164).

By contrast, modern-day large-capacity magazines surpass those historical limitations with ruthless, lethal efficiency. For example, on October 1, 2017, a shooter opened fire on the Route 91 Harvest music festival in Las Vegas, Nevada. (ER-569–70).[2] Armed with assault rifles equipped with 100- and 25-round magazines, the shooter fired more than 1,000 rounds into the crowd in 11 minutes, including 289 rounds in one 60-second interval. (ER-596, 658–69). That is, in a fraction of the time that it would have taken to reload one 1850s repeater, the shooter used large-capacity magazines to fire 289 bullets into a music festival. The Las Vegas shooter ultimately killed 58, and more than 800 were injured. (ER-596–98, 658–65). The technologies are distinct.

Finally, the trial court cited for support to *Delgado*, 298 Or 395. (ER-781–82). *Delgado* held that an outright ban of switchblade knives violated Article I, section 27, because the only difference from its historical antecedent, the jackknife, was “the presence of [a] spring-operated mechanism that opens the knife.” 298 Or at 403. That is, the resulting weapon was the same; the only difference lay in how the knife was opened. But large-capacity magazines

[2] The trial court’s refusal to consider the police report on the shooting is addressed in the Sixth Assignment of Error. Regardless of the trial court’s error, this court may consider such public facts in the context of a facial challenge, particularly those facts referenced in the measure itself. *Payless Drug Stores Nw.*, 300 Or at 247; *Fed. Cartridge Corp.*, 202 Or at 565.

present wholly distinct weaponry from revolvers and pistols in the 1850s—in form, function, and lethality. *Delgado* is inapt.

2. Measure 114's restrictions on large-capacity magazines are reasonable.

Even if large-capacity magazines were protected "arms" under Article I, section 27, Measure 114's restrictions still would pass constitutional muster. The restrictions reasonably relate to significant threats to public safety, and they do so without unduly frustrating armed self-defense. In ruling otherwise, the trial court misconstrued the plain statutory text as effectively banning all magazines, and further misstated the pertinent legal standard.

a. The restrictions reasonably relate to public safety without unduly frustrating armed self-defense.

As noted, the constitution permits "reasonable regulations" of protected weapons. *Christian*, 354 Or at 33. To determine a law's reasonableness, a court weighs: (1) the harm to the public that the law seeks to address; (2) whether the law reasonably relates to that purpose; and (3) whether the law unduly infringes armed self-defense. *Christian*, 354 Or at 33–34; *Hirsch/Friend*, 338 Or at 678. Measure 114's restrictions on large-capacity magazines easily satisfy this test.

i. The restrictions seek to prevent gun violence.

Measure 114 seeks to prevent significant harms to public safety, specifically, "horrific deaths and devastating injuries due to mass shootings, homicides and suicides." M114, Preamble. As pertinent here, the people found that large-capacity magazines "pose a grave and immediate risk to the health, safety and well-being of the citizens of this State, particularly our youth." *Id.* Such magazines are frequently used in mass shooting; they "increase casualties by allowing a shooter to continue firing for longer periods of time before reloading"; and state restrictions on large-capacity magazines "have been found to reduce the number of fatalities and injuries in shooting incidents." *Id.*

Data supports the people's legislative findings. Between 2001 and 2021, Oregon firearm-related homicides more than tripled, from 47 in 2001, to 146 in 2021. (Tr-1527). And between 1982 and 2022, the country experienced 179 mass shootings in which four or more victims were killed, the number and frequency of which also have increased over time. (Tr-1681, 1702).

Large-capacity magazines pose a particular threat. NERA Economic Consulting, an economic research firm that analyzes data quantitatively, examined news accounts and crime statistics of mass shootings. (Tr-1601, 1679–80). In 115 of 179 public mass shootings, NERA was able to determine whether a large-capacity magazine was used; across that subset, the use of a large-capacity magazine resulted in an exponential increase in the number of shots fired and, unsurprisingly, a concomitant exponential increase in the number of fatalities and injuries:

	# mass shootings	Avg. shots fired	Avg. fatalities	Avg. injuries	Avg. total casualties
LCM	73	99	10	16	26
No LCM	42	16	6	3	9

(Tr-1696–702).

Mass shootings involving four or more casualties are even more common. In 2021 alone, the country experienced 689 such mass shootings with 3,453 total casualties; in 2022, 645 such mass shootings with 3,298 total casualties. (Tr-1703–06). Oregon has not been immune to this mass violence. Since 2014, Oregon has experienced 21 such mass shootings with 118 total casualties, including at Umpqua Community College in 2015, the deadliest mass shooting in state history. (Tr-1709–11).

Of course, numbers alone do not tell the complete story of gun violence. The state proffered additional evidence, through three witnesses, on the community-shattering impacts of gun violence: Dr. Melissa Brymer, Joshua Friedlein, and Paul Kemp. The trial court excluded their testimony, along with submitted offers of proof, as irrelevant—a ruling addressed in the Second Assignment of Error below. But because the trial court erred, and because the evidence is plainly relevant, the state briefly summarizes their testimony here.

Dr. Brymer is a clinical psychologist who is the Director of the Terrorism and Disaster Program at the UCLA-Duke University National Center for Child Traumatic Stress. (ER-495). She has counseled nearly a dozen communities shattered by mass gun violence, including Virginia Tech, Sandy Hook, Aurora, Las Vegas, Parkland, Uvalde, and Nashville. (ER-496). In her experience, survivors and their families must navigate a world where crowds, sounds, and everyday activities feel dangerous. (ER-497). The trauma also extends outward to the community at large: to police officers who respond to a shooting; to doctors who treat or lose a patient; to faith leaders who assist in the healing process; to friends and neighbors who lose a friend or neighbor; even to nearby communities, who often receive threats of copycat violence. (ER-497). The community mental-health consequences of mass shootings are diverse, profound, and life-altering. (ER-498).

Joshua Friedlein is a survivor of the mass shooting at Umpqua Community College in 2015. (ER-555). Mr. Friedlein lived the terror of being trapped in a classroom during the shooter's rampage, anticipating his own death, and fearing for the lives of friends and loved ones, some of whom were killed that day. (ER-555–56). For eight years following the shooting, he struggled with post-traumatic stress disorder, depression, anxiety, panic attacks, and episodes of suicidality. (ER-556). He continues to experience anxiety in public places and is retraumatized after each new mass shooting. (ER-556).

Paul Kemp is the brother-in-law of Steve Forsyth, who was killed in the Clackamas Town Center shooting in December 2012. (ER-559). Mr. Kemp responded to the mall that day, waiting with his sister and niece after news of the shooting broke and his brother-in-law could not be located. (ER-559). He and his family suffered intense trauma and grief in losing a loved one to a mass shooting. (ER-559–60). As they awaited word at the mall, they received counseling from the Trauma Intervention Program, a nonprofit that provides support to victims and their families in the hours following a tragedy; Mr. Kemp then volunteered with that program for four years, providing on-site support to seven grieving families, five due to firearm suicides. (ER-560).

That firearm-related casualties and traumas are real public-safety harms cannot reasonably be denied. Article I, section 27, allows the people of Oregon to adopt reasonable regulations to address them. *Christian*, 354 Or at 33.

ii. The restrictions reasonably relate to preventing gun violence.

Restricting the capacity of magazines reasonably relates to the public-safety threats that Measure 114 seeks to address. Statistics and studies confirm what common sense suggests: Large-capacity magazines are associated with an increase in mass shootings and firearm-related violence, while state restrictions on such magazines decrease the incidence and lethality of mass shootings.

As discussed above, a shooter's use of a large-capacity magazine typically results in more shots fired, more fatalities, more injuries, and more casualties. (Tr-1695–702). Epidemiological studies have uniformly found that large-capacity magazines are used in most mass shootings; that a shooter's use of a large-capacity magazine results in more than double the number of average fatalities compared to mass shootings where such a magazine is not used; and that state restrictions on large-capacity magazines reduce the average number of mass-shooting fatalities. (Tr-1482, 1487–89, 1501–06; *see* M114, Preamble (citing studies); ER-220, 307 (summarizing studies); 222–467 (studies)).[3] Those correlations alone are more than sufficient to reasonably relate the magazine restrictions to Measure 114's stated intent.

Indeed, logic alone reasonably relates the two. The defining feature of a large-capacity magazine allows a shooter to fire more than 10 rounds without having to pause to reload. Limiting magazine capacity means that a shooter will have to pause to reload sooner and more frequently, thereby giving bystanders greater opportunities to try to stop a shooter or flee. (Tr-1491–92, 1497). And this has, in fact, happened. In 2011, Representative Gabby Giffords and 18 others were shot, six of whom died, when a gunman opened fire in a supermarket parking lot; his rampage was stopped when he paused to reload. (Tr-1497). In 2019, a gunman opened fire on the Chabad of Poway synagogue, killing one and injuring two; again, the gunman was stopped when he paused to reload. (Tr-1497). Perhaps unsurprisingly, one of plaintiffs'

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[3] The trial court's refusal to consider these studies is addressed in the Third Assignment of Error. As discussed above, this court may consider such facts in a facial challenge.

experts conceded the obvious fact that limiting magazine capacity creates these reload windows. (Tr-556–57; *see* Tr-1778 (discussing reload steps)).

iii. The restrictions do not unduly frustrate armed self-defense.

Measure 114's restrictions on magazine capacity do not unduly frustrate armed self-defense. Undisputed evidence at trial established that ample firearm self-defense options are permissible under the statute. If Measure 114 burdens armed self-defense at all, the burden is minimal.

As an initial matter, some firearms, like a revolver or a pistol with a 10-round magazine, are compliant as sold. (Tr-540, 882–83, 1748–51). They are not affected at all by the magazine restrictions.

For firearms that currently have a magazine with a capacity of more than 10 rounds, capacity-compliant magazines are readily available. Plaintiffs' experts conceded that every major firearm manufacturer, and large after-market magazine manufacturers, make and sell magazines with a capacity of 10 or fewer rounds for both rifles and pistols, including the popular brands Glock, Remington, Smith & Wesson, Sig Sauer, Browning, and Magpul. (Tr-882–83, 1054, 1066, 1766–69, 1785–97). Plaintiffs Arnold and Asmussen testified that they both own capacity-compliant magazines. (Tr-574, 581). And Mr. Arnold's preferred self-defense weapon uses a 10-round magazine. (Tr-592).

Compliant magazines are not only readily available, but they also are readily usable. Plaintiffs' experts also conceded that the vast majority of firearms will readily accept and operate with capacity-compliant magazines. (Tr-857, 1094, 1763–69, 1807). Namely, the capacity of a magazine does not impact a firearm's operability: A firearm that takes a magazine generally functions the same regardless of magazine size; the capacity impacts only how often the user needs to pause to reload. (Tr-857, 1094, 1763–69, 1807).

In addition, the statute allows permanent modifications for a magazine to accept 10 or fewer rounds. M114 § 11(1)(d). In other jurisdictions that limit magazine capacity, such as Washington and Canada, manufacturers add metal rivets or take similar steps to render magazines capacity-compliant. (Tr-802).

Finally, more than 10 rounds of ammunition are generally not used or needed for armed self-defense. NERA Economic Consulting conducted two studies to analyze instances where a defender fired a firearm in self-defense against another person. The first analyzed the National Rifle Association's armed-citizen database, a self-reported database of defensive gun uses; the second analyzed news stories on defensive gun use using Factiva, an aggregator of more than 33,000 news sources. (Tr-1612–14, 1633–37). Each study examined January 2011 to May 2017. (Tr-1635). Consistent across both, at least 99% of defensive gun uses involved firing 10 or fewer rounds in self-defense, and the average number of rounds fired was just over 2:

	Total shots fired (% of incidents)				**Avg. shots fired**
	0	*1–5*	*6–10*	*>10*	
NRA	18%	80%	2%	0.3%	2.2
Factiva	12%	86%	3%	0%	2.3

(Tr-1622–23, 1660).

NERA also conducted a separate study of gun uses in Portland between 2019 and 2022. (Tr-1666). Out of 3,956 reported shootings, only one involved a defensive gun use, and the defender there fired 4 or 5 rounds. (Tr-1666–67).

Plaintiffs, meanwhile, offered no evidence at trial that *any* defensive gun use by a civilian against an attacker in Oregon has *ever* involved firing more than 10 rounds of ammunition. Instead, plaintiffs only presented testimony from a sheriff who, while hunting, "hazed" a pack of wolves by firing 30 rounds from a .22 caliber firearm. (Tr-994, 1810).

In short, capacity-compliant magazines are readily available and usable. And more than 10 rounds are virtually never, if ever, used in self-defense. The magazine restrictions therefore do not unduly frustrate armed self-defense.

b. The trial court's ruling to the contrary was error.

Measure 114's magazine restrictions are reasonable. The trial court's contrary conclusion is based on three errors of law. (ER-780–99). First, the court adopted an implausible interpretation of the statute to ban virtually all magazines. Second, the court conducted an overbreadth analysis, reviewing possible future applications of the law, which is not permissible under Article I, section 27. Third, the court applied the wrong legal standard.

i. The trial court misconstrued the text of the statute.

First, the trial court ruled that the statute "effectively bans all firearm magazines fixed or attached" and thus "effectively bans most of firearms currently within the possession of Oregon citizens." (ER-789). That interpretation violates the text of the statute and core canons of construction.

In interpreting a statute, the "paramount goal is to ascertain the intent of the legislature that enacted the disputed provision, and [courts] determine that intent by examining the text, in context, as well as legislative history[.]" *Marshall v. PricewaterhouseCoopers, LLP*, 371 Or 536, 540, 539 P3d 766 (2023) (cleaned up). Here, the text defines a large-capacity magazine as

> a fixed or detachable magazine, belt, drum, feed strip, helical feeding device, or similar device, including any such device joined or coupled with another in any manner, or a kit with such parts, that has an overall capacity of, or that can be readily restored, changed, or converted to accept, more than 10 rounds of ammunition and allows a shooter to keep firing without having to pause to reload.

M114 § 11(1)(d).

That is, the statute restricts both those magazines with a current capacity that exceeds 10 rounds of ammunition, and those "that can be readily restored, changed, or converted to accept" more than 10 rounds. *Id.* Specifically prohibited is "any such device coupled with another in any matter, or a kit with such parts." *Id.* For example, many manufacturers make magazine extensions that attach to the bottom of a magazine to increase firing capacity. (Tr-808, 1783). Such an extension attached to a magazine is clearly prohibited if the resulting capacity exceeds 10 rounds of ammunition.

Put another way, Measure 114 does not restrict magazines with a capacity of 10 or fewer rounds. As noted, every major firearm manufacturer, and many after-market magazine manufacturers, make and sell such capacity-compliant magazines. (Tr-882–83, 1054, 1066, 1766–69, 1785–97). Further, magazines with greater capacity can be permanently modified. (Tr-801–02).

To be sure, future cases may raise some questions about how the statute applies to interesting edge cases. For example, it may be necessary to decide when a particular modification is sufficiently "permanent" to render a large-capacity magazine capacity-compliant, as the statute allows. M114 § 11(1)(d)(A). But a facial challenge is not the proper venue for such line drawing. *Christian*, 354 Or at 39.

Nevertheless, the trial court concluded that, in prohibiting the purchase and restricting the use of *large-capacity* magazines, the voters intended to ban *all* magazines. To do so, the trial court interpreted the phrase "readily restored, changed, or converted" to mean that all magazines are effectively banned because, with enough time, effort, and ingenuity, a gunsmith can use tools or parts to increase *any* magazine's capacity to hold more than 10 rounds of ammunition, whether by adding an extension or removing parts from the magazine. (ER-785–88). In doing so, the trial court impermissibly read the term "readily" out of the statute. The Supreme Court already has interpreted the term "readily" in the firearm-modification context, and it requires a short temporal window. *State v. Briney*, 345 Or 505, 200 P3d 550 (2008).

In *Briney*, the question was whether defendant's pistol, which had a broken firing pin, constituted a firearm under a definition requiring that the pistol be "readily capable of use as a weapon." *Id.* at 507. An individual could obtain a new firing pin via overnight delivery and then install the new pin in a matter of minutes. *Id.* at 508. The court held that the pistol could not "readily" be used as a weapon, reasoning that "readily" required "that the firearm either be operational *or promptly able to be made so*." *Id.* at 516 (emphasis added).

Here, no evidence at trial suggested that every magazine can "promptly" be made into a device capable of holding more than 10 rounds of ammunition. The trial court reasoned that a user could remove interior parts from a capacity-compliant magazine to do so "in [a] manner of seconds." (ER-784). No one testified to that effect, and the record refutes it.

For example, one plaintiffs' expert testified about his attempts to modify two 10-round magazines, neither of which happened promptly. (Tr-1861–69). With one, he used a knife to remove four of six spring coils that push ammunition toward the chamber of a firearm; with the other, he removed the locking floorplate of the magazine, which secures the baseplate and holds the ammunition in the magazine. (Tr-1861–69). The former took 15-to-20 minutes, the latter five minutes. (Tr-1863, 1869). He managed to squeeze 11 rounds into each magazine but never fired either. (Tr-1865). Unsurprisingly, another plaintiffs' expert counsels against such home modifications, citing concerns over safety and functionality: "I just don't think it would be a safe thing to do if you want an operational firearm." (Tr-801, 830).

The trial court cited three video exhibits and one piece of testimony, each of which is inapt. (ER-784 n 16). In one exhibit, plaintiffs' expert showed a 10-round magazine that had attached a 3-round magazine extension, for a total capacity of 13 rounds. (Ex 19). The joined combination is indeed prohibited by Measure 114. But as in *Briney*, the fact that magazine extensions exist out in the world does not mean that a 10-round magazine, standing alone, can "readily" be converted to hold more than 10 rounds.

The second exhibit was an advertisement for a "block" that users insert to decrease a magazine's capacity. (Ex 20). The third exhibit showed plaintiffs' expert using a power drill to remove a dimple in a magazine that the manufacturer had inserted to limit capacity. (Ex 21). And in the last, the expert testified about possibly using boiling water to remove a magazine's baseplate to attach a magazine extension. (Tr-832). But although there may be questions about whether a particular modification is sufficiently permanent, that does not mean that *every* capacity-compliant magazine, standing alone, can be "readily" modified to hold more than 10 rounds.

The trial court also concluded that all 10-round magazines are barred under the statute because all firearms can hold one round in the chamber of the gun, resulting in an overall capacity of 11 rounds. (ER-788). That contravenes the text of Measure 114. The statute regulates the capacity of "ammunition feeding device[s]," that is, of magazines. The chamber is not an ammunition feeding device; it is part of a firearm, into which a magazine feeds ammunition. (Tr-1053–54, 1748, 1751). In other words, the chamber is not part of the magazine, nor of the *magazine's* capacity. (Tr-1054, 1751).

At bottom, the trial court adopted a strained interpretation of the statute that bans all firearm magazines. Armed with that interpretation, the court found the statute unconstitutional. But courts are required to "*avoid* interpreting a statute in a way that would render it unconstitutional if a different, but also plausible, interpretation would be constitutional." *City of Damascus v. State ex rel. Brown*, 367 Or 41, 67, 472 P3d 741 (2020) (emphasis added). The plain text of the statute permits capacity-compliant magazines of 10 or fewer rounds, easily avoiding the constitutional problems created by the trial court's unsupported reading.

Indeed, the trial court's implausible interpretation is belied by decades of experience with similar laws. The former federal assault-weapons ban also restricted large-capacity magazines, including devices "that can be *readily restored or converted to accept*, more than 10 rounds of ammunition." *Former* 18 U.S.C. § 921(31) (2003) (emphasis added). Yet Plaintiff Arnold testified that he lawfully purchased and possessed capacity-compliant magazines under that law, as did others. (Tr-592, 1756, 1779).

Similarly, Connecticut, Delaware, Illinois, Massachusetts, New York, Rhode Island, Vermont, and the District of Columbia each restricts large-capacity magazines, including capacity-compliant magazines that can be "readily" converted into a large-capacity magazine. Conn. Gen. Stat. § 53-202w(a)(1); Del. Code tit. 11 § 1468; 720 Ill. Comp. Stat. § 5/24-1.10(a)(1)(2); Mass. Gen. Laws ch. 140, § 121; N.Y. Penal Law § 265.00(23); R.I. Gen. Laws § 11-47.1-2; Vt. Stat. Ann. tit. 13, § 4021; D.C. Code Ann. § 7-2506.01. But James Yurgealitis, a former firearms expert for the federal Bureau of Alcohol, Tobacco, Firearms, and Explosives purchased a variety of 10-round magazines in three of those states in the weeks leading up to trial, including magazines that accept extensions. (Tr-1785–96).

In short, the trial court's interpretation of the statute contravenes the statute's plain text. The trial court's determination that all magazines would be banned under Measure 114 has no legal or practical basis.

ii. The trial court conducted an impermissible overbreadth analysis.

Second, the trial court turned the inquiry for assessing facial constitutionality on its head. In a facial challenge, the pertinent legal question is "whether the ordinance is capable of constitutional application in *any* circumstance." *Christian*, 354 Or at 40 (emphasis added). That is, a statute is facially constitutional unless a challenger shows that there are "no reasonably likely circumstances in which application of the statute would pass constitutional muster." *Id.* (citation omitted).

Nowhere in the trial court's opinion did the court ask, much less answer, that question. Instead, the court speculated on various ways in which the statute might be applied impermissibly in the future. (ER-783–92). That is an overbreadth analysis. As the Supreme Court has explained, an overbreadth challenge asks whether a "statute swept so broadly as to infringe rights that it could not reach." *Christian*, 354 Or at 35 (quoting *State v. Blocker*, 291 Or 255, 261–62, 307 P3d 429 (1981)). The Supreme Court also has squarely held that "overbreadth challenges are not cognizable in Article I, section 27, challenges." *Id.* at 40. Neither a challenger nor a court can "raise hypothetical questions about the application of [the] law[] untethered by facts on the ground," seeking "to determine the rights of parties who are not before the court." *Id.* at 39. The trial court erred by doing exactly that.

iii. The trial court re-weighed the policy merits.

Third, the trial court did not apply the correct legal standard. The question of law is whether the people's policy decision to enact Measure 114 was reasonable. *Id.* at 33–34; *Hirsch/Friend*, 338 Or at 678. The trial court conducted no such analysis.

Instead, the court assessed the policy merits of the measure for itself. On harm, the court opined that "mass shootings rank very low in frequency" and "are highly sensationalized by the media"; that "[t]he historic number of causalities [sic] from mass shootings is staggeringly low in comparison [to] the media's sensationalized coverage of the events"; and that the "number of people killed and injured is statistically insignificant compared to the number of lawful gun owners." (ER-793–97). The court further opined that "the restriction on large capacity magazines would [not] affect the mass shooting event outcomes with any scientific certainty," as there was not "evidence demonstrating a positive public safety result for the large capacity ban beyond a speculative, de minimis impact on mass shooting fatalities which occur very rarely." (ER-794, 799). The court also stated that "[t]he limited number of mass shootings in the country weighed against the massive criminalization of lawful firearm possession in Oregon does not allow for" the burden imposed by the law, which the court had misconstrued as an absolute ban of firearms. (ER-798).

It is frankly shocking to suggest that Oregonians' desire to decrease the frequency and harms of mass shootings is unreasonable. And that rationale lacks support in the record. There was no evidence at trial about whether the media sensationalizes mass-shooting events, nor on how many Oregonians might be affected by the magazine restrictions. Indeed, both named plaintiffs testified that they own capacity-compliant magazines. (Tr-574, 581).

More fundamentally, the trial court misunderstood the pertinent legal inquiry. There is no minimum number of mass shootings that Oregon communities must suffer before voters can legislate to mitigate or prevent them. And the legislative power is not limited to policies that a court believes are certain to be effective. To pass constitutional muster, a legislative policy decision need only reasonably relate to the harm that the legislative body seeks to address, without unduly frustrating armed self-defense. *Christian*, 354 Or at 33–34; *Hirsch/Friend*, 338 Or at 678. The restrictions easily clear that bar.

B. Measure 114's permit-to-purchase provisions are facially constitutional.

Plaintiffs next challenge the facial constitutionality of Measure 114's permit-to-purchase requirements. Their challenge is foreclosed by *Christian*, 354 Or 22. In any event, the provisions are reasonable. In ruling otherwise, the trial court misstated the record and again applied the wrong legal standard.

1. Plaintiffs' permit challenge is foreclosed by *Christian*.

Plaintiffs' challenge to the permit requirements is foreclosed by the Supreme Court's decision in *Christian*, 354 Or 22. There, the court held that requiring a license to carry a loaded firearm in public was facially constitutional because the restriction was not a total ban on carrying a firearm for self-defense; instead, anyone who acquired a license to carry a concealed handgun was free to do so. *Id.* at 41. That holding applies equally here.

The *Christian* court reiterated that a "facial challenge is limited to whether the ordinance is capable of constitutional application in any circumstance." *Id.* at 40. Under Oregon law, a sheriff "shall issue" a concealed-handgun license to any applicant who passes a background check, lacks a disqualifying mental condition, and demonstrates competence with firearm safety. ORS 166.291. Thus, any Oregonian can lawfully carry a loaded firearm for self-defense simply by obtaining a license. *Christian*, 354 Or at 41.

So too here. Sheriffs and chiefs of police "shall issue" a permit-to-purchase to any applicant who passes a background check, lacks a disqualifying mental condition, and demonstrates competence with firearm safety. M114 §§ 3(3), 4(1), 4(3). As such, to purchase a legal firearm for self-defense, any Oregonian need only satisfy those constitutionally permissible requirements and obtain a permit; any permit holder then can purchase a firearm unimpeded by Measure 114. Plaintiffs' challenge hence fails under *Christian*, 354 Or at 41.

2. Measure 114's permit requirements are reasonable.

Even if *Christian* did not directly control, the permit requirements are facially constitutional because they reasonably seek to address significant threats to public safety without unduly frustrating armed self-defense. Implicit in *Christian* is the recognition that requiring a background check, screening psychological state, and acquiring competence with a firearm all reasonably relate to firearm safety: Doing so prevents dangerous individuals from acquiring a firearm and ensures that firearm users can handle the lethal weapon safely. Moreover, any burden caused by the law is not undue, as any Oregonian with a permit may purchase a firearm.

As with the magazine restrictions, epidemiological studies further underscore the law's reasonableness. Nine peer-reviewed, published epidemiological studies have analyzed the impact of state-level gun-permit requirements on firearm homicide rates; eight of the studies found a statistically significant decrease in firearm-related homicides in states that instituted permit requirements; the ninth study had analyzed only one year of data from 1970, making it significantly less robust than the others.[4] (ER-43, 46–125). Further, two peer-reviewed, published epidemiological studies have analyzed the impact

[4] The trial court's refusal to consider these studies is addressed in the Fourth Assignment of Error. As discussed, this court may consider such facts in a facial challenge.

of state permit requirements on mass-shooting events; both found a statistically significant decrease—between 40% and 56%—in the number of mass shootings in states that instituted such requirements. (ER-44, 47, 126–81).

In short, epidemiological studies confirm what logic suggests: Requiring permits promotes public safety and helps to reduce firearm-related homicides and mass shootings. The law's permit requirements are reasonable.

3. The trial court's ruling to the contrary was error.

The trial court concluded otherwise, making two factual determinations that the record contradicts, and applying "intermediate scrutiny," which has no basis in Oregon law. (ER-768–80). The court erred.

a. The trial court misstated the record and misread the text of the statute.

First, the trial court found determinative that the statute "delays the purchase of firearms for a minimum of 30 days" and that, in the future, the FBI could "refuse[] to conduct criminal background checks." (ER-768–69). Neither reasoning has any basis in the record or statutory text.

The notion that Measure 114 establishes a "30-day absolute prohibition on the initial purchase of a firearm" is flatly wrong. The statute provides that any applicant who has not received a permit within 30 days can sue in circuit court to compel its issuance: The trial court reviews the matter de novo and must issue a decision "within 15 judicial days of filing or as soon as practicable thereafter"; the resulting decision is then appealable to this court. M114

§§ 5(1), (5), (8), (10), (11). But the availability of that remedy does not imply, much less require, a 30-day delay in processing an application. A permit agent is free to grant a permit as soon as the statutory requirements have been met.

The trial court incorrectly stated that a 30-day minimum delay was "agreed upon by the parties at trial." (ER-768). The record belies that assertion. During opening statements, the court engaged in an extended colloquy with the state's counsel on the permit process, including the judicial-review provisions:

> COURT: So it's 30 days -- you agree that it has to be issued within 30 days.
>
> COUNSEL: Correct.
>
> COURT: Or you can seek relief.
>
> COUNSEL: Correct, Your Honor. And I will say the statute directs the issuance of a permit if the * * * requirements are met during that 30 days.
>
> COURT: Okay. Thank you.
>
> COUNSEL: And -- and another one is that *that's a maximum*, not that the statute requires or even contemplates that a permit agent would unduly sit on an application if it's -- if they've met all the requirements *in a few hours or a few days*.

(Tr-517 (emphases added)). During trial, the court then recounted defendants' position that delay "could not be more than 30 days." (Tr-1101). At no point did the state "agree" that Measure 114 creates a minimum 30-day prohibition against purchasing firearms. More importantly, the statute does no such thing.

The trial court's characterization of a permit requirement as a temporary-yet-absolute prohibition cannot be reconciled with *Christian*. There, too, a person who did not have a license could not engage in the regulated conduct, but the law was facially constitutional because one need only obtain a license to engage in it. *Christian*, 354 at 41. Indeed, any license or permit system necessarily requires time to process applications. No precedent supports treating such a system as an absolute prohibition.

As to the FBI, the trial court stated that an FBI background check "is required by the" statute and that, although the FBI currently states that it will process background-check requests, the FBI could change its mind "[a]t any moment." (ER-777 n 10, 778). Neither rationale has merit.

First, the statute does not require that the FBI conduct a background check. Rather, the statute directs OSP to *request* a check *from* the FBI:

> The applicant must submit to fingerprinting and photographing by the permit agent. The permit agent shall fingerprint and photograph the applicant and shall conduct any investigation necessary to determine whether the applicant meets the qualifications described in paragraph (b) of this section. The permit agent shall request the department [of state police] to conduct a criminal background check, including but not limited to a fingerprint identification, through the Federal Bureau of Investigation. The Federal Bureau of Investigation shall return the fingerprint cards used to conduct the criminal background check and may not keep any record of the fingerprints.

M114 § 4(1)(e). OSP then must report the results of its background checks, including any information received from the FBI, to the permit agent:

> Upon completion of the criminal background check and determination of whether the permit applicant is qualified or disqualified from purchasing or otherwise acquiring a firearm the department shall report the results, including the outcome of the fingerprint-based criminal background check, to the permit agent.

Id.

This structure—requiring OSP to request a background check from the FBI—is consistent with basic federalism. Under the Supremacy Clause, the state cannot "directly regulate the Federal Government's operations or property." *Blackburn v. United States*, 100 F3d 1426, 1435 (9th Cir. 1996). If the statute did impermissibly direct the FBI, the proper judicial recourse would be to sever that ineffective provision, rather than to invalidate the entire statute. M114 § 12 (severability clause); ORS 174.040 (severability). But the statute does no such thing. Instead, it requires OSP to report the results of its background checks to the permit agent, including whatever information the FBI provides. If those checks reveal no disqualifiers, then OSP would so report, and the permit agent "shall issue" the permit. M114 § 4(3)(a).

Second, the trial court's unsupported speculation about what the FBI may or may not do in the future is improper. Even if the FBI decided not to process fingerprint-based background checks, that would not preclude issuance of any permit, as just discussed. More fundamentally, hypothetical speculation about the future has no place in a facial challenge.

b. The trial court applied "intermediate scrutiny," which has no basis in Oregon law.

The trial court also invoked "intermediate scrutiny" to conclude that Measure 114 is facially unconstitutional. (ER-772). The court reasoned that the state must show "an important government objective and competent evidence" before regulating one's right to bear arms, including by "proving a citizen is too dangerous to own a firearm." (ER-776). The court further indicated that the state was required to prove that a permit process would definitively reduce firearm-related violence. (ER-779). That standard has no basis in Oregon law.

Under Article I, section 27, a legislative policy decision need only be reasonable. *Christian*, 354 Or at 33–34; *Hirsch/Friend*, 338 Or at 678. In reasoning otherwise, the trial court cited two Oregon cases. (ER-773, 776 n 9). Both, however, involved claims under the *federal* constitution. *Christian*, 354 Or at 41–46 (Second Amendment); *Matter of Comp. of Williams*, 294 Or 33, 40, 653 P2d 970 (1982) (Equal Protection Clause). It is long established "that the Oregon Constitution has a content independent of that of the federal constitution." *State v. Soriano*, 68 Or App 642, 645, 684 P2d 1220 (1984), *aff'd*, 298 Or 392 (1984). This includes Article I, section 27. *Christian*, 354 Or at 33–34; *Hirsch/Friend*, 338 Or at 671, 678; *Kessler*, 289 Or at 61–62.

Particularly puzzling is that the trial court improperly excluded, as irrelevant, the very evidence that the court found lacking. (Tr-477–79, 1456, 1465). As discussed above and in the fourth assigned error below, studies show that permit requirements decrease firearm-related homicides and mass shootings. (ER-46–47 (summarizing studies)). The Oregon Constitution does not require such statistical proof to justify an exercise of legislative authority to promote public safety. But they further underscore the law's reasonableness.

C. Measure 114's closure of the Charleston Loophole is facially constitutional.

Finally, plaintiffs challenge Measure 114's closure of the Charleston Loophole, which requires the completion, not just initiation, of a point-of-sale background check to transfer a firearm. That challenge is foreclosed by *Hirsch/Friend*, 338 Or 622. Also, the law is reasonable. Rather than assess constitutionality, the trial court examined severability, and incorrectly so.

1. Plaintiffs' Charleston challenge is foreclosed by *Hirsch/Friend*.

Plaintiffs' challenge to the closure of the Charleston Loophole is foreclosed by *Hirsch/Friend*, 338 Or 622, and *Christian*, 354 Or 22. Under that case law, the legislature permissibly may exclude those with a criminal background from bearing arms. And any Oregonian whose background check has cleared experiences no infringement on their right to armed self-defense.

In *Hirsch/Friend*, the court upheld the facial constitutionality of a state prohibition on felons possessing a firearm. 338 Or at 677. In doing so, the court undertook an extensive analysis of the history leading up to the adoption of Article I, section 27, examining the Oregon constitutional convention, Oregon territorial laws, English history, American colonial history, and the adoption of the Second Amendment. *Id.* at 643–673; *see State v. Parras*, 326 Or App 246, 255, 531 P3d 711, *rev den*, 371 Or 511 (2023) (discussing the "extensive historical excavation" conducted in *Hirsch/Friend*). The court concluded that "the drafters of the Oregon Constitution * * * did not intend to deprive the legislature of the authority to restrict arms * * * to protect the public safety." *Hirsch/Friend*, 338 Or at 677. As pertinent there, the legislature reasonably could choose to promote public safety by disarming those "posing identifiable threats to the safety of the community by virtue of earlier commission of serious criminal conduct." *Id.*

Here, requiring a completed background check at the point of sale or transfer is a logical and permissible means to that constitutional end. If the legislature permissibly can disarm convicted felons, then it necessarily follows that the legislature can institute a process with which to identify those felons before they acquire a firearm. And anyone whose background check has cleared is then free to proceed with a transfer, unimpeded by Measure 114, just like a license holder in *Christian*, 354 Or at 41.

2. Measure 114's Charleston closure is reasonable.

Even if *Hirsch/Friend* were not dispositive, closing the Charleston Loophole is reasonable and therefore constitutional. The legislature permissibly can disarm convicted felons to promote public safety. *Hirsch/Friend*, 338 Or at 677. A completed background check ensures that an individual does not, in fact, have a disqualifying conviction. Further, a point-of-sale background check ensures that an individual has not acquired one since any previous checks, permit-related or otherwise.

Statistics demonstrate the public-safety value of closing the loophole.[5] In 2020 alone, at least 2,989 individuals with a disqualifying conviction nevertheless were able to purchase a firearm because their background check did not complete within the loophole's timeframe. (Tr-1597). Closing the loophole to prevent those transfers reasonably promotes public safety by preventing those "posing identifiable threats to the safety of the community by virtue of earlier commission of serious criminal conduct" from acquiring a firearm despite their disqualifying convictions. *Hirsch/Friend*, 338 Or at 677.

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[5] The trial court's refusal to consider these statistics is addressed in the Fifth Assignment of Error. As discussed, this court may consider such facts in a facial challenge.

3. The trial court enjoined the Charleston closure by examining only the law's severability, rather than its constitutionality.

Eliding the above analysis, the trial court simply refused to consider the facial constitutionality of closing the Charleston Loophole. At trial, the court stated that "[i]t's all related to the permit to purchase program, and I'm not going to deviate or separate out that." (Tr-1102). In its letter opinion, the court then did not discuss the loophole closure at all. Instead, the court stated that Sections 1 through 10 of the statute, which include the closure provisions, are "so essentially and inseparably connected with and dependent upon the unconstitutional permit-to-purchase scheme, the court finds it apparent the remaining parts would not have been enacted without the unconstitutional part." (ER-768). This was error.

Under Oregon law, severability is the rule, not the exception. Specifically, "it is the legislative intent, in the enactment of any statute, that if any part of the statute is held unconstitutional, the remaining parts shall remain in force." ORS 174.040. Measure 114 includes a severability clause that emphasizes that each part should "be given effect" even absent any "invalid provision or application." M114 § 12.

The legislature generally provides three exceptions to this rule, only one of which the trial court invoked: when "[t]he remaining parts are so essentially and inseparably connected with and dependent upon the unconstitutional part that it is apparent that the remaining parts would not have been enacted without the unconstitutional part." ORS 174.040(2). That exception is inapt.

Briefly, if the permit requirements were actually unconstitutional, the trial court could have tailored injunctive relief to enjoin permit-to-purchase without also enjoining the loophole closure. The law requires that a point-of-sale background check complete before a firearm transfer can proceed. M114 §§ 6(3)(c), 6(14), 7(3)(d)(B), 8(3)(c). An injunction against requiring permits, while still requiring a completed background check, would effectuate the unambiguous legislative preference for as many parts of the law going into effect as possible. M114 § 12; ORS 174.040. The two policies are distinct, and an injunction easily could treat them separably.

SECOND ASSIGNMENT OF ERROR

The trial court erred in ruling that community harms from firearm violence are irrelevant to the constitutionality of Measure 114.

A. Preservation of error

The state preserved this assigned error. Before trial, plaintiffs moved in limine to exclude "the impacts of tragedies on surviving family members" of firearm violence, arguing that "the death of a loved one is not relevant to determining whether or not this law is or is not constitutional." (Tr-464; Pls' Mot in Lim 4–6 (Aug 31, 2023)). The state disagreed, arguing that victim-impact testimony was relevant to the scope of harms that Measure 114 was enacted to prevent. (Tr-465–67; Defs' Resp to Pls' Mot in Limine 2–4 (Sept 6, 2023)). The trial court granted plaintiffs' motion, ruling that such evidence was "not relevant to the court's facial inquiry." (Tr-477).

At trial, the state moved for reconsideration, reiterating that the law's preamble references mass-shooting harms. (Memo in Supp of Mot to Admit Evid 1–5 (Sept 20, 2023)). The state also filed written offers of proof on three witnesses excluded by the ruling: Dr. Brymer, Mr. Friedlein, and Mr. Kemp. (ER-495–560; Tr-1823–26, 1874). The trial court adhered to its relevance ruling and disallowed the offers of proof. (ER-751).

Typically, "when a trial court excludes testimony, a party must make an offer of proof if the party later wants to assign error to that ruling." *State v. Babson*, 355 Or 383, 412, 326 P3d 559 (2014). However, an offer of proof is not required when the trial court does not allow one to be made. *Matter of E.J.*, 304 Or App 148, 159, 466 P3d 702 (2020) (citing *State v. Affeld*, 307 Or 125, 129, 764 P2d 220 (1988)). Further, "a challenge to exclusion of evidence may be preserved, notwithstanding the absence of an offer of proof, if the questions asked and the arguments presented to the court on the issue were adequate to inform the trial court of the substance of the evidence and its error in excluding it." *Id.* (quoting *State v. Lasky*, 259 Or App. 307, 315, 314 P3d 304 (2013)). For example, if a "court excludes an entire class of evidence by declaring, in advance, that it is inadmissible as a matter of law, the ruling renders a further offer futile." *State v. Olmstead*, 310 Or 455, 461, 800 P2d 277 (1990).

Here, the trial court excluded victim-impact harms as a matter of law, rendering an offer of proof futile. Nevertheless, the state moved for reconsideration to allow the court a chance to correct its pretrial ruling, filing offers of proof while that motion remained pending to further inform the court, which the trial court disallowed. The parties also fully briefed and argued the merits of the legal issue.[6]

B. Standard of review

This court reviews for legal error "a trial court's decision to exclude evidence as irrelevant." *Thomas v. Dillon Family Ltd. P'ship II*, 319 Or App 429, 432, 511 P3d 43, *rev den*, 370 Or 214 (2022). As a rule, a "trial court has no discretion to label as irrelevant evidence that meets the standard of relevance of OEC 401." *State v. Cunningham*, 337 Or 528, 536, 99 P3d 271 (2004), *cert den*, 544 US 931 (2005).

ARGUMENT

To underscore the magnitude of harm to public safety that Measure 114 was enacted to prevent, the state proffered Dr. Brymer, Mr. Friedlein, and Mr.

[6] The trial court's ruling disallowing the offers of proof is puzzling, but the state does not assign error to that ruling because *E.J.* makes clear that this assigned error is preserved regardless. The filed offers of proof also provide a written record with which this court can assess the proffer's relevancy.

Kemp to relate the full scope of community harms caused by firearm violence. As stated in its preamble, the law seeks to prevent "horrific deaths and devastating injuries due to mass shootings, homicides and suicides."

The bar for relevance in Oregon is low. Under OEC 401, evidence is relevant if it has "any tendency" to make a pertinent fact "more probable or less probable." That legal standard is a "very low threshold," where "evidence is relevant so long as it increases or decreases, even slightly, the probability of the existence of a fact that is of consequence to the determination of the action." *Davis*, 336 Or at 25.

Here, Dr. Brymer would tell of the widespread trauma of mass shootings, which ripple across communities; Mr. Friedlein would recount the specific terror of the Umpqua mass shooting, which continues to haunt its survivors; and Mr. Kemp would share the anguish of the Clackamas Town Center shooting, which led to his helping other families grieving from firearm-related violence. (ER-495–560). Stories about survivors of firearm violence bear on the law's reasonableness and concomitant constitutionality, informing the relationship between the law's intent and its infringement, if any, on armed self-defense.

Indeed, on the relevance of the proffered testimony, the state points to the trial court's own opinion. In striking down the magazine restrictions, the court reasoned, in part, that the asserted harms from mass shootings identified in the law's preamble are "not validated by the evidence"; that the "number of casualties from mass shooting events is staggeringly low in comparison [to] the media's sensationalized coverage of the events"; and that the "number of people killed and injured [in mass shootings] is statistically insignificant." (ER-793, 796–97). Dr. Brymer, Mr. Friedlein, and Mr. Kemp each would have spoken to those mass-shooting harms. It is relevant that behind every casualty statistic is a person, a family, and a community whose lives are upended if not shattered.

The trial court's dismissal of survivors' stories as *irrelevant* was incorrect. The written offers of proof are properly before this court as evidence of Measure 114's reasonableness.

THIRD ASSIGNMENT OF ERROR

The trial court erred in ruling that peer-reviewed, published epidemiological studies analyzing the public-safety effects of state restrictions on large-capacity magazines, and concomitant testimony about those studies, lack a scientific foundation under OEC 702.

A. Preservation of error

The state preserved this assigned error. At trial, the state called Dr. Michael Siegel as a witness, and the trial court qualified Dr. Siegel as an expert in epidemiology with a focus on firearms violence and safety. (Tr-1477–80). Nevertheless, when Dr. Siegel attempted to testify about one of his peer-reviewed, published studies on firearm violence, as well as his review of eight additional peer-reviewed, published studies on firearm violence, the trial court ruled that an insufficient foundation had been laid for the studies and testimony under OEC 702. (Tr-1592–94). The trial court then refused to allow the state to make an offer of proof, stating: "you're not getting an offer of proof to tell me that I'm all wet on the policy determinations." (Tr-1594–98). The state filed a written offer of proof, which the trial court disallowed. (ER-750).

B. Standard of review

This court reviews for legal error a trial court's ruling on the admissibility of scientific evidence under OEC 702. *Jennings*, 331 Or at 299.

ARGUMENT

To buttress the reasonable relationship between Measure 114's magazine restrictions and the public-safety harms that those restrictions seek to address, the state proffered epidemiological evidence and testimony through Dr. Siegel. Dr. Siegel is an epidemiologist and professor in the Department of Public Health and Community Medicine at Tufts University who trained as an epidemiologist at the CDC and has published 18 peer-reviewed articles on firearm violence. (Tr-1477–79).

Dr. Siegel was prepared to discuss his peer-reviewed, published epidemiological study that found a statistically significant decrease in mass shootings in states that instituted restrictions on large-capacity magazines. (ER-293–306). Dr. Siegel also was prepared to opine that evidence supports a causal relationship between large-capacity magazines and mass shootings: The use of such magazines increases injuries and fatalities in a mass shooting, and state magazine restrictions decrease the incidence and lethality of mass shootings. (ER-44).

In *Jennings*, the court rejected a proposed rule of law that expert opinion on causation could be admitted *only* if based on "statistically significant, peer-reviewed, published epidemiological studies." 331 Or at 310. Instead, the court reasoned that courts should assess the scientific validity of any type of scientific testimony based on several non-exclusive factors, which courts should view as guideposts rather than as a defined checklist. *Id.* at 302 & n 8 (quoting *State v. Brown*, 297 Or 404, 417, 687 P2d 751 (1984)).

In doing so, *Jennings* reiterated the generally accepted trustworthiness of peer-reviewed, published epidemiological studies. In sum, "[e]pidemiology is at the top" of scientific methodologies "in attempting to ascertain whether a causal connection exists"; "causality is usually addressed from epidemiologic studies"; and "[p]ublication or lack thereof in a peer-reviewed journal is a relevant, though not dispositive, consideration in assessing the scientific validity of a particular technique or methodology on which an opinion is based." *Id.* at 306–09 (citations omitted). As the Supreme Court previously had explained, "submission to the scrutiny of the scientific community is a component of 'good science,' in part because it increases the likelihood that substantive flaws in methodology will be detected." *State v. O'Key*, 321 Or

285, 304, 899 P2d 663 (1995) (quoting *Daubert v. Merrell Dow Pharm., Inc.*, 509 US 579, 593, 113 S Ct 2786, 125 L Ed 2d 469 (1993)).

Jennings also instructed that a finding of causation generally does not derive from one individual study. Rather, "[a] conclusion about causation ultimately is a qualitative decision," where "'the drawing of causal inferences is informed by scientific expertise,'" but generally "'it is not a determination that is made by using scientific methodology.'" 331 Or at 309 (quoting Michael D. Green et al., *Reference Guide on Epidemiology* 375, in Federal Judicial Center, *Reference Manual on Scientific Evidence* (2d ed. 2000)). Instead, the court highlighted that a causal analysis that seeks to "eliminate[] other potential causes * * * is a generally accepted form of scientific inquiry." *Id.* at 308.

Here, the state laid a proper foundation. As to the first piece, Dr. Siegel's study, it bears repeating that the study's finding—a decrease in the incidence of mass shootings in states that instituted restrictions on large-capacity magazines—was itself the result of a "statistically significant, peer-reviewed, published epidemiological stud[y]." *Jennings*, 331 Or at 310. In testimony, Dr. Siegel then testified in detail about his study's methodology.

Specifically, Dr. Siegel explained that he used data from all 50 states provided by the National Institute of Justice, the most comprehensive database of mass shootings ever compiled; he examined the impact of eight different gun laws using a difference-in-differences regression analysis, the most rigorous and common analysis in epidemiology for isolating the impact of individual policies; he controlled for a host of variables, including state population, population density, poverty rate, unemployment rate, divorce rate, incarceration rate, alcohol consumption, and gun ownership; he compared the mass-shooting rates in states before and after they enacted magazine restrictions to states that had other firearm restrictions or no restrictions at all, the most common method in epidemiology for measuring the impact of individual policies; and he reported a 95% confidence interval, a standard error rate in epidemiology. (Tr-1510–16, 1541–50, 1571–74, 1584–93).

As to the second piece, the causal relationship between large-capacity magazines and mass-shooting harms, Dr. Siegel similarly explained his methodology. He explained that, to identify a causal inference, epidemiologists typically examine multiple sources of information, including the consistency of findings in a line of evidence (e.g., multiple studies on one issue), consistency of findings across lines of evidence on the issue (e.g., multiple studies on a related issue), and plausibility of a given causal relationship. (Tr-1490–91).

Further, Dr. Siegel was prepared to explain that all three epidemiological methods supported a causal inference here. Four peer-reviewed, published studies found that the use of a large-capacity magazine in a mass shooting results in more than double the number of fatalities than when a large-capacity magazine is not used; five peer-reviewed, published studies (including his own) found that state magazine restrictions resulted in a statistically significant reduction in the number of mass shootings; and the causal relationship was plausible, given the need for a mass shooter to pause to reload more often when using a capacity-compliant magazine. (ER-44; Tr-1482, 1487–91, 1496–98, 1501–07; *see* ER-220-467 (all nine studies)).

The trial court excluded the above studies and testimony, and disallowed the offers of proof, solely for lack of scientific foundation under OEC 702; in doing so, the trial court did not identify what aspect of the above foundation the court found lacking. (ER-750; Tr-1592–94). In its posttrial letter opinion, the court stated only that Dr. Siegel made "no attempt to extract a single policy option from the eight [gun laws] to identify its effect on mass shootings." (ER-795). But that is precisely what Dr. Siegel testified that his difference-in-differences regression analysis did. (Tr-1510–16, 1550).

In that opinion, the trial court also found Dr. Siegel not credible because, in the court's view, Dr. Siegel was "hyper-charging the impact of firearms in Oregon" by reporting the three-fold increase in firearm-related homicides between 2001 and 2021 as a "technically true" percentage, rather than as a raw number. (ER-796). In other words, the court found him not credible because he accurately reported a 310% rise in firearm-related homicides in Oregon. The purpose behind this credibility finding is unclear. But the trial court's apparent preference for addition over multiplication is not an appropriate basis for an adverse credibility finding, much less for excluding evidence under OEC 702.

Again, Dr. Siegel is a CDC-trained epidemiologist who has published 18 peer-reviewed, epidemiological studies on firearm violence; he reached his opinion after reviewing nine peer-reviewed, published epidemiological studies on large-capacity magazines and firearm-related violence; and he reached his causal inference using a technique generally accepted in the field of epidemiology. The foundation for his proposed testimony was painstaking, and the proffered evidence easily satisfies OEC 702. *Jennings*, 331 Or at 306–09.

FOURTH ASSIGNMENT OF ERROR

The trial court erred in ruling that peer-reviewed, published epidemiological studies analyzing the public-safety effects of state permit requirements are irrelevant to the constitutionality of Measure 114.

A. Preservation of error

The state preserved this assigned error. Before trial, plaintiffs moved in limine to exclude evidence about other states' permit programs. (Tr-452; Pls' Mot in Lim 8–10 (Aug 31, 2023)). The state argued that such evidence was relevant to the reasonableness of Measure 114's permit requirements. (Tr-456). The trial court granted plaintiffs' motion, ruling that the efficacy of permit programs was "outside the scope of the court's inquiry." (Tr-479).

At trial, the state moved for reconsideration, reiterating "that the historical effectiveness of permit-to-purchase programs informs, and therefore relates to, the reasonableness of the voters' decision to implement such a program in Oregon." (Memo in Supp of Mot to Admit Evid 5 (Sept 20, 2023)). The trial court adhered to its prior relevance ruling, stating that "it makes no sense to me how I weigh that." (Tr-1456, 1465). The state filed an offer of proof, which the trial court disallowed. (ER-43–181, 750).

B. Standard of review

This court reviews for legal error "a trial court's decision to exclude evidence as irrelevant." *Thomas*, 319 Or App at 432.

ARGUMENT

To buttress the reasonableness of the relationship between Measure 114's permit-to-purchase requirements and the public-safety harms that they seek to address, the state proffered evidence and testimony through Dr. Siegel. He was prepared to discuss nine peer-reviewed, published epidemiological studies that analyzed the impact of state-level gun-permit requirements on firearm homicide rates; eight of the studies found a statistically significant decrease in firearm-related homicides in states that instituted permit requirements, and the ninth study had analyzed only one year of data from 1970, making it significantly less robust than the other eight. (ER-43). Dr. Siegel also was prepared to discuss two peer-reviewed, published epidemiological studies that analyzed the impact of state permit requirements on mass-shooting events; both found a statistically significant decrease—between 40% and 56%—in the number of mass-shooting events in states that required permits. (ER-44).

That evidence bears on, and is therefore relevant to, the reasonableness of the policy decision here. As discussed above, the trial court excluded this evidence on relevance grounds and then, incongruously, decried a lack of evidence about mass-shooting harms. (ER-793, 796–97). But studies show that state permit requirements decrease rates of firearm violence from both homicides and mass shootings. (ER-47, 126–81). The proffered evidence thus underscores the reasonable relation between permit-to-purchase and the harms that Measure 114 was enacted to prevent.

FIFTH ASSIGNMENT OF ERROR

The trial court erred in ruling that statistical data on firearm sales under the Charleston Loophole are irrelevant to the constitutionality of Measure 114.

A. Preservation of error

The state preserved this assigned error. At trial, the trial court declared sua sponte that it would not consider the constitutionality of the loophole closure, reasoning that the issue was subsumed by the law's permit-to-purchase provisions. (Tr-1102). As noted, the trial court had excluded, on relevance grounds, out-of-state data on that issue. The state moved for reconsideration, and the trial court adhered to its prior ruling, excluding Charleston-related evidence as irrelevant. (Tr-1465–66). The state made an offer of proof, which the trial court disallowed. (Tr-1597–98).

B. Standard of review

This court reviews for legal error "a trial court's decision to exclude evidence as irrelevant." *Thomas*, 319 Or App at 432.

ARGUMENT

To buttress the reasonable relationship between Measure 114's closure of the Charleston Loophole and the public-safety harms that the law seeks to address, the state proffered a statistic. In 2020 alone, at least 2,989 individuals whose background check disqualified them from acquiring a firearm were nevertheless able to purchase one because their check was not completed within the timeframe required by the loophole. (Tr-1597).

That evidence bears on the reasonableness of the law's closure of the loophole to advance public safety. In a single year, the loophole enabled thousands with a disqualifying background from nevertheless obtaining a firearm because their background check did not complete within a few business days. Closing the loophole would prevent those transfers.

SIXTH ASSIGNMENT OF ERROR

The trial court erred in ruling that an investigative report by the Las Vegas Metropolitan Police Department on the largest mass shooting in the nation's history is irrelevant to the constitutionality of Measure 114.

A. Preservation of error

The state preserved this assigned error. At trial, the state moved under OEC 803(8) to admit exhibit 105, an investigative report by the Las Vegas police department about the Route 91 Harvest music festival mass shooting in October 2017. (Tr-1722–31, 1822). The trial court excluded the report as "cumulative and not relevant" because the fact of the shooting as "1 of 179" was "already accounted for" in the record. (Tr-1823).

B. Standard of review

This court reviews for legal error "a trial court's decision to exclude evidence as irrelevant." *Thomas*, 319 Or App at 432. The court reviews for an abuse of discretion a trial court's ruling that evidence is cumulative. *State v. Skelton*, 153 Or App 580, 584, 957 P2d 585, *rev den*, 327 Or 448 (1998).

ARGUMENT

To underscore the public-safety harms that Measure 114 was enacted to prevent, the state proffered a 187-page investigative report by the Las Vegas police department about the city's October 2017 mass shooting. (ER-563). There, a single shooter used large-capacity magazines to perpetrate the worst mass shooting in the nation's history, killing 58 and injuring more than 800 in 11 minutes, and firing 289 rounds into the crowd in one 60-second interval. (ER-581, 596–98, 658–65, 687).

The report provides tragic—and relevant—details about the shooter using large-capacity magazines to commit mass slaughter, harms that Measure 114 was expressly enacted to prevent. In the main, the trial court ruled otherwise by reasoning that the only relevant evidence in the report is the fact that a mass shooting occurred. (Tr-1823). Put another way, according to the trial court, the use of large-capacity magazines to kill and injure hundreds in mere minutes was irrelevant. That is baseless. Those painful, pertinent details appear nowhere else in the record; to the extent that the trial court ruled that such facts were cumulative, the court abused its discretion in so ruling.

CONCLUSION

To the extent that Measure 114 regulates protected weapons at all, the law constitutes "reasonable regulations to promote public safety" that "do[] not unduly frustrate the individual right to bear arms for the purpose of self-defense." *Christian*, 354 Or at 33. The law is therefore facially constitutional under Article I, section 27, and this court should reverse the trial court's general and supplemental judgments to the contrary.

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Respectfully submitted,

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EXCERPT OF RECORD

EXCERPT OF RECORD

Pursuant to ORAP 5.50, appellants submit the following, as indexed below.

INDEX

IN THE CIRCUIT COURT OF THE STATE OF OREGON

FOR THE COUNTY OF HARNEY

JOSEPH ARNOLD, CLIFF ASMUSSEN, GUN OWNERS OF AMERICA, INC., and GUN OWNERS FOUNDATION, Plaintiffs, v. KATE BROWN, Governor of the State of Oregon, in her official capacity; and ELLEN ROSENBLUM, Attorney General of the State of Oregon, in her official capacity, and TERRI DAVIE, Superintendent of the Oregon State Police, in her official capacity, Defendants,	Case No. **COMPLAINT FOR DECLARATORY AND INJUNCTIVE RELIEF** Claims not subject to mandatory arbitration

Plaintiffs Joseph Arnold, Cliff Asmussen, Gun Owners of America, Inc., and Gun Owners Foundation ("Plaintiffs") allege as follows for their Complaint against Defendants Kate Brown, the Governor of Oregon, in her official capacity, and Ellen Rosenblum, Attorney General of Oregon, in her official capacity ("Defendants"):

1.

Plaintiffs seek injunctive and declaratory relief pursuant to ORS 28.020 against Defendants as the chief law enforcement officers of Oregon, to permanently enjoin and declare unconstitutional the recently enacted 2022 Ballot Measure 114 ("BM 114").

/ / /

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JURISDICTION AND VENUE

2.

This Court has jurisdiction pursuant to ORCP 4(A)(4) because all Defendants are engaged in substantial and not isolated activities within the State of Oregon.

3.

This is the proper venue pursuant to ORS 14.060 because Harney County is where the cause of this suit arose. Harney County is where, because of BM114, the individual Plaintiffs, as well as the members and supporters of Plaintiffs Gun Owners of America, Inc. and Gun Owners Foundation, reside and will be unable to exercise their Constitutional Rights under Or. Const. Art. 1, Sec. 27, including being unable to purchase a firearm and being unable to purchase or possess a magazine capable of holding more than 10 rounds of ammunition on or after December 8, 2022.

PARTIES

4.

Plaintiff Joseph Arnold ("Arnold") is a resident of Harney County, Oregon and a law-abiding person who can legally possess firearms, and has an Oregon Concealed Handgun License. Plaintiff Arnold is a member of GOA. Plaintiff Arnold possesses what BM114 designates as "large capacity magazines" and, in fact, has a handgun which he carries that utilizes an 11-round ammunition magazine, which would be considered a prohibited "large capacity magazine" pursuant to BM114. Upon information and belief, for Arnold's specific handgun, a magazine that holds fewer than 11 rounds of ammunition is not available on the commercial market and, therefore, Plaintiff Arnold will no longer be able to carry his firearm. Plaintiff Arnold desires to continue to purchase firearms, including handguns, after December 8, 2022 (when BM114 becomes effective) without the need to apply for a permit to purchase, and without having his

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information (including his firearm) registered and recorded in a government database. Plaintiff Arnold also does not want to pay a fee for the required permit to purchase or take the required safety class as he already has a Concealed Handgun License, a precondition of which was demonstrating competence with a firearm. Finally, Plaintiff Arnold is currently attempting to purchase a handgun, but Oregon has failed to timely complete his background check for over two weeks – and this is before BM114 has even been implemented.

5.

Plaintiff Cliff Asmussen ("Asmussen") is a resident of Harney County, Oregon and a law-abiding person who can legally possess firearms, and has an Oregon Concealed Handgun License. Plaintiff Asmussen is a member of GOA. Plaintiff Asmussen has magazines that suddenly now are considered prohibited "large capacity magazines" under BM114. Additionally, Plaintiff Asmussen carries a pistol with a magazine capacity greater than 10 rounds when he is out in rural Harney County, but not engaged in hunting, and thus would not fall under the BM114 exception for hunting. Plaintiff Asmussen also wants to continue to purchase firearms after December 8, 2022, without being made to get a permit simply to purchase a firearm, to pay a fee to receive the permit, and to take a "safety" class when it is unnecessary for him to do so merely to exercise his constitutional rights.

6.

Plaintiff Gun Owners of America, Inc. ("GOA") is a California non-stock corporation with its principal place of business in Springfield, Virginia. GOA is organized and operated as a non-profit membership organization that is exempt from federal income taxes under Section 501(c)(4) of the U.S. Internal Revenue Code. GOA was formed in 1976 to preserve and defend the Second Amendment rights of gun owners. GOA has more than 2 million members and supporters across

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the country, including many who reside throughout the State of Oregon and in Harney County, Oregon.

7.

Plaintiff Gun Owners Foundation ("GOF") is a Virginia not-for-profit, non-stock corporation, with its principal place of business in Springfield, Virginia. GOF is organized and operated as a non-profit legal defense and educational foundation that is exempt from federal income taxes under section 501(c)(3) of the United States Internal Revenue Code. GOF is supported by gun owners across the country, including within the state of Oregon.

8.

GOA and GOF bring this action in a representational capacity on behalf of, and asserting the interests of, their members and supporters in Oregon. GOA has many thousands of members and supporters across the state of Oregon, including over 100 members and supporters in Harney County, Oregon. Each of these persons would have standing to challenge BM114 in their own right. Protection of these members' and supporters' rights and interests is germane to GOA and GOF's mission, which is to preserve and protect the rights of Americans to keep and bear arms, including against infringement by anti-gun politicians and unconstitutional state statutes. Litigation of the challenges raised in this case does not require participation of each of GOA and GOF's members and supporters. GOA and GOF are capable of fully and faithfully representing the interests of their members and supporters without participation by each of these individuals. Indeed, GOA and GOF routinely litigates cases on behalf of their members and supporters.

9.

Many of the gun owners represented in this matter by GOA and GOF, like the individual Plaintiffs, wish to purchase a firearm but will be unable to do so after December 8, 2022 due to

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BM114. Many of these gun owners, like the individual Plaintiffs, wish to possess (or continue to possess), use, or acquire magazines capable of holding more than 10 rounds but will not be able to after December 8, 2022 due to BM114.

10.

Defendant Kate Brown is the Governor of the State of Oregon. Defendant Ellen Rosenblum is the Attorney General of the State of Oregon. Defendants are the chief law enforcement officers of Oregon. Defendants are charged by the Oregon Constitution with the duty to uniformly and adequately enforce the laws of the State of Oregon. Defendant Rosenblum directly supervises every district attorney and sheriff in all matters pertaining to their respective official duties, including informing the public, local prosecutors, and law enforcement regarding the meaning of Oregon laws, including BM114. Defendants are responsible for formulating, executing, and administering BM114's restrictions on magazines capable of holding more than 10 rounds (the "magazine restrictions"). Defendants are also responsible for formulating, executing, and administering BM114's requirement that Oregonians obtain a "permit to purchase" firearms in the State of Oregon (the "permit to purchase restriction"). Defendants can enforce these restrictions against Plaintiffs and other Oregon citizens.

11.

Defendant Terri Davie is the Superintendent of the Oregon State Police. Her officers will be tasked with enforcing BM114's magazine restrictions, and BM114 imposes numerous duties on the Oregon State Police with regard to the permitting process including, but not limited to, developing the standardized application for a permit to purchase. *See e.g.*, BM114, §§ 4(1)(c), (e), (2)(a), (c), (4)(a), (5)(a), (b), (9).

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GENERAL ALLEGATIONS

Background of BM114

12.

Oregon voters recently enacted BM114 by a narrow majority on the November 8, 2022 general election ballot. BM114 goes into effect on December 8, 2022. A true copy of BM114 is attached and incorporated as **Exhibit 1**.

13.

Generally, BM114 contains two parts. The first requires a law-abiding person to obtain a "permit to purchase" before acquiring any firearm, and constructs a convoluted, multi-step permitting process requiring involvement by both state and local law enforcement (fingerprinting, photographs, investigation, background check), along with completion of a firearm safety course, and payment of a fee, up to $65 for the original permit and up to $50 for each renewal. *See* BM114, § 4. Even after a permit to purchase has been acquired, a firearms dealer *still* cannot transfer a firearm to the permit holder until the state police have been contacted and *again* approve the transfer. BM114, § 6(2)(d). After transfer, the dealer must notify the state police that a firearm has been transferred. BM114, § 6(3)(c). Finally, the state police are authorized to "retain a record of the information … sufficient to reflect each firearm purchased by a permit holder," thus creating a gun registry of all firearm sales, maintained by the state. *See* BM114, § 6(7)(a). These provisions apply not only to transfers of firearms by licensed dealers, but to all transfers of firearms, including private sales, gifts, and the loaning of a firearm.

14.

The second part of BM114 is a prohibition on possession of standard capacity firearm magazines, banning the "manufacture, importation, possession, use, purchase, sale, or other[]

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transfer[]" of a magazine with a capacity greater than 10 rounds of ammunition. BM114, § 11(2). Aside from exempting government agents such as military and law enforcement, BM114 provides no general exception even for continuing to possess magazines already owned prior to the effective date. Rather, BM114 provides a mere "affirmative defense"—contained in a non-existent statute (ORS 166.055)—from prosecution for magazines owned prior the effective date, but only if the magazine has been maintained at a person's private property, subject to certain limited exceptions for transport to and from certain places and events. *See* BM114, § 11(5). Concealed carry is not one of those exceptions, as BM114 requires large capacity magazines being transported to be "not inserted into the firearm" and "locked in a separate container." BM114, § 11(5)(c)(D). Violation of BM114's magazine ban is a Class A misdemeanor. BM114, § 11(6). Additionally, BM114, § 11(5)(c) does not appear to include a self-defense exception for usage of large capacity magazines, even while one is in their own home, or target shooting on their own property.

15.

BM114 requires training in order to exercise the right to acquire a firearm, in the form of providing "proof of completion of a firearm safety course," which is required to be taught by certain types of entities, BM114, § 4(8)(a), "certified by a law enforcement agency," and required to cover certain topics, BM114, § 4(8)(c).

16.

Upon information or belief, such training does not yet exist and is not yet offered, either by law enforcement or certified private trainers, and no certification system by law enforcement has yet been developed, let alone implemented by local law enforcement. Until that occurs, BM114 operates to effectively eliminate the right to keep and bear arms within Oregon, as no permit can be acquired without training, and no firearm can be acquired without a permit.

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17.

This elimination of the right to keep and bear arms has been widely reported, with the Oregon State Sheriff's Association going on record to say that "without a permit system in place" they believe "that all firearms sales by dealers, at gun shows, and most private transfers ... in Oregon will immediately stop." *See* https://www.koin.com/news/oregon/without-permitting-system-in-place-ossa-expects-gun-sales-to-halt-after-measure-114/.

18.

Moreover, even once the permit to purchase program is developed, delays with background checks processed at the state level and the lack of access to the requisite training courses will make the firearm purchasing process take months or longer.

19.

BM114 §4(1)(e) requires that an applicant "submit to fingerprinting and photographing by the permit agent." Lacking from this requirement is any timeline for the "permit agent" to complete photographing, fingerprinting, and the required background check.

20.

Because there are no timelines, the permitting scheme that will be enacted via BM114 will be put to abusive ends and will lead to lengthy wait times in processing license applications. These significant delays are more egregious than those in other states and infringe on Plaintiffs' rights to keep and bear arms.

21.

Even when the Plaintiffs' background check is complete, the permit agent is clothed with unbridled discretion to deny a permit to purchase based on what are termed "reasonable grounds," a hopelessly vague and ambiguous term that BM114 does not define. BM114 §4(1)(b)(C).

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22.

Even once the permit to purchase program is developed, currently existing delays with background checks processed at the state level, and the lack of ready access to the requisite training courses, will make the firearm purchasing process take months or longer – merely to be able to exercise an enumerated right. Moreover, the permitting scheme enacted via BM114 will be put to abusive ends and will establish lengthy wait times in processing license applications. These significant delays are more egregious than those in even the most anti-gun of states and violate Plaintiffs' rights to keep and bear arms.

23.

The background check required by BM114 is unnecessary prophylaxis-upon-prophylaxis, as Oregon *already* requires background checks to buy firearms, even for transfers between private citizens.[1] Moreover, buying a firearm from a federally licensed firearm dealer *already* requires the purchaser to fill out an ATF Form 4473[2] and submit to a federal NICS background check. However, due to the extreme backlog currently for background checks to be performed, the Oregon "Firearm Instant Check System" ("FICS") will continue to be "not instant," and therefore applicants will wait weeks or months in order while the background check to purchase a firearm is processed. Moreover, if FICS cannot complete a background check within thirty days, then federal law requires a new Form 4473 to be completed and another background check to be started, resulting in an endless loop where a person would never be able to acquire a firearm. *See* 27 CFR 478.102(c).

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[1] https://www.oregon.gov/osp/programs/cjis/pages/firearms-instant-check-system.aspx.
[2]https://www.atf.gov/firearms/docs/4473-part-1-firearms-transaction-record-over-counter-atf-form-53009/download.

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24.

Hundreds of thousands of law-abiding Oregonians, including Plaintiffs and their members and supporters, own and possess firearms equipped with magazines capable of holding more than 10 rounds of ammunition. Firearm magazines, including magazines capable of holding more than 10 rounds, are not unusual or novel technology, but rather have become ubiquitous among modern firearms overwhelmingly chosen and in common use by law-abiding gun owners for lawful purposes including self-defense. Many (if not most) of the nation's best-selling handguns and rifles come standard with magazines that can hold more than 10 rounds, and such magazines are lawfully and possessed and responsibly utilized by millions of law-abiding citizens in the vast majority of States that allow them.[3] Nor are so-called "large capacity" firearms a new invention but predate even the founding of the republic.

25.

A recent article from Reason magazine reported on a survey which billed itself as the "Largest-Ever Survey of American Gun Owners," finding that "Americans own some 415 million firearms, including 171 million handguns, 146 million rifles, and 98 million shotguns."[4] That survey suggests that Americans own "up to 44 million AR-15-style rifles and up to 542 million

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[3] "Millions of ammunition magazines able to hold more than 10 rounds are in common use by law-abiding responsible citizens for lawful uses like self-defense. This is enough to decide that a magazine able to hold more than 10 rounds passes the *Heller* test and is protected by the Second Amendment. The simple test applies because a magazine is an essential mechanical part of a firearm. The size limit directly impairs one's ability to defend one's self." *Duncan v. Becerra*, 366 F. Supp. 3d 1131, 1142 (S.D. Cal. 2019) (*rev'd by, remanded by Duncan v. Bonta*, 19 F.4th 1087, 2021 U.S. App. LEXIS 35256 (9th Cir. Cal., Nov. 30, 2021) (en banc), *cert. granted, judgment vacated*, 142 S.Ct. 2895 (2022).

[4] https://webcache.googleusercontent.com/search?q=cache:1kYof3RwPOkJ:https://reason.com/2022/09/09/the-largest-ever-survey-of-american-gun-owners-finds-that-defensive-use-of-firearms-is-common/&cd=1&hl=en&ct=clnk&gl=us&client=firefox-b-1-d.

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magazines with capacities exceeding 10 rounds are already in circulation." These numbers demonstrate that magazines with a capacity exceeding 10 rounds are commonly owned in the United States.

26.

Historically, magazines holding more than 10 rounds predated the ratification of the Second Amendment (and Oregon's Second Amendment analogue). *See Symposium Article: The History of Firearm Magazines And Magazine Prohibitions*, 78 Alb. L. Rev. 849, 852 ("The first known firearm that was able to fire more than ten rounds without reloading was a sixteen-shooter created around 1580, using 'superposed' loads (each round stacked on top of the other).").

27.

Although BM114 maligns so-called "large capacity magazines" as popularly used by many perpetrators (40%) of violent crime, such magazines are also overwhelmingly chosen by police forces (approaching 100%) across the country whose job it is to stop such bad actors, and overwhelmingly chosen by law-abiding gun owners who desire to protect themselves from such violent acts (such as by multiple attackers). Magazines capable of holding more than 10 rounds are standard with many of the most popular firearms and firearm platforms. Magazines between 15 and 30 rounds are standard magazine sizes sold with many of the most popular firearms and firearm platforms.[5]

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[5] Additionally, there are countless stories of individuals needing more than ten rounds to defend themselves: *See* (Florida man fired 30 rounds while fighting off seven intruders); https://crimeresearch.org/2020/10/ten-cases-over-the-last-few-years-where-people-have-had-fire-ten-or-more-shots-in-self-defense/ (detailing "ten cases where law-abiding citizens ... fired at least 10 shots in self-defense"); https://concealednation.org/2019/04/man-uses-ak-47-against-5-home-invaders-killing-3-and-injuring-2/ (man used "AK-47 to defend his home and his life" against five armed attackers).

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28.

The so-called "large capacity magazines" that BM114 prohibits are legal to own under federal law, and a supermajority of states do not ban or restrict their ownership or possession.

29.

Magazines are protected by the Oregon constitution because the right to keep and bear arms encompasses the right to own, possess, and carry magazines that hold more than ten rounds of ammunition. And likewise, there are no "well-established and representative historical" analogues which would support a ban on these types of magazines. *See N.Y. State Rifle & Pistol Ass'n v. Bruen*, 142 S. Ct. 2111, 2133 (2022).

30.

Off duty law enforcement officers are not exempted from BM114's magazine restrictions. The law enforcement exemption is limited to on duty officers and must be "related directly to activities within the scope of that person's official duties." BM114, § 11(4)(c).

Article 1, Section 27

31.

Article 1, Section 27 of the Oregon State Constitution provides that "[t]he people shall have the right to bear arms for the defence of themselves, and the State, but the Military shall be kept in strict subordination to the civil power[.]"

32.

The Oregon Supreme Court has held that "As a general matter, we examine the text of the constitution in its **historical context**, along with relevant cases interpreting it . . . In conducting that examination, our purpose is not to freeze the meaning of the state constitution to the time of its adoption, but is instead to identify, in light of **the meaning understood by the framers**,

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relevant underlying principles that may inform our application of the constitutional text to modern circumstances." *Couey v. Atkins*, 257 Or 460, 490 (2015) (internal citations omitted) (emphasis added); s*ee also State v. Christian*, 354 Or 22, 30, (2013) ("we considered early American examples of restrictions…."), 32–33 (noting the Court's having "discussed the text and history of Article I, section 27" and the "historical circumstances pertaining to Article I, section 27....."), 42 (discussing *Heller*'s "extensive analysis of the text and historical circumstances pertaining to the Second Amendment."). In other words, the Oregon Supreme Court has used an analytical method that parallels that used by the Supreme Court in *Bruen*.

33.

The Second Amendment to the United States' Constitution and Article 1, Section 27 of the Oregon State Constitution, protect coextensive rights possessed by Oregonians, making interpretations of the Second Amendment (and federal case law) persuasive to the interpretation of Article 1, Section 27. Due to the similarity of the federal and state provisions, and the similar historical approaches taken by state and federal courts to analyze the rights, this Complaint addresses authorities under the Second Amendment, although—for avoidance of confusion—**Plaintiffs do not bring a challenge under the Second Amendment, and seek relief solely for a violation of Article I, Section 27 of the Oregon State Constitution**.

34.

Indeed, Oregon's Constitution cannot afford its citizens fewer protections with regard to the right to keep and bear arms than the United States' Constitution. *McDonald v. Chicago*, 561 US 742 (2010); *see Stickley v. City of Winchester*, 2022 Va. Cir. LEXIS 201, *35 (Winchester County Circuit Court, Sep. 27, 2022) ("the Fourteenth Amendment incorporates the Second Amendment to the States. Therefore, Article I, Section 13, of the Constitution of Virginia is, at the

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very least, co-extensive with the Second Amendment as to the enumerated rights guaranteed by the Second Amendment. As a result, it is appropriate for this Court to examine Second Amendment jurisprudence to determine whether the provisions of §§ 16-34(a)(2), (3), and (4) violate Article I, Section 13.").

35.

The Bill of Rights from Oregon's 1859 Constitution "was taken verbatim from sections 32 and 33 of the Indiana Constitution of 1851" and those sections remained unchanged from Indiana's 1816 Constitution. *State v. Kessler*, 289 Or 359, 363 (1980). When drafting Indiana's Constitution in 1816, "[t]he drafters of Indiana's bill of rights of 1816 borrowed freely from the wording of other state constitutions, most notably the constitutions of Kentucky, Ohio, Tennessee, and Pennsylvania" which were drafted between 1776 and 1802. *Id.* This makes Oregon's "right to bear arms provision" traceable "to state provisions drafted in the revolutionary and post-revolutionary war era." *Id.* The bill of rights, including the Second Amendment, were ratified on December 15, 1791.

36.

Since the Oregon Constitution was ratified after the ratification of the Second Amendment, it would make absolutely no sense for Oregonians to knowingly ratify a state provision that protected less than the Second Amendment and, therefore, would immediately become inoperative and ineffective. For that reason as well, Article 1, Section 27 must be read to provide at least protection as the Second Amendment, and thus making federal authorities persuasive and relevant to an Article 1, Section 27 analysis.

37.

The Second Amendment to the United States Constitution provides: "A well regulated

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Militia being necessary to the security of a free State, the right of the people to keep and bear Arms shall not be infringed."

38.

In its landmark 2008 decision in *District of Columbia v. Heller*, 554 U.S. 570 (2008), the Supreme Court rejected the nearly uniform opinions reached by the courts of appeals, which for years had claimed that the Second Amendment protects only a communal right of a state to maintain an organized militia. *Heller*, 554 U.S. at 581. Setting the record straight, the *Heller* Court explained that the Second Amendment recognizes, enumerates, and guarantees to individuals the preexisting right to keep and carry arms for self-defense and defense of others in the event of a violent confrontation. *Id*. at 592.

39.

Then, in *McDonald*, 561 U.S. 742, the Supreme Court explained that the Second Amendment is fully applicable to the states through operation of the Fourteenth Amendment. *Id*. at 791.

40.

In *Caetano v. Massachusetts*, 577 U.S. 411 (2016), the Supreme Court reaffirmed its conclusion in *Heller* that "the Second Amendment extends, prima facie, to all instruments that constitute bearable arms, even those that were not in existence at the time of the founding …" and that this "Second Amendment right is fully applicable to the States." *Id*. at 411, 416.

41.

Finally, as the Supreme Court has now explained in *Bruen*, the Second and Fourteenth Amendments together guarantee individual Americans not only the right to "keep" firearms in their homes, but also the right to "bear arms," meaning "to carry a handgun for self-defense outside

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the home," free from infringement by either federal or state governments. *Bruen*, 142 S Ct at 2122.

42.

Importantly, in addition to clearly recognizing the right of "'law-abiding, responsible citizens' … to public carry" (*Id*. at 2138, n.9), *Bruen* also rejected outright the methodology used within many circuits to judge Second Amendment challenges.

43.

Prior to *Bruen*, the U.S. Court of Appeals for the Fourth Circuit had adopted a two-part test for analyzing Second Amendment cases:

> [W]e have concluded that a two-part approach to Second Amendment claims seems appropriate under *Heller*. Pursuant to that two-part approach, we first ask whether the challenged law imposes a burden on conduct falling within the scope of the Second Amendment's guarantee. If the answer is no, then the challenged law is valid. If, however, the challenged law imposes a burden on conduct protected by the Second Amendment, we next apply[] an appropriate form of means-end scrutiny…. [W]e … select between strict scrutiny and intermediate scrutiny…. [T]he level of scrutiny we apply depends on the nature of the conduct being regulated and the degree to which the challenged law burdens the right.

Kolbe v. Hogan, 849 F.3d 114, 132-133 (4th Cir. 2017); *see also Bruen*, 142 S Ct at 2127, n.4 (collecting cases using two-part test). Other circuits had adopted and used a substantially similar formula, which invariably utilized the very same "judge-empowering 'interest-balancing inquiry'" that *Heller* had explicitly rejected. *See Heller* at 634; *see also Duncan v. Becerra*, 265 F. Supp. 3d 1106, 1117 (S.D. Cal. 2017), *aff'd* 742 Fed. Appx. 218 (9th Cir. 2018) ("the Ninth Circuit uses what might be called a tripartite binary test with a sliding scale and a reasonable fit.").

44.

Rejecting this widespread atextual, "judge empowering" (*Bruen*, 142 S Ct at 2129) interest-balancing approach, *Bruen* directed (again) the courts back to first principles, to assess the text of the Second Amendment, informed by the historical tradition. *Bruen*, 142 S Ct at 2127. First, the

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Supreme Court "decline[d] to adopt that two-part approach" used in this and other circuits, and reiterated that, "[i]n keeping with *Heller*, we hold that when the Second Amendment's plain text covers an individual's conduct, the Constitution presumptively protects that conduct." *Bruen*, 142 S Ct at 2126. Second, the Court held that, "[t]o justify [a] regulation, the government may not simply posit that the regulation promotes an important interest. Rather, the government must demonstrate that the regulation is consistent with this Nation's historical tradition of firearm regulation. Only if a firearm regulation is consistent with this Nation's historical tradition may a court conclude that the individual's conduct falls outside the Second Amendment's 'unqualified command.'" *Id.* (citation omitted). Third, in reviewing the historical evidence, the Court in *Bruen* cabined review of relevant history to a narrow time period, because "not all history is created equal," focusing on the period around the ratification of the Second Amendment, and *perhaps* the Fourteenth Amendment (but noted that "post-ratification" interpretations "cannot overcome or alter that text," and "we have generally assumed that the scope of the protection applicable to the Federal Government and States is pegged to the public understanding of the right when the Bill of Rights was adopted in 1791."). *See Bruen*, 142 S Ct at 2135–56 (discussing the lack of relevant historical prohibitions on concealed carry in public).

45.

According to the Second Amendment's text, and as elucidated by the Court in *Bruen*, if a member of "the people" wishes to "keep" or "bear" a protected "arm," then the ability to do so "shall not be infringed." Period. There are no "ifs, ands or buts," and it does not matter (even a little bit) how important, significant, compelling, or overriding the government's justification for or interest in infringing the right. It does not matter whether a government restriction "minimally" versus "severely" burdens (infringes) the Second Amendment. There are no relevant statistical

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studies to be consulted. There are no sociological arguments to be considered. The ubiquitous problems of crime or the density of population do not affect the equation. The only appropriate inquiry then, according to *Bruen*, is what the "public understanding of the right to keep and bear arms" was during the ratification of the Second Amendment in 1791, and perhaps during ratification of the Fourteenth Amendment in 1868. *Bruen*, 142 S Ct at 2138.

46.

The Supreme Court has also instructed as to the scope of the protected persons, arms, and activities covered by the Second Amendment. First, *Heller* explained that "in all six other provisions of the Constitution that mention 'the people,' the term unambiguously refers to all members of the political community, not an unspecified subset." *Heller* at 580. *Heller* cited to *United States v. Verdugo-Urquidez*, 494 U.S. 259, 265 (1990), which held that "'[T]he people' … refers to a class of persons who are part of a national community or who have otherwise developed sufficient connection with this country to be considered part of that community." *Id*. Second, *Heller* then turned to the "substance of the right: 'to keep and bear Arms.'" *Id*. at 581. The Court explained that "'[k]eep arms' was simply a common way of referring to possessing arms, for militiamen *and everyone else*." *Id*. at 583 (emphasis original). Next, the Court instructed that the "natural meaning" of "bear arms" was "wear, bear, or carry ... upon the person or in the clothing or in a pocket, for the purpose ... of being armed and ready for offensive or defensive action in a case of conflict with another person." *Id*. at 584. And "[a]t the time of the founding, as now, to 'bear' meant to 'carry.'" *Id. Bruen*, in fact, was more explicit, explaining that the "definition of 'bear' naturally encompasses public carry." *Bruen*, 142 S Ct at 2134. Third, with respect to the term "arms," the Court explained that "the Second Amendment extends, prima facie, to all instruments that constitute bearable arms, even those that were not in existence at the time of the

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founding." *Heller* at 582. Indeed, the "arms" protected by the Second Amendment include "weapons of offence, or armour of defence… Arms are any thing that a man wears for his defence, or takes into his hands, or useth in wrath to cast at or strike another." *Heller* at 581 (punctuation omitted).

47.

As relevant here, in addition to clearly establishing the framework by which lower courts are to analyze challenges implicating Second Amendment rights, *Bruen* also acknowledged the inherent risk in all permitting schemes, "because any permitting scheme can be put toward abusive ends, we do not rule out constitutional challenges to shall-issue regimes where, for example, *lengthy wait times in processing license applications* or exorbitant fees deny ordinary citizens their right to public carry." *Bruen*, 142 S Ct at 2138, n.9 (emphasis added). BM114 creates and encourages precisely such "abusive ends," requiring a permit not merely to carry but even to possess a firearm, and compounding the problems with a state background check system that already experiences *significant* delays in acquiring firearms.

INJURIES TO PLAINTIFFS &

INJUNCTIVE RELIEF ALLEGATIONS

48.

The individual Plaintiffs own, or intend to own on or after December 8, 2022, possess, and use magazines capable of holding more than 10 rounds of ammunition, but such possession and use will be impossible due to the prohibition provided for in BM114. All individual Plaintiffs intend to possess or continue possessing magazines capable of holding more than 10 rounds of ammunition outside of their homes on or after December 8, 2022, and but for BM114, the individual Plaintiffs would continue to possess magazines holding more than 10 rounds of

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ammunition outside of their homes, and would continue to use such magazines for all lawful purposes now prohibited by BM114.

49.

Plaintiffs GOA and GOF represent their members and supporters, many of whom own, or desire to own on or after December 8, 2022, magazines capable of holding more than 10 rounds of ammunition. Many of their members and supporters intend to possess or continue possessing magazines capable of holding more than 10 rounds of ammunition outside of their homes on or after December 8, 2022 and but for BM114, the members and supporters of GOA and GOF would continue to possess magazines holding more than 10 rounds of ammunition outside of their homes.

50.

The individual Plaintiffs intend to purchase a firearm on or after December 8, 2022 but will be unable to do so without violation of their rights to keep and bear arms, due to the unavailability of the requisite firearm safety course, the non-existence of the requisite permit to purchase scheme in place after BM114's enactment, the permitting process itself, and the significant delays that will continue to grow in obtaining a firearm in Oregon, and but for BM114, the individual Plaintiffs would purchase a firearm on or after December 8, 2022.

51.

Plaintiffs GOA and GOF represent their members. Many of their members intend to purchase a firearm on or after December 8, 2022 but will be unable to due to the unavailability of the requisite firearm safety course and the non-existence of the requisite permit to purchase scheme in place due to BM114, and that but for BM114, the members and supporters of GOA and GOF would purchase a firearm on or after December 8, 2022.

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52.

BM114 violates, violates, and is inconsistent with Or. Const. Art. 1, Sec. 27.

53.

Because BM114 will operate as a complete and outright ban on the purchase of any firearm (either new or used) starting on December 8, 2022, BM114 violates and is inconsistent with Or. Const. Art. 1, Sec. 27.

54.

If not enjoined by this Court, Defendants and their agents, representatives, and employees will administer, implement, and enforce BM114, including against Plaintiffs. This will violate or be inconsistent with Or. Const. Art. 1, Sec. 27 and subject the individual Plaintiffs, and GOA and GOF's members, to criminal arrest and prosecution, potential imprisonment, and loss of property.

55.

This will cause the individual Plaintiffs, and GOA and GOF's members, irreparable injury. The depravation of a fundamental constitutional right, even temporarily, constitutes irreparable injury. *See Elrod v. Burns*, 427 US 347, 373 (1976) ("The loss of First Amendment freedoms, for even minimal periods of time, unquestionably constitutes irreparable injury."); *Melendres v. Arpaio*, 695 F3d 990, 1002 (9th Cir 2012) ("It is well established that the deprivation of constitutional rights 'unquestionably constitutes irreparable injury.'") ("It is always in the public interest to prevent the violation of a party's constitutional rights."; *see also Elkhorn Baptist Church v. Brown*, 366 Or 506, 546 (2020) ("The inability of plaintiffs to worship in the manner that they prefer and the inability of intervenors to carry on their businesses in the manner that is usual (or at all) is irreparable harm for these purposes, even if temporary.) (Garrett, J., concurring).

/ / /

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FIRST CLAIM FOR RELIEF

Declaratory Judgment; ORS 28.020

(BM114 Violates Or. Const. Art. 1, Sec. 27)

56.

Plaintiffs reallege and incorporate by reference the allegations of the prior Paragraphs as though fully set forth herein.

57.

Article 1, Section 27 of the Oregon State Constitution bars prohibitions on and violation of the right to bear arms in public in order to engage in the reasonable defense of oneself against felonious attack.

58.

The Oregon Supreme Court has provided that "Article I, section 27, prevents the legislature from infringing on the people's individual right to bear arms for purposes limited to self-defense." *Christian*, 354 Or at 30.

59.

The Oregon Supreme Court has further concluded that, while "the legislature may specifically regulate the manner of possession and use of protected weapons to promote public safety as long as the exercise of that authority does not unduly frustrate the right to bear arms guaranteed by Article I, section 27." *Christian*, 354 Or at 38. BM114, however, *completely eliminates* the right to possess and use certain arms, and *completely eliminates* the ability even to acquire arms.

60.

BM114 requires Oregonians wishing to purchase any firearm from a licensed dealer,

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private party, or gun show to first obtain, and then present, a valid government issued permit to purchase the firearm issued under BM114, Section 4.

61.

Requiring a permit to purchase a firearm violates the right to bear arms guaranteed by the Oregon Constitution.

62.

Requiring a permit to purchase a firearm violates the rights of Oregonians to bear arms by placing the onus on each Oregonian wishing to exercise their right under the Oregon Constitution to affirmatively prove their worthiness to exercise their right rather than on the State to prove that they do not possess that right. This makes the right to bear arms the exception, not the rule.

63.

Requiring a permit to purchase a firearm is inconsistent not only with Oregon's historical tradition of firearm regulation, but the nation's historical tradition from the Founding to the present day.

64.

On information and belief, most, if not all, Oregon counties, as well as the Oregon State Police, do not have in place any procedure or process for accepting, reviewing, or granting applications for permits to purchase under BM114.

65

BM114 requires Oregonians wishing to obtain a permit to purchase under BM114, Section 4 to provide "proof of completion of a firearm safety course as defined in subsection (8) of [Section 4]." BM114, § 4(8) requires that the firearm safety course include "(D) In-person demonstration of the applicant's ability to lock, load, unload, fire and store a firearm before an instructor certified

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by a law enforcement agency."

66.

Requiring Oregonians to complete a firearm safety course in order to obtain a permit to purchase a firearm violates the rights of Oregonians to keep and bear arms by placing the onus on each Oregonian wishing to exercise their Second Amendment right to affirmatively prove their worthiness to exercise their right rather than on the State to prove that they do not possess that right. This makes the right to keep and bear arms the exception, not the rule.

67.

Requiring Oregonians to complete a firearm safety course in order to obtain a permit to purchase a firearm violates the right to bear arms guaranteed by the Oregon Constitution.

68.

Requiring Americans to complete a firearm safety course in order to obtain a permit to purchase a firearm is inconsistent not only with the Oregon's historical tradition of firearm regulation, but the nation's historical tradition from the Founding to the present day.

69.

On information and belief, most, if not all, Oregon counties do not have in place any firearm safety course meeting all requirements of BM114, § 4(8). Thus, an Oregonian could not obtain a permit to purchase even if so desired, because BM114 requires an impossibility.

70.

BM114 bans the manufacture, import, possession, use, purchase, sale, or other transfer of magazines capable of holding more than 10 rounds.

71.

Article 1, Section 27 protects the right of Oregonians to bear "arms" which are, "as

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modified by its modern design and function," of the sort in existence in the mid-nineteenth century, were in common use, and were used for personal defense. *See Oregon State Shooting Ass'n v. Multnomah County*, 122 Or App 540, 544 (1993) (quoting *State v. Delgado*, 298 Or 395, 400 (1984)).

72.

Banning magazines capable of holding more than 10 rounds of ammunition violates the right to bear arms guaranteed by the Oregon Constitution.

73.

Banning the mere possession of arms is not permitted under the Oregon Constitution. *See Christian*, 354 Or at 40–41 (citing *State v. Bocker*, 291 Or 255, 259 (1981); *Delgado*, 298 Or at 403–04).

74.

The magazines banned through BM114 are of the sort that were in existence in the mid-nineteenth century (when the Article 1, Section 27 was ratified), were in common use, and were used for personal defense.

ATTORNEY FEES

75.

Plaintiffs claim a right to recover reasonable attorney fees and costs pursuant to the Court's inherent equitable authority under the constitutional and substantial benefit theories and any other applicable provision of law. *De Young v. Brown*, 368 Or 64 (2021).

PRAYER FOR RELIEF

WHEREFORE, Plaintiffs request judgment against Defendants as follows:

1. For entry of Judgment against Defendants;

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2. On Plaintiffs' First Claim for Relief, for entry of a declaration under the Oregon Uniform Declaratory Judgment Act that BM114 is unconstitutional on its face pursuant to Article 1, Section 27 of the Oregon State Constitution, and entry of a permanent injunction permanently enjoining Defendants and their officers, agents, and employees from enforcing BM114 in its entirety, or in such portions and applications as the Court finds to be unconstitutional;

3. Plaintiffs' reasonable attorney fees and costs pursuant to this Court's inherent equitable authority under the constitutional and substantial benefit theories; and

4. Any other relief as this Court may deem just and proper.

DATED: **December 2, 2022**

Tyler Smith and Associates, PC

By /s/ Tyler D. Smith
Tyler D. Smith, OSB #075287
Tony L. Aiello, Jr., OSB #203404
Of Attorneys for Plaintiffs
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Tyler@RuralBusinessAttorneys.com
Tony@RuralBusinessAttorneys.com

VERIFICATION

WE, the undersigned, individually or on behalf of our respective corporations named as Plaintiffs to this action, declare under penalty of perjury that we have read the foregoing Complaint for Declaratory and Injunctive Relief, and the matters and things stated therein are true to the best of our knowledge and belief.

Dated: Dec 2, 2022

Joseph Arnold, Individually

Dated: Dec 2, 2022

Cliff Asmussen, Individually

Dated: 12-2-22

Erich Pratt

Erich Pratt, Senior Vice President of Gun Owners of America, Inc.

Dated: 12-2-22

Erich Pratt

Erich Pratt, Senior Vice President of Gun Owners Foundation

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MAY 4, 2021 9:20am
Elections Division

PREAMBLE

Whereas the People of the State of Oregon have seen a sharp increase in gun sales, gun violence, and raised fear in Oregonians of armed intimidation, it is imperative to enhance public health and safety in all communities; and

Whereas the gun violence in Oregon and the United States, resulting in horrific deaths and devastating injuries due to mass shootings, homicides and suicides is unacceptable at any level, and the availability of firearms, including semiautomatic assault rifles and pistols with accompanying large-capacity ammunition magazines, pose a grave and immediate risk to the health, safety and well-being of the citizens of this State, particularly our youth; and

Whereas Oregon currently has no permit requirements for purchasing a semiautomatic assault firearm or any other type of weapon and studies have shown that permits-to-purchase reduce firearm-related injuries and death and studies further have shown that firearm ownership or access to firearms triples the risk of suicide and doubles the risk of homicide when compared to someone who does not have access, this measure will require that anyone purchasing a firearm must first complete a safety training course, successfully pass a full background check and, only then, will an individual be granted a permit-to-purchase a firearm, so that firearms are kept out of dangerous hands; and

Whereas large-capacity magazines are often associated with semiautomatic assault rifles, and can also be used with many semiautomatic firearms including shotguns and pistols, and estimates suggest that nearly 40% of crime guns used in serious violent crimes, including attacks on law enforcement officers, are equipped with large-capacity magazines; and

Whereas firearms equipped with large-capacity magazines increase casualties by allowing a shooter to continue firing for longer periods of time before reloading, thus explaining their use in all 10 of the deadliest mass shootings since 2009, and in mass shooting events from 2009 to 2018 where the use of large-capacity magazines caused twice as many deaths and 14 times as many injuries, including the 2015 shooting at Umpqua Community College in Roseburg, Oregon in which 10 people were killed and 7 more were injured; and

Whereas restrictions on high-capacity magazines during the 10-year federal ban from 1994-2004 and the ban in over nine (9) states and the District of Columbia have been found to reduce the number of fatalities and injuries in shooting incidents, this measure will enhance the safety of residents, particularly children, of this state by prohibiting the manufacture, sale, or transfer of large-capacity ammunition magazines and regulate the use of such magazines that are currently owned;

Now, therefore:

Be It Enacted by the People of the State of Oregon

SECTION 1. Sections 2 to 11 of this 2022 Act are added to and made a part of ORS 166.210 to 166.490.

SECTION 2. The People of the State of Oregon find and declare that regulation of sale, purchase and otherwise transferring of all firearms and restriction of the manufacture, import, sale, purchase, transfer, use and possession of ammunition magazines to those that hold no more than 10 rounds will promote the public health and safety of the residents of this state and this Act shall be known as the Reduction of Gun Violence Act.

DEFINTIONS

SECTION 3. Definitions. As used in sections 3 to 10 of this 2022 Act:

(1) "Criminal background check" has the same meaning given to this term in ORS 166.432(1)(a) to (e).

(2) "Department" means the Department of State Police.

(3) "Gun dealer" means a person engaged in the business, as defined in 18 U.S.C. 921, of selling, leasing or otherwise transferring a firearm, whether the person is a retail dealer, pawnbroker or otherwise.

(4) "Permit" or "permit-to-purchase" mean an authorization issued to a person to purchase or acquire a firearm, provided all other requirements at the time of purchase or acquisition are met.

(5) "Permit Agent" means a county sheriff or police chief with jurisdiction over the residence of the person making an application for a permit-to-purchase, or their designees.

(6) "Transfer" has the meaning given that term in ORS 166.435(1)(a).

(7) "Transferor" means a person who is not a gun dealer or licensed as a manufacturer or importer under 18 U.S.C. 923

and who intends to deliver a firearm to a transferee.

PERMIT-TO-PURCHASE PROCESS

SECTION 4.

(1)(a) A person may apply for a permit-to-purchase a firearm or firearms under this section to the police chief or county sheriff with jurisdiction over the residence of the person making the application, or their designees, hereinafter referred to as "permit agent".

(b) A person is qualified to be issued a permit-to-purchase under this section if the person:

(A) Is not prohibited from purchasing or acquiring a firearm under state or federal law, including but not limited to successfully completing a criminal background check as described under paragraph (e) of this subsection;

(B) Is not the subject of an order described in ORS 166.525 to 166.543;

(C) Does not present reasonable grounds for a permit agent to conclude that the applicant has been or is reasonably likely to be a danger to self or others, or to the community at large, as a result of the applicant's mental or psychological state or as demonstrated by the applicant's past pattern of behavior involving unlawful violence or threats of unlawful violence;

(D) Provides proof of completion of a firearm safety course as defined in subsection (8) of this section; and

(E) Pays the fee described in paragraph (b) of subsection (3) of this section.

(c) An application for a permit under this section must state the applicant's legal name, current address and telephone number, date and place of birth, physical description, and any additional information determined necessary by department rules. The application must be signed by the applicant in front of the permit agent.

(d) The permit agent shall verify the applicant's identity with a government-issued form of identification bearing a photograph of the applicant.

(e) The applicant must submit to fingerprinting and photographing by the permit agent. The permit agent shall fingerprint and photograph the applicant and shall conduct any investigation necessary to determine whether the applicant meets the qualifications described in paragraph (b) of this section. The permit agent shall request the department to conduct a criminal background check, including but not limited to a fingerprint identification, through the Federal Bureau of Investigation. The Federal Bureau of Investigation shall return the fingerprint cards used to conduct the criminal background check and may not keep any record of the fingerprints. Upon completion of the criminal background check and determination of whether the permit applicant is qualified or disqualified from purchasing or otherwise acquiring a firearm the department shall report the results, including the outcome of the fingerprint-based criminal background check, to the permit agent.

(2)(a) If during the background check, the department determines that:

(A) A purchaser is prohibited from possessing a firearm under ORS 166.250 (1)(c), the department shall report the attempted application for a permit, the purchaser's name and any other personally identifiable information to all federal, state and local law enforcement agencies and district attorneys that have jurisdiction over the location or locations where the attempted application for a permit was made and where the permit applicant resides;

(B) Based on the judgment of conviction, the permit applicant is prohibited from possessing a firearm as a condition of probation or that the permit applicant is currently on post-prison supervision or parole, the department shall report the attempted application for a permit to the permit applicant's supervising officer and the district attorney of the county in which the conviction occurred.

(C) The permit applicant is prohibited from possessing a firearm due to a court order described in ORS 166.255 (1)(a), the department shall report the attempted application for a permit to the court that issued the order.

(D) The permit applicant is under the jurisdiction of the Psychiatric Security Review Board, the department shall report the attempted application for a permit to the board.

(b) Reports required by paragraphs (A) to (D) of subsection (2)(a) shall be made within 24 hours after the determination is made, unless a report would compromise an ongoing investigation, in which case the report may be delayed as long as necessary to avoid compromising the investigation.

(c) On or before January 31 of each year, beginning in 2024, the department shall annually publish a report indicating for each county the number of applications made to any permit agent, the number of permits-to-purchase issued and the number of permits-to-purchase denied and the reasons for denial. The department may, by rule, include any additional

information that it determines would be helpful to ensuring the permit-to-purchase process is being administered in a consistent and equitable manner.

(3)(a) Within 30 days of receiving an application for a permit under this section, if the permit agent has verified the applicant's identity and determined that the applicant has met each of the qualifications described in paragraph (1)(b) of this section, the permit agent shall issue the permit-to-purchase.

(b) The permit agent may charge a reasonable fee reflecting the actual cost of the process but shall not exceed $65, including the cost of fingerprinting, photographing and obtaining a criminal background check.

(4)(a) The department shall develop:

(A) A standardized application form for a permit under this section; and

(B) A form in quadruplicate for use by permit agents in issuing permits under this section.

(b) The issuing permit agent shall maintain a copy of each permit issued under this section.

(c) The person named in a permit shall:

(A) Maintain a copy of the permit as long as the permit is valid.

(B) Present a copy of the permit to the gun dealer or transferor of a firearm when required under ORS 166.412, 166.435, 166.436 or 166.438.

(5)(a) The permit agent shall report the issuance of a permit under this section to the department, and shall provide to the department a copy of the permit and any information necessary for the department to maintain an electronic searchable database of all permits issued under this section. A permit agent revoking a permit shall report the revocation to the department at the time that notice of the revocation has been sent to the permit holder.

(b) The department shall maintain the electronic database described in paragraph (a) of this subsection by ensuring that new permits are added to the database, renewed permits are assigned a new expiration date, and expired or revoked permits are marked expired or revoked but retained in the database.

(6)(a) A permit-to-purchase issued under this section does not create any right of the permit holder to receive a firearm.

(b) A permit-to-purchase issued under this section is not a limit on the number of firearms the permit holder may purchase or acquire during the time period when the permit is valid.

(7)(a) A permit-to-purchase issued under this section is valid for five years from the date of issuance, unless revoked.

(b) A person may renew an unexpired permit issued under this section by repeating the procedures set forth in subsection (1) of this section, except:

(A) A full finger print set does not need to be taken again if the original set has been retained by the permit agent or is otherwise available; and

(B) The training course does not need to be completed, provided the course previously taken fully complies with each of the requirements set forth in subsection 8 of this section.

(c)The permit agent may charge a reasonable fee for renewal of the permit, reflecting the actual cost of the process but shall not exceed $50, including the cost of obtaining a criminal background check and photographing.

(8) As used in this section, "proof of completion of a firearm safety course" means the following:

(a) Proof of completion of any firearms training course or class available to the general public that is offered by law enforcement, a community college, or a private or public institution or organization or firearms training school utilizing instructors certified by a law enforcement agency, and that includes the components set forth in paragraph (c) of this subsection; or

(b) Proof of completion of any law enforcement firearms training course or class that is offered for security guards, investigators, reserve law enforcement officers, or any other law enforcement officers, and that includes the components set forth in paragraph (c) of this subsection;

(c) A firearms training course or class required for issuance of a permit-to-purchase must include:

(A) Review of federal and state laws in place at the time of the class and other safe practices related to ownership, purchase, transfer, use and transportation of firearms;

(B) Review of federal and state safe storage laws in place at the time of the class and other safe practices related to safe storage, including reporting lost and stolen guns;

(C) Prevention of abuse or misuse of firearms, including the impact of homicide and suicide on families, communities and the country as a whole; and

(D) In-person demonstration of the applicant's ability to lock, load, unload, fire and store a firearm before an instructor certified by a law enforcement agency. This requirement may be met separately from the other course requirements in subpargagraphs (A), (B) and (C) of paragraph (c), which may be completed in an on-line course, provided the on-line course has been conducted by a trainer certified by law enforcement.

(d) Proof of successful completion of a training course in order to meet the requirements for a concealed handgun license issued under ORS 166.291 and 166.292 may be submitted for a permit as a substitute for the requirements in paragraph (c) of this subsection, provided the completed course included each of the components set forth in paragraph (c) of this subsection.

(9) The department may adopt rules to carry out the provisions of this section.

PERMIT-TO-PURCHASE DUE PROCESS APPEAL

SECTION 5. (1) If the application for the permit-to-purchase is denied, the permit agent shall set forth in writing the reasons for the denial. The denial shall be placed in the mail to the applicant by certified mail, restricted delivery, within 30 days after the application was made. If no decision is issued within 30 days, the person may seek review under the procedures in subsection (5) of this section.

(2) Notwithstanding subsections (1) to (3) of section 4 of this 2022 Act, and subject to review as provided in subsection (5) of this section, a permit agent may deny a permit-to-purchase if the permit agent has reasonable grounds to believe that the applicant has been or is reasonably likely to be a danger to self or others, or to the community at large, as a result of the applicant's mental or psychological state or as demonstrated by the applicant's past pattern of behavior involving unlawful violence or threats of unlawful violence.

(3)(a) Any act or condition that would prevent the issuance of a permit-to-purchase is cause for revoking a permit-to-purchase.

(b) A permit agent may revoke a permit by serving upon the permittee a notice of revocation. The notice must contain the grounds for the revocation and must be served either personally or by certified mail, restricted delivery. The notice and return of service shall be included in the file of the permit holder. The revocation is effective upon the permit holder's receipt of the notice.

(4) Any peace officer or corrections officer may seize a permit-to-purchase and return it to the issuing permit agent if the permit is held by a person who has been arrested or cited for a crime that can or would otherwise disqualify the person from being issued a permit. The issuing permit agent shall hold the permit for 30 days. If the person is not charged with a crime within the 30 days, the permit agent shall return the permit unless the permit agent revokes the permit as provided in subsection (3) of this section.

(5) A person denied a permit-to-purchase or whose permit is revoked or not renewed may petition the circuit court in the petitioner's county of residence to review the denial, nonrenewal or revocation. The petition must be filed within 30 days after the receipt of the notice of denial or revocation.

(6) The judgment affirming or overturning the permit agent's decision shall be based on whether the petitioner meets the criteria that are used for issuance of a permit-to-purchase and, if the petitioner was denied a permit, whether the permit agent has reasonable grounds for denial under subsection (2) of this section. Whenever the petitioner has been previously sentenced for a crime under ORS 161.610 (Enhanced penalty for use of firearm during commission of felony) or for a crime of violence for which the person could have received a sentence of more than 10 years, the court shall grant relief only if the court finds that relief should be granted in the interest of justice.

(7) Notwithstanding the provisions of ORS 9.320 (Necessity for employment of attorney), a party that is not a natural person, the state or any city, county, district or other political subdivision or public corporation in this state, without appearance by attorney, may appear as a party to an action under this section.

(8) Petitions filed under this section shall be heard and disposed of within 15 judicial days of filing or as soon as practicable thereafter.

(9) Filing fees for actions shall be as for any civil action filed in the court. If the petitioner prevails, the amount of the filing fee shall be paid by the respondent to the petitioner and may be incorporated into the court order.

(10) Initial appeals of petitions shall be heard de novo.

(11) Any party to a judgment under this section may appeal to the Court of Appeals in the same manner as for any other civil action.

(12) If the governmental entity files an appeal under this section and does not prevail, it shall be ordered to pay the attorney fees for the prevailing party.

REQUIRES PERMITS FOR LICENSED DEALER SALES

SECTION 6. ORS 166.412 is amended to read:

(1) As used in this section:

(a) "Antique firearm" has the meaning given that term in 18 U.S.C. 921;

(b) "Department" means the Department of State Police;

(c) "Firearm" has the meaning given that term in ORS 166.210, except that it does not include an antique firearm;

(d) "Firearms transaction record" means the firearms transaction record required by 18 U.S.C. 921 to 929;

(e) "Firearms transaction thumbprint form" means a form provided by the department under subsection (11) of this section;

(f) "Gun dealer" means a person engaged in the business, as defined in 18 U.S.C. 921, of selling, leasing or otherwise transferring a firearm, whether the person is a retail dealer, pawnbroker or otherwise; and

(g) "Purchaser" means a person who buys, leases or otherwise receives a firearm from a gun dealer.

(2) Except as provided in subsection[~~s (3)(c) and~~] (12) of this section, a gun dealer shall comply with the following before a firearm is delivered to a purchaser:

(a) The purchaser shall present to the gun dealer current identification meeting the requirements of subsection (4) of this section **and a valid permit issued under section 4 of this 2022 Act**.

(b) The gun dealer shall complete the firearms transaction record and obtain the signature of the purchaser on the record.

(c) The gun dealer shall obtain the thumbprints of the purchaser on the firearms transaction thumbprint form and attach the form to the gun dealer's copy of the firearms transaction record to be filed with that copy.

(d) The gun dealer shall**,** [~~request~~] by telephone **or computer, verify that the purchaser has a valid permit-to-purchase a firearm issued under section 4 of this 2022 Act and request** that the department conduct a criminal history record check on the purchaser and shall provide the following information to the department:

(A) The federal firearms license number of the gun dealer;

(B) The business name of the gun dealer;

(C) The place of transfer;

(D) The name of the person making the transfer;

(E) The make, model, caliber and manufacturer's number of the firearm being transferred;

(F) The name and date of birth of the purchaser;

(G) The Social Security number of the purchaser if the purchaser voluntarily provides this number to the gun dealer; and

(H) The type, issuer and identification number of the identification presented by the purchaser.

(e) The gun dealer shall receive a unique approval number for the transfer from the department and record the approval number on the firearms transaction record and on the firearms transaction thumbprint form.

(f) The gun dealer may destroy the firearms transaction thumbprint form five years after the completion of the firearms transaction thumbprint form.

(3)(a) Upon receipt of a request of the gun dealer for a criminal history record check, the department shall immediately, during the gun dealer's telephone call or by return call:

(A) Determine, from criminal records and other information available to it, whether the purchaser is disqualified under ORS 166.470 from completing the purchase; and

(B) Notify the gun dealer when a purchaser is disqualified from completing the transfer or provide the gun dealer with a unique approval number indicating that the purchaser is qualified to complete the transfer.

(b) If the department is unable to determine if the purchaser is qualified or disqualified from completing the transfer within 30 minutes, the department shall notify the gun dealer and provide the gun dealer with an estimate of the time when the department will provide the requested information.

(c) **The dealer may not transfer the firearm unless the dealer receives a unique approval number from the department and, within 48 hours of completing the transfer, the dealer shall notify the state that the transfer to the permit holder was completed**. [~~If the department fails to provide a unique approval number to a gun dealer or to notify the gun dealer that the purchaser is disqualified under paragraph (a) of this subsection before the close of the gun dealer's next business day following the request by the gun dealer for a criminal history record check, the gun dealer may deliver the firearm to the purchaser.~~]

(4)(a) Identification required of the purchaser under subsection (2) of this section shall include one piece of current identification bearing a photograph and the date of birth of the purchaser that:

(A) Is issued under the authority of the United States Government, a state, a political subdivision of a state, a foreign government, a political subdivision of a foreign government, an international governmental organization or an international quasi-governmental organization; and

(B) Is intended to be used for identification of an individual or is commonly accepted for the purpose of identification of an individual.

(b) If the identification presented by the purchaser under paragraph (a) of this subsection does not include the current address of the purchaser, the purchaser shall present a second piece of current identification that contains the current address of the purchaser. The Superintendent of

State Police may specify by rule the type of identification that may be presented under this paragraph.

(c) The department may require that the gun dealer verify the identification of the purchaser if that identity is in question by sending the thumbprints of the purchaser to the department.

(5) The department shall establish a telephone number that shall be operational seven days a week between the hours of 8 a.m. and 10 p.m. for the purpose of responding to inquiries from gun dealers for a criminal history record check under this section.

(6) No public employee, official or agency shall be held criminally or civilly liable for performing the investigations required by this section provided the employee, official or agency acts in good faith and without malice.

(7)(a) The department may retain a record of the information obtained during a request for a criminal history record check for no more than five years**, except for the information provided to the dealer under subsection (2)(d) of this section, sufficient to reflect each firearm purchased by a permit holder, which must be attached to the electronic record of the permit stored by the department. The department may develop a system for removal of the information in subsection (2)(d)(E) of this section, upon proof of sale or transfer of the firearm to another permit holder and for recording of the information to reflect the transfer of ownership to the permit of the new owner**.

(b) The record of the information obtained during a request for a criminal history record check by a gun dealer is exempt from disclosure under public records law.

(c) If the department determines that a purchaser is prohibited from possessing a firearm under ORS 166.250 (1)(c), the department shall report the attempted transfer, the purchaser's name and any other personally identifiable information to all federal, state and local law enforcement agencies and district attorneys that have jurisdiction over the location or locations where the attempted transfer was made and where the purchaser resides.

(d) If the department determines that, based on the judgment of conviction, the purchaser is prohibited from possessing a firearm as a condition of probation or that the purchaser is currently on post-prison supervision or parole, the department shall report the attempted transfer to the purchaser's supervising officer and the district attorney of the county in which the conviction occurred.

(e) If the department determines that the purchaser is prohibited from possessing a firearm due to a court order described in ORS 166.255 (1)(a), the department shall report the attempted transfer to the court that issued the order.

(f) If the department determines that the purchaser is under the jurisdiction of the Psychiatric Security Review Board, the department shall report the attempted transfer to the board.

(g) Reports required by paragraphs (c) to (f) of this subsection shall be made within 24 hours after the determination is made, unless a report would compromise an ongoing investigation, in which case the report may be delayed as long as necessary to avoid compromising the investigation.

(h) On or before January 31 of each year, a law enforcement agency or a prosecuting attorney's office that received a report pursuant to paragraph (c) of this subsection during the previous calendar year shall inform the department of any action that was taken concerning the report and the outcome of the action.

(i) The department shall annually publish a written report, based on any information received under paragraph (h) of this subsection, detailing the following information for the previous year:

(A) The number of purchasers whom the department determined were prohibited from possessing a firearm under ORS 166.250 (1)(c), arranged by category of prohibition;

(B) The number of reports made pursuant to paragraph (c) of this subsection;

(C) The number of investigations arising from the reports made pursuant to paragraph (c) of this subsection, the number of investigations concluded and the number of investigations referred for prosecution, all arranged by category of prohibition; and

(D) The number of criminal charges arising from the reports made pursuant to paragraph (c) of this subsection and the disposition of the charges, both arranged by category of prohibition.

(8) A law enforcement agency may inspect the records of a gun dealer relating to transfers of firearms with the consent of a gun dealer in the course of a reasonable inquiry during a criminal investigation or under the authority of a properly authorized subpoena or search warrant.

(9) When a firearm is delivered, it shall be unloaded.

(10) In accordance with applicable provisions of ORS chapter 183, the Superintendent of State Police may adopt rules necessary for:

(a) The design of the firearms transaction thumbprint form;

(b) The maintenance of a procedure to correct errors in the criminal records of the department;

(c) The provision of a security system to identify gun dealers that request a criminal history record check under subsection (2) of this section; and

(d) The creation and maintenance of a database of the business hours of gun dealers.

(11) The department shall publish the firearms transaction thumbprint form and shall furnish the form to gun dealers on application at cost.

(12) This section does not apply to transactions between persons licensed as dealers under 18 U.S.C 923.

(13)(a) If requested by a transferor who is not a gun dealer, a gun dealer may request a criminal background check pursuant to ORS 166.435 or 166.438 and may charge a reasonable fee for providing the service.

(b) A gun dealer that requests a criminal background check under this subsection is immune from civil liability for any use of the firearm by the recipient or transferee, provided that the gun dealer requests the criminal background check as described in this section **and also provided that the dealer verifies that the recipient has a valid permit-to-purchase the firearm and the dealer has received a unique approval number from the department indicating successful completion of the background check**.

(14) Knowingly selling or delivering a firearm to a purchaser or transferee who does not have a valid permit-to-purchase a firearm in violation of subsection 2(d) of this section, or prior to receiving a unique approval number from the department based on the criminal background check in violation of subsection 3(c) of this section, is a Class A misdemeanor.

REQUIRES PERMITS FOR PRIVATE TRANSFERS

SECTION 7. ORS 166.435 is amended to read:

(1) As used in this section:

(a) "Transfer" means the delivery of a firearm from a transferor to a transferee, including, but not limited to, the sale, gift, loan or lease of the firearm. "Transfer" does not include the temporary provision of a firearm to a transferee if the transferor has no reason to believe the transferee is

prohibited from possessing a firearm or intends to use the firearm in the commission of a crime, and the provision occurs:

(A) At a shooting range, shooting gallery or other area designed for the purpose of target shooting, for use during target practice, a firearms safety or training course or class or a similar lawful activity;

(B) For the purpose of hunting, trapping or target shooting, during the time in which the transferee is engaged in activities related to hunting, trapping or target shooting;

(C) Under circumstances in which the transferee and the firearm are in the presence of the transferor;

(D) To a transferee who is in the business of repairing firearms, for the time during which the firearm is being repaired;

(E) To a transferee who is in the business of making or repairing custom accessories for firearms, for the time during which the accessories are being made or repaired; or

(F) For the purpose of preventing imminent death or serious physical injury, and the provision lasts only as long as is necessary to prevent the death or serious physical injury.

(b) "Transferee" means a person who is not a gun dealer or licensed as a manufacturer or importer under 18 U.S.C. 923 and who intends to receive a firearm from a transferor.

(c) "Transferor" means a person who is not a gun dealer or licensed as a manufacturer or importer under 18 U.S.C. 923 and who intends to deliver a firearm to a transferee.

(2) Except as provided in ORS 166.436 and 166.438 and subsection (4) of this section, a transferor may not transfer a firearm to a transferee unless the transfer is completed through a gun dealer as described in subsection (3) of this section.

(3)(a) A transferor may transfer a firearm to a transferee only as provided in this section. Except as provided in paragraph (b) of this subsection, prior to the transfer both the transferor and the transferee must appear in person before a gun dealer, with the firearm **and a valid permit-to-purchase issued to the transferee under section 4 of this 2022 Act**, and request that the gun dealer perform a criminal background check on the transferee.

(b) If the transferor and the transferee reside over 40 miles from each other, the transferor may ship or deliver the firearm to a gun dealer located near the transferee or a gun dealer designated by the transferee, and the transferor need not appear before the gun dealer in person.

(c) A gun dealer who agrees to complete a transfer of a firearm under this section shall request a criminal history record check on the transferee as described in ORS 166.412 and shall comply with all requirements of federal law.

(d) If, upon completion of a criminal background check, the gun dealer:

(A) Receives a unique approval number from the Department of State Police indicating that the transferee is qualified to complete the transfer, the gun dealer shall notify the transferor, enter the firearm into the gun dealer's inventory and transfer the firearm to the transferee.

(B) Receives notification that the transferee is prohibited by state or federal law from possessing or receiving the firearm **or that the department is unable to determine if the transferee is qualified or disqualified from completing the transfer**, the gun dealer shall notify the transferor and neither the transferor nor the gun dealer shall transfer the firearm to the transferee. If the transferor shipped or delivered the firearm to the gun dealer pursuant to paragraph (b) of this subsection, the gun dealer shall comply with federal law when returning the firearm to the transferor.

(e) A gun dealer may charge a reasonable fee for facilitating a firearm transfer pursuant to this section.

(4) The requirements of subsections (2) and (3) of this section do not apply to:

(a) The transfer of a firearm by or to a law enforcement agency, or by or to a law enforcement officer, private security professional or member of the Armed Forces of the United States, while that person is acting within the scope of official duties.

(b) The transfer of a firearm as part of a firearm turn-in or buyback event, in which a law enforcement agency receives or purchases firearms from members of the public.

(c) The transfer of a firearm to:

(A) A transferor's spouse or domestic partner;

(B) A transferor's parent or stepparent;

(C) A transferor's child or stepchild;

(D) A transferor's sibling;

(E) A transferor's grandparent;

(F) A transferor's grandchild;

(G) A transferor's aunt or uncle;

(H) A transferor's first cousin;

(I) A transferor's niece or nephew; or

(J) The spouse or domestic partner of a person specified in subparagraphs (B) to (I) of this paragraph.

(d) The transfer of a firearm that occurs because of the death of the firearm owner, provided that:

(A) The transfer is conducted or facilitated by a personal representative, as defined in ORS 111.005, or a trustee of a trust created in a will; and

(B) The transferee is related to the deceased firearm owner in a manner specified in paragraph (c) of this subsection.

(5)(a) A transferor who fails to comply with the requirements of this section commits a Class A misdemeanor.

(b) Notwithstanding paragraph (a) of this subsection, a transferor who fails to comply with the requirements of this section commits a Class B felony if the transferor has a previous conviction under this section at the time of the offense.

REQUIRES PERMITS FOR ALL TRANSFERS AT GUN SHOWS

SECTION 8. ORS 166.436 is amended to read:

(1) The Department of State Police shall make the telephone number established under ORS 166.412 (5) available for requests for criminal background checks under this section from persons who are not gun dealers and who are transferring firearms at gun shows.

(2) Prior to transferring a firearm at a gun show, a transferor who is not a gun dealer [~~may request~~] **shall** by telephone **verify that the transferee has a valid permit-to-purchase a firearm under section 4 of this 2022 Act and request** that the department conduct a criminal background check on the recipient upon providing the following information to the department:

(a) The name , address and telephone number of the transferor;

(b) The make , model, caliber and manufacturer's number of the firearm being transferred;

(c) The name, date of birth , race, sex and address of the recipient ;

(d) The Social Security number of the recipient if the recipient voluntarily provides that number ;

(e) The address of the place where the transfer is occurring; and

(f) The type, issuer and identification number of a current piece of identification bearing a recent photograph of the recipient presented by the recipient. The identification presented by the recipient must meet the requirements of ORS 166.412 (4)(a).

(3)(a) Upon receipt of a request for a criminal background check under this section, the department shall immediately, during the telephone call or by return call:

(A) Determine from criminal records and other information available to it whether the recipient is disqualified under ORS 166.470 from completing the transfer or is otherwise prohibited by state or federal law from possessing a firearm; and

(B) Notify the transferor when a recipient is disqualified from completing the transfer or provide the transferor with a unique approval number indicating that the recipient is qualified to complete the transfer. The unique approval number is a permit valid for 24 hours for the requested transfer. If the firearm is not transferred from the transferor to the recipient within 24 hours after receipt of the unique approval number, a new request must be made by the transferor.

(b) If the department is unable to determine whether the recipient is qualified for or disqualified from completing the transfer within 30 minutes of receiving the request , the department shall notify the transferor and provide the transferor with an estimate of the time when the department will provide the requested information.

(c) The transferor may not transfer the firearm unless the transferor receives a unique approval number from the department and, within 48 hours of the completed transfer, the transferor shall notify the state that the transfer to the permit holder was completed.

(4) A public employee or public agency incurs no criminal or civil liability for performing the criminal background checks required by this section, provided the employee or agency acts in good faith and without malice.

(5)(a) The department may retain a record of the information obtained during a request for a criminal background check under this section for the period of time provided in ORS 166.412 (7), **as amended by this 2022 Act**.

(b) The record of the information obtained during a request for a criminal background check under this section is exempt from disclosure under public records law.

(c) If the department determines that a recipient is prohibited from possessing a firearm under ORS 166.250 (l)(c), the department shall report the attempted transfer, the recipient's name and any other personally identifiable information to all federal, state and local law enforcement agencies and district attorneys that have jurisdiction over the location or locations where the attempted transfer was made and where the recipient resides.

(d) If the department determines that, based on the judgment of conviction, the recipient is prohibited from possessing a firearm as a condition of probation or that the recipient is currently on post-prison supervision or parole, the department shall report the attempted transfer to the recipient's supervising officer and the district attorney of the county in which the conviction occurred.

(e) If the department determines that the recipient is prohibited from possessing a firearm due to a court order described in ORS 166.255 (1)(a), the department shall report the attempted transfer to the court that issued the order.

(f) If the department determines that the recipient is under the jurisdiction of the Psychiatric Security Review Board, the department shall report the attempted transfer to the board.

(g) Reports required by paragraphs (c) to (f) of this subsection shall be made within 24 hours after the determination is made, unless a report would compromise an ongoing investigation, in which case the report may be delayed as long as necessary to avoid compromising the investigation.

(h) On or before January 31 of each year, a law enforcement agency or a prosecuting attorney's office that received a report pursuant to paragraph (c) of this subsection during the previous calendar year shall inform the department of any action that was taken concerning the report and the outcome of the action.

(i) The department shall annually publish a written report, based on any information received under paragraph (h) of this subsection, detailing the following information for the previous year:

(A) The number of recipients whom the department determined were prohibited from possessing a firearm under ORS 166.250 (1)(c), arranged by category of prohibition;

(B) The number of reports made pursuant to paragraph (c) of this subsection;

(C) The number of investigations arising from the reports made pursuant to paragraph (c) of this subsection, the number of investigations concluded and the number of investigations referred for prosecution, all arranged by category of prohibition; and

(D) The number of criminal charges arising from the reports made pursuant to paragraph (c) of this subsection and the disposition of the charges, both arranged by category of prohibition.

(6) The recipient of the firearm must be present when the transferor requests a criminal back-ground check under this section.

(7)(a) Except as otherwise provided in paragraph (b) of this subsection, a transferor who receives notification under this section that the recipient is qualified to complete the transfer of a firearm, has the recipient fill out the form required by ORS 166.438 (1)(a) and retains the form as required by ORS 166.438 (2) is immune from civil liability for any use of the firearm from the time of the transfer unless the transferor knows, or reasonably should know, that the recipient is likely to commit an unlawful act involving the firearm.

(b) The immunity provided by paragraph (a) of this subsection does not apply:

(A) If the transferor knows, or reasonably should know, that the recipient of the firearm intends to deliver the firearm to a third person who the transferor knows, or reasonably should know, may not lawfully possess the firearm; or

(B) In any product liability civil action under ORS 30.900 to 30.920.

REQUIRES PERMITS FOR ALL TRANSFERS AT GUN SHOWS (2015 Amendment)

SECTION 9. ORS 166.438 is amended to read:

(1) A transferor who is not a gun dealer may not transfer a firearm at a gun show unless the transferor:

(a)(A) Verifies with the department that the recipient has a valid permit-to-purchase issued under section 4 of this 2022 Act;

([~~A~~]**B**) Requests a criminal background check under ORS 166.436 prior to completing the transfer;

([~~B~~]**C**) Receives a unique approval number from the department indicating that the recipient is qualified to complete the transfer; and

([~~C~~]**D**) Has the recipient complete the form described in ORS 166.441; or

(b) Completes the transfer through a gun dealer.

(2) The transferor shall retain the completed form referred to in subsection (1) of this section for at least five years and shall make the completed form available to law enforcement agencies for the purpose of criminal investigations.

(3) A person who organizes a gun show shall post in a prominent place at the gun show a notice explaining the requirements of subsections (1) and (2) of this section. The person shall provide the form required by subsection (1) of this section to any person transferring a firearm at the gun show.

(4) Subsection (1) of this section does not apply if the transferee is licensed as a dealer under 18 U.S.C. 923.

(5)(a) Failure to comply with the requirements of subsection (1), (2) or (3) of this section is a Class A misdemeanor.

(b) Notwithstanding paragraph (a) of this subsection, failure to comply with the requirements of subsection (1), (2) or (3) of this section is a Class C felony if the person has two or more previous convictions under this section **at the time of the offense.**

(6) It is an affirmative defense to a charge of violating subsection (1) or (3) of this section that the person did not know, or reasonably could not know, that more than 25 firearms were at the site and available for transfer.

SECTION 10. The amendments to ORS 166.412, 166.435, 166.436 and 166.438 by sections 3 to 9 of this 2022 Act apply to firearm transfers conducted on or after the effective date of this 2022 Act.

PROHIBITIONS/EXCEPTIONS TO LARGE-CAPACITY MAGAZINES

SECTION 11. (1) As used in this section:

(a) "Armed Forces of the United States" has the meaning given that term in ORS 348.282.

(b) "Detachable magazine" means an ammunition feeding device that can be loaded or unloaded while detached from a firearm and readily inserted in a firearm;

(c) "Fixed magazine" means an ammunition feeding device contained in or permanently attached to a firearm in such a manner that the device cannot be removed without disassembly of the firearm action;

(d) "Large-capacity magazine" means a fixed or detachable magazine, belt, drum, feed strip, helical feeding device, or similar device, including any such device joined or coupled with another in any manner, or a kit with such parts, that has an overall capacity of, or that can be readily restored, changed, or converted to accept, more than 10 rounds of ammunition and allows a shooter to keep firing without having to pause to reload, but does not include any of the following:

(A) An ammunition feeding device that has been permanently altered so that it is not capable, now or in the future, of accepting more than 10 rounds of ammunition;

(B) An attached tubular device designed to accept, and capable of operating only with 0.22 caliber rimfire ammunition; or

(C) A tubular ammunition feeding device that is contained in a lever-action firearm.

(e) "Loaded" has the meaning given that term in ORS 166.360;

(f) "Person" means any natural person, corporation, partnership, fire or association.

(2) Notwithstanding ORS 166.250 to 166.470, and except as expressly provided in subsections (3) to (5) of this section, a person commits the crime of unlawful manufacture, importation, possession, use, purchase, sale or otherwise transferring of large-capacity magazines if the person manufactures, imports, possesses, uses, purchases, sells or otherwise transfers any large-capacity magazine in Oregon on or after the effective date of this 2022 Act.

(3) Subsection (2) of the section does not apply during the first 180 days following the effective date of this 2022 Act, with respect to:

(a) A licensed gun dealer that within 180 days of the effective date of this 2022 Act:

(A) Transfers or sells the large-capacity magazines in the gun dealer's inventory to a non-resident gun dealer or other transferee outside of this state;

(B) Purchases or acquires temporary custody from an owner of any large-capacity magazine for permanent removal from this state within the 180 days of the effective date of this 2022 Act;

(C) Permanently alters any large-capacity magazine in the gun dealer's inventory or custody so that it is not capable, upon alteration or in the future, of accepting more than 10 rounds of ammunition or permanently alter the magazine so it is no longer a; or

(D) Permanently disposes of the large-capacity magazines in the gun dealer's custody or inventory.

(b) A firearms manufacturer, properly licensed under federal, state and local law, that is a party to a contract, in existence and binding on the effective date of this 2022 Act, with an entity outside of this state, for the manufacture of large-capacity magazines, provided that:

(A) All manufacturing is completed no later than 180 days after the effective date of this 2022 Act; and

(B) The entity outside of Oregon receiving the large-capacity magazines is made aware in writing on or before the delivery of the ammunition devices of the restrictions pertaining to large-capacity magazines in this state as set forth in this 2022 Act.

(4) Subsection (2) of the section does not apply at any time to:

(a) A firearms manufacturer properly licensed under federal, state and local law that manufactures large-capacity magazines, provided:

(A) The manufacturing is for exclusive sale or transfer to the Armed Forces of the United States or a law enforcement agency and solely for authorized use by that entity related to the official duties of the entity; and

(B) Any large-capacity magazine, permitted to be manufactured under paragraph (a)(A) of this subsection after the effective date of this 2022 Act, shall include a permanent stamp or marking indicating that the large-capacity magazine was manufactured or assembled after the effective date of this 2022 Act. The stamp or marking must be legibly and conspicuously engraved or cast upon the outer surface of the large-capacity magazine. The department may promulgate such rules as may be necessary for the implementation of this section, including but not limited to rules requiring such large-capacity magazine be stamped with information indicating the limitation for use only by military and law enforcement or such other identification to distinguish clearly large-capacity magazines manufactured after the effective date of this 2022 Act. Except as provided in paragraph (3)(b) of this section, no large-capacity magazines without such stamp may be manufactured in this state after the effective date of this Act.

(b) A licensed gun dealer that sells or otherwise transfers large-capacity magazines to the Armed Forces of the United States or a law enforcement agency solely for authorized use by that entity, provided the large-capacity magazines have been engraved as provided in paragraph (a)(B) of this subsection.

(c) Any government officer, agent or employee, member of the Armed Forces of the United States or peace officer, as that term is defined in ORS 133.005, that is authorized to acquire, possess or use a large-capacity magazine provided that any acquisition, possession or use is related directly to activities within the scope of that person's official duties.

(5) As of the effective date of this 2022 Act, it shall be an affirmative defense, as provided in ORS 166.055, to the unlawful possession, use and transfer of a large-capacity magazine in this state by any person, provided that:

(a) The large-capacity magazine was owned by the person before the effective date of this 2022 Act and maintained in the person's control or possession; or

(b) The possession of a large-capacity magazine was obtained by a person who, on or after the effective date of this section, acquired possession of the large-capacity magazine by operation of law upon the death of a former owner who was in legal possession of the large-capacity magazine; and

(c) In addition to either (a) or (b) of this subsection the owner has not maintained the large-capacity magazine in a manner other than:

(A) On property owned or immediately controlled by the registered owner;

(B) On the premises of a gun dealer or gunsmith licensed under 18 U.S.C. 923 for the purpose of lawful service or repair;

(C) While engaging in the legal use of the large-capacity magazine, at a public or private shooting range or shooting gallery or for recreational activities such as hunting, to the extent permitted under state law; or

(D) While participating in firearms competition or exhibition, display or educational project about firearms sponsored, conducted by, approved or under the auspices of a law enforcement agency or a national or state-recognized entity that fosters proficiency in firearms use or promotes firearms education; and

(E) While transporting any large-capacity magazines in a vehicle to one of the locations authorized in paragraphs (c)(A) to (D) of this subsection, the large-capacity magazine is not inserted into the firearm and is locked in a separate container.

(d) The person has permanently and voluntarily relinquished the large-capacity magazine to law enforcement or to a buyback or turn-in program approved by law enforcement, prior to commencement of prosecution by arrest, citation or a formal charge.

(6) Unlawful manufacture, importation, possession, use, purchase, sale or otherwise transferring of a large-capacity magazine is a class A misdemeanor.

<u>SECTION 12.</u> If any provision of this 2022 Act or its application to any person or circumstance is held invalid, the invalidity does not affect other provisions or applications of this Act which can be given effect without the invalid provision or application, and to this end the provisions of this Act are severable. The people hereby declare that they would have adopted this Chapter, notwithstanding the unconstitutionality, invalidity and ineffectiveness of any one of its articles, sections, subsections, sentences or clauses.

<u>SECTION 13.</u> The provisions of this 2022 Act apply to all actions taken on or after the effective date of this 2022 Act, unless expressly stated otherwise herein. This 2022 Act may be known and cited as the Reduction of Gun Violence Act.

IN THE CIRCUIT COURT OF THE STATE OF OREGON

FOR THE COUNTY OF HARNEY

JOSEPH ARNOLD, CLIFF ASMUSSEN, GUN OWNERS OF AMERICA, INC., and GUN OWNERS FOUNDATION,

Plaintiffs,

v.

TINA KOTEK, Governor of the State of Oregon, in her official capacity; and ELLEN ROSENBLUM, Attorney General of the State of Oregon, in her official capacity, and CASEY CODDING, Superintendent of the Oregon State Police, in his official capacity,

Defendants.

Case No. 22CV41008

DEFENDANTS' MOTION FOR LEAVE TO FILE OFFERS OF PROOF

MOTION

Defendants move this Court for leave to file the attached offers of proof for the following witnesses: (1) Dr. Michael Siegel, (2) Dr. Melissa Brymer, (3) Joshua Friedlein, and (4) Paul Kemp.

MEMORANDUM OF LAW

This Court should permit defendants to file the attached offers of proof. Where a trial court excludes testimony, the proponent of the testimony must make an offer of proof to make a record that is susceptible to appellate review. "One method of making an offer of proof is by question and answer. It also is acceptable, however, for a party's counsel to state what the proposed evidence is expected to be." *State v. Phillips*, 314 Or 460, 466 (1992). "One purpose of the offer of proof is to apprise the court of the nature and bearing of the testimony in question, and the offer of proof must clearly and distinctly state specific evidentiary facts." *Edwards v.*

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Criteser, 269 Or 587, 595 (1974) (citation omitted). "The only situations in which an offer of proof is not required are those situations in which an offer of proof is impossible because of a trial court's refusal to allow the offer of proof to be made." *State v. Affeld*, 307 Or 125, 129 (1988). Here, the Court has excluded defendants' testimony and stated that it will not permit defendants to make offers of proof on excluded testimony. In response to these decisions, defendants bring this motion seeking leave to file offers of proof.

First, the Court should permit defendants to file an offer of proof for Dr. Brymer, Friedlein, and Kemp. On plaintiffs' motion in limine, this Court excluded testimony regarding "the impacts of tragedies on surviving family members," which plaintiffs reiterated and the Court confirmed during trial. Defendants understand this ruling to exclude the testimony of Dr. Brymer, Friedlein, and Kemp. Dr. Brymer is a clinical psychologist with extensive experience providing support services to surviving family members and communities affected by mass shooting events. Dr. Brymer would have provided expert testimony about the effects of shooting events on the family members of casualties and the community writ large. Friedlein is a survivor of the Umpqua Community College shooting, and Kemp is the family member of one of the victims of the Clackamas Town Center shooting; both would have testified about the effect these events had on them and their communities. Consistent with case law, defendants seek to file offers of proof for each of these witnesses to "clearly and distinctly" state the testimony each witness would have provided.

Second, the Court should permit defendants to file an offer of proof for the testimony of Dr. Siegel. This morning, the Court excluded Dr. Siegel's testimony on foundation grounds. Accordingly, defendants are entitled to make an offer to "clearly and distinctly" articulate the testimony that Dr. Siegel would have provided had he been permitted to testify.

At trial, this Court indicated that defendants waived their opportunity to file a formal offer of proof by not doing so a week before trial at a motion in limine hearing. Respectfully, defendants disagree. No case law requires a party to make a *pre*-trial offer of proof. This is especially true here where plaintiffs' motion identified the specific witnesses moved against and

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did not identify *any* of the four witnesses described here. Separately, requiring pre-trial offers of proof for witness testimony violates the Oregon rule against pre-trial witness and expert disclosures.

CONCLUSION

This Court should grant the defendants' motion for leave to file offers of proof.

DATED: September 22, 2023.

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IN THE CIRCUIT COURT OF THE STATE OF OREGON

FOR THE COUNTY OF HARNEY

JOSEPH ARNOLD, CLIFF ASMUSSEN, GUN OWNERS OF AMERICA, INC., and GUN OWNERS FOUNDATION, Plaintiffs, v. TINA KOTEK, Governor of the State of Oregon, in her official capacity; and ELLEN ROSENBLUM, Attorney General of the State of Oregon, in her official capacity, and CASEY CODDING, Superintendent of the Oregon State Police, in his official capacity, Defendants.	Case No. 22CV41008 **OFFER OF PROOF FOR DR. MICHAEL SIEGEL**

At the September 7, 2023 pretrial conference and at trial, the Court excluded evidence concerning the effectiveness of other states' permit-to-purchase laws and of large-capacity magazine restrictions. (9/7/23 Tr. 81:20-82:24.) If such evidence were not excluded, Dr. Michael Siegel would testify that:

- He reviewed all nine studies in the peer-reviewed literature that analyzed the impact of state-level gun permit requirements on firearm homicide rates. Those articles are attached to this offer of proof and summarized in Trial Exhibit 147, which Dr. Siegel authored and would testify represents a fair summary of the underlying writings.
- As Exhibit 147 summarizes, eight of the nine studies found that permit-to-purchase policies decrease homicide rates. The one study that found no statistically significant relationship reviewed homicide rates in only one year (1970) and thus is significantly less robust than the eight other studies.

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- These studies are strong evidence that background checks conducted through a gun permitting process are more effective than stand-alone background checks conducted at the point-of-sale without a permit requirement. This is likely because permitting involves a more intensive and localized examination of an applicant's criminal history and is more likely to pick up disqualifying misdemeanor offenses than a federal background check. Thus, he concludes that not only do state permitting laws reduce overall firearm homicide, but they also help to enhance the background check system that is in place in all states.
- Dr. Siegel also identified only two peer-reviewed studies that consider whether permit-to-purchase policies reduce the incidents of mass shootings. Both studies concluded that state permit-to-purchase policies reduce the occurrence of mass shootings, as summarized in Trial Exhibit 147.
- The totality of evidence supports that there is a causal relationship between use of large capacity magazines and mass shooting events, namely, an increase in the number of fatalities and injuries in those events.
- The totality of evidence supports that there is a causal relationship between state prohibitions of large capacity of magazines and mass shooting events, namely, a decrease in both the incidence and severity of public mass shootings.

The Court also excluded medical testimony concerning the lethality of contemporary firearms. (9/7/23 Tr. 79:11-18.) If such evidence were not excluded, Dr. Siegel would further testify there has been a large increase from 1990 to 2015 in the share of firearms produced that are of higher caliber and therefore greater lethality. *See* Smith VM, Siegel M, Xuan Z, Ross CS, Galea S, Kalesan B, Fleegler E, Goss KA. Broadening the perspective on gun violence: An examination of the firearms industry, 1990-2015. *American Journal of Preventive Medicine* 2017; 53(5):584-591. PMID: 28648260 (Siegel Offer of Proof Ex. 13).

In support of this offer, Defendants attach Defendants' Trial Exhibit 142 (Siegel Offer of Proof Ex. 14); Defendants' Trial Exhibit 146 and cited studies (Siegel Offer of Proof Exs. 15-

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20); Defendants' Trial Exhibit 153 and cited studies (Siegel Offer of Proof Exs. 21-25); and the transcript of Dr. Siegel's testimony at the trial of *Oregon Firearms Federation, Inc., et al v. Kotek, et al*, Case No. 2:22-cv-01815-IM (Lead Case) (D Or June 6, 2023) (Siegel Offer of Proof Ex. 26). Defendants note that although probative of some of Dr. Siegel's anticipated testimony here, the transcript from *Oregon Firearms Federation* is more limited in nature than what Dr. Siegel would have testified to before this Court.

DATED: September 22, 2023.

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TABLE B: Studies Examining the Effectiveness of State Gun Permit Requirements in Reducing Firearm Homicide Rates

Study, Date (years covered)	**Measure of State Firearms Laws**	**Outcome**
Overall Firearm Homicide Rates		
Liu, Siegel, and Sen, 2022[1] (2000-2019)	State-level permit requirements	State permit requirements were associated with statistically significantly lower rates of firearm homicide (1.79 per 100,000 population). Firearm homicide rates in a state were statistically significantly higher (10.6 per 100,000 population) if neighboring states failed to have a permit requirement.
McCourt et al., 2020[2] (1985-2017)	State-level permit requirements in Connecticut and Missouri	Permit requirements were associated with a statistically significantly lower firearm homicide rates (rates decreased by 28% in Connecticut after implementation of law; rates increased by 47% in Missouri after repeal of law)
Knopov et al., 2019[3] (1991-2016)	State-level permit requirements	Permit requirements were associated with a statistically significant 18% reduction in firearm homicide rates among both the White and Black populations.
Siegel et al., 2019[4] (1991-2016)	State-level permit requirements	Permit requirements were associated with a statistically significant 20% reduction in firearm homicide rates in both urban and non-urban areas.
Crifasi et al., 2018[5] (1984-2015)	State-level permit requirements	Permit requirements were associated with a statistically significant 14% reduction in firearm homicide rates in urban counties.
Rudolph et al., 2015[6] (1984-2005)	Enactment of permit to purchase law in Connecticut (compared before and after trends with those in 39 control states)	Implementation of law was associated with a statistically significant 40% reduction in the firearm homicide rate.
Webster et al., 2014[7] (1999-2012)	Repeal of purchase to permit law in Missouri (compared before and after trends with all other states)	Repeal of law was associated with a statistically significant 23% increase in the firearm homicide rate.
Lester and Murrell, 1982[8] (1960, 1970)	State restrictions on purchase of handguns (scale of 0-7)	No statistically significant relationship between state laws in 1968 and firearm homicide rates in 1970 (p-value not reported).
Sommers, 1980 (1977)[9]	State handgun licensing requirement	Licensing was associated with a statistically significant decrease in homicide rates (1.78 per 100,000 population).

DEFENDANTS' TRIAL EXHIBIT 147

Change in Incidence of Mass Shootings		
Siegel, Goder-Reiser, et al., 2020[10] (1976-2018)	State-level permit requirements	Permit requirements were statistically significantly associated with a 40% reduction in the incidence of mass public shootings.
Webster et al., 2020[11] (1984-2017)	State-level permit requirements	Permit requirements were statistically significantly associated with a 56% reduction in the incidence of mass shootings.

1 **Liu Y, Siegel M, Sen B. (2022)** Association of state-level firearm-related deaths with firearm laws in neighboring states. *JAMA Network Open*; 5(11):e2240750. https://doi.org/10.1001/jamanetworkopen.2022.40750.

2 **McCourt, Crifasi CK, Stuart EA, et al. (2020)** Purchaser licensing, point-of-sale background check laws, and firearm homicide and suicide in 4 US states, 1985-2017. *American Journal of Public Health*; 110(10):1546-1552. https://ajph.aphapublications.org/doi/epdf/10.2105/AJPH.2020.305822.

3 **Knopov A, Rothman EF, Cronin SW, Xuan Z, Siegel M, Hemenway D. (2019)** Impact of state firearm laws on homicide rates among the Black and White populations in the United States, 1991-2016. *Health and Social Work*; 44(4):232-240. https://academic.oup.com/hsw/article-abstract/44/4/232/5610107.

4 **Siegel M, Solomon B, Knopov A, Rothman EF, Cronin SW, Xuan Z, Hemenway D. (2020)** The impact of state firearm laws on homicide rates in suburban and rural areas compared to large cities in the United States, 1991-2016. *Journal of Rural Health*; 36(2):255-265. https://onlinelibrary.wiley.com/doi/10.1111/jrh.12387.

5 **Crifasi CK, Merrill-Francis M, McCourt A, Vernick JS, Wintemute GH, Webster DW. (2018)** Association between firearm laws and homicide in urban counties. *J Urban Health* 2018; 95:383-390. https://link.springer.com/article/10.1007/s11524-018-0273-3; Crifasi CK, Merrill-Francis M, McCourt A, Vernick JS, Wintemute GH, Webster DW. Correction to: Association between firearm laws and homicide in urban counties. *J Urban Health*; 95(5):773-776. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6181823/.

6 **Rudolph KE, Stuart EA, Vernick JS, Webster DW. (2015)** Association between Connecticut's permit-to-purchase handgun law and homicides. *American Journal of Public Health*; 105(8):e49-e54. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4504296/.

7 **Webster DW, Crifasi DK, Vernick JS. (2014)** Effects of repeal of Missouri's handgun purchaser licensing law on homicides. *J Urban Health*; 91(2):293-302. https://link.springer.com/article/10.1007/s11524-014-9865-8.

8 **Lester D, Murrell ME. (1982)** The preventive effect of strict gun control laws on suicide and homicide. *Suicide and Life-Threatening Behavior*; 12:131–140.

9 **Sommers PM. (1980)** Deterrence and gun control: An empirical analysis. *Atlantic Economic Journal*; 8:89-94.

10 **Siegel M, Goder-Reiser M, Duwe G, Rocque M, Fox JA, Fridel EE. (2020)** The relation between state gun laws and the incidence and severity of mass public shootings in the United States, 1976-2018. *Law and Human Behavior*; 44(5):347-360. https://content.apa.org/record/2020-78672-001.

11 **Webster, D. W., McCourt, A. D., Crifasi, C. K., Booty, M. D., & Stuart, E. A. (2020)**. Evidence concerning the regulation of firearms design, sale, and carrying on fatal mass shootings in the United States. *Criminology & Public Policy*, 19, 171–212. http://dx.doi.org/10.1111/1745-9133.12487.

JAMA Network Open

ER-48

Original Investigation | Public Health

Association of State-Level Firearm-Related Deaths With Firearm Laws in Neighboring States

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Abstract

IMPORTANCE Firearms are easily transported over state borders; hence permissive firearm laws in one state may have an interstate association with firearm-related deaths in nearby states.

OBJECTIVES To examine whether certain firearm laws have an interstate association with firearm-related deaths in nearby states.

DESIGN, SETTING, AND PARTICIPANTS This cross-sectional observational study used data on state firearm-related deaths in the 48 contiguous states of the US between January 1, 2000, and December 31, 2019. A spatial autoregressive model with fixed effects for state and year was used to evaluate within-state, interstate, and overall associations between firearm laws and firearm-related deaths. Analyses were performed during January 2022.

EXPOSURES The following 9 types of laws were evaluated: universal background checks for all firearms purchase, background checks for handgun sales at gun shows, license requirement to purchase all firearms, state dealer license requirement for handgun sales, requirement of retaining records of handgun sales, ban on purchasing a handgun on behalf of another, prohibition of firearm possession by persons who committed violent misdemeanors, required relinquishment of firearms for persons becoming prohibited from possessing them, and discretion in granting a concealed carry permit.

MAIN OUTCOMES AND MEASURES State-level total firearm-related death rates, suicide rates, and homicide rates.

RESULTS In sum, the study period included 662 883 firearm-related deaths of all intents. License requirement for firearm purchase had a within-state association (effect size, −1.79 [95% CI, −2.73 to −0.84]), interstate association (effect size, −10.60 [95% CI, −17.63 to −3.56]), and overall association (effect size, −12.38 [95% CI, −19.93 to −4.83]) per 100 000 population decrease in total firearm-related deaths. This law also had within-state association (effect size, −1.26 [95% CI, −1.72 to −0.80]), interstate association (effect size, −9.01 [95% CI, −15.00 to −3.02]), and overall association (effect size, −10.27 [95% CI, −16.53 to −4.01]) per 100 000 population decrease in firearm-related homicide.

CONCLUSIONS AND RELEVANCE The findings of this pooled cross-sectional analysis suggest that certain firearm laws in one state were associated with other states' firearm-related deaths. Synergic legislative action in adjacent states, federal firearm legislation, and measures that reduce migration of firearms across state borders should be part of the overarching strategy to prevent firearm-related deaths.

JAMA Network Open. 2022;5(11):e2240750. doi:10.1001/jamanetworkopen.2022.40750

Key Points

Question How are states' firearm laws associated with firearm-related deaths in nearby states?

Findings In this pooled cross-sectional analysis involving firearm laws and firearm-related deaths from 2000 to 2019 in the 48 contiguous states, a permit requirement for purchasing all firearms had an interstate association with decreased total firearm-related deaths and homicide, whereas the prohibition of firearm possession for individuals who have committed a violent misdemeanor had an interstate association with decreased firearm suicide.

Meaning These findings suggest that synergic legislative action to implement firearm laws in proximate states may help prevent firearm-related deaths.

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

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Introduction

Gun violence continues to be a major public health problem in the US. The years 2020 and 2021 have seen extraordinarily high numbers of gun-related fatalities.[1] The response from the political leadership continues to be polarized, with Democrat lawmakers calling for more stringent gun regulations and Republican lawmakers dismissing the need for and the effectiveness of such regulations. On June 23, 2021, the Biden-Harris administration announced its strategy to combat gun violence using funding from the Rescue Act,[2] a critical component of which addresses the flow of firearms used to commit crimes by launching multijurisdictional firearms trafficking strike forces to stop illegal gun trafficking across state lines.

Guns are easily transportable, and there are relatively few barriers to gun migration and gun trafficking from states with weak gun regulations to states with strong gun regulations. For example, crime gun tracing data suggest that, in high-regulation states, crime guns are more likely to have been purchased out of state.[3-5] Although actual firearm migration is difficult to measure, there is a growing body of research on interstate differences in gun regulations and within-state firearm-related violence.[6-9] A recent study by Liu et al[9] used data on all states from 2000 to 2017 and found that weaker firearm laws in neighboring states were associated with higher within-state firearm-related deaths and, further, that failing to account for weaker laws in neighboring states led to underestimation of the impact of the state's own laws on within-state firearm-related deaths.

The present study extends the work of Liu et al[9] in 2 critical ways. First, instead of considering the laws in neighboring states only, we used a spatial analysis approach that considers the geographical distance between all contiguous states in the US . Second, instead of aggregating across firearm laws, this study used a more granular approach toward categorizing firearm laws to better inform policy makers on which laws were most strongly associated with firearm-related deaths.

Methods

Study Sample

All states of the US were included in this cross-sectional study except Alaska and Hawaii because they are noncontiguous with other US states. The District of Columbia was excluded because it has no relevant entries on state laws in the State Firearm Law Database. The final analysis included the remaining 48 states. The study period was from January 1, 2000, to December 31, 2019. This study was deemed exempt from human participant review by the institutional review board of the University of Alabama at Birmingham. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Measures

The total numbers of firearm-related deaths by state from 2000 to 2019 were extracted from the Web-based Injury Statistics Query and Reporting System (WISQARS) of the Centers for Disease Control and Prevention[10] as main outcome variables, including deaths due to all intent, homicide excluding legal intervention, and suicide. WISQARS is a public-access, free online database that provides data on fatal and nonfatal injuries of various causes, violent death, and cost of injuries from a variety of trusted sources.

Outcome Measures

The rates of total firearm-related deaths of each state and year were calculated as the main outcome variable. The rates of firearm-related homicide and suicide were also calculated as secondary outcomes.

Information on state firearm laws was obtained from the State Firearm Law Database[11] developed by Siegel et al.[12] This database tracks the presence of 134 laws in 14 categories across all 50 states from 1991 to 2020. Categories include buyer regulations, dealer regulations, background checks, prohibition of gun purchase and possession, domestic violence–related gun laws, "stand your ground" laws, concealed carry permitting laws, assault weapons regulations, gun trafficking laws, and restrictions on places where guns may be carried. Each of the 134 laws are coded based on their year of implementation as being either present (1) or absent (0) for each state during each year. The deciles of the total number of all firearm laws were used as an index to capture the strictness of states' own firearm regulations.

Firearm Regulations

For this study, the following categories of laws were identified based on previous literature as having potential association with interstate movement of firearms and firearm-related mortality[6,7,9,13-17]: (1) requiring universal background checks at the point of purchase for all firearms (background check laws); (2) requiring background checks for handgun sale at gun shows (gun show laws); (3) requiring a license or permit to purchase all firearms (permit laws); (4) requiring a state dealer license for sale of handguns (licensed dealer laws); (5) requiring all private sellers and licensed dealers to keep and retain records of handgun sales (record-keeping laws); (6) prohibiting any person from purchasing a handgun on behalf of another person (straw purchase laws); (7) prohibiting firearm possession for people who have committed a violent misdemeanor (violence prohibition laws); (8) requiring people to relinquish their firearms after they become prohibited from possessing them (relinquishment laws); and (9) providing authorities with discretion in deciding whether to grant a concealed carry permit, or the law bans all concealed weapons (may-issue laws).

Other Covariates

We controlled for additional state-level and potentially time-varying covariates that may be associated with the number of violent deaths based on previous literature.[7,9,13,18] These covariates included population size, proportion 65 years or older, race and ethnicity (extracted from US Census Bureau American Community Survey basic race alone table[19]), unemployment rate, poverty rate, and proportion of population 25 years or older without a high school diploma, which were obtained from the US Census Bureau for 2000 to 2019.[19] Property crime rates were obtained from the Federal Bureau of Investigation's summary reporting system via Crime Data Explorer[20] as a measure of the propensity for crimes in the state. The per capita number of licensed gun dealers, obtained from the US Bureau of Alcohol, Tobacco, Firearms and Explosives,[21] and the percentage of the state's population holding a hunting license, obtained from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation,[22] were included as indicators of household gun ownership.[13,23,24] As a measure of the general state sentiment toward firearm regulation, the vote share differences between the Republican and Democratic presidential candidates in each presidential election year within the study period[25] were included, and extrapolated for years between presidential elections.

Statistical Analysis

To investigate the association between states' firearm laws and other states' firearm-related deaths (interstate association), we built a spatial autoregressive linear model (spatial Durbin model), accounting for geographically correlated dependent and independent variables[26]:

$$y_{nt} = \rho W y_{nt} + X_{nt}\beta + P_{nt}\gamma + WP_{nt}\theta + \mu_n + \tau_t + \epsilon_{nt}$$

where y denotes the rate of firearm-related deaths; ρ, the spatial autoregressive coefficient; W, the spatial weight matrix; X, the state-level variables, including the deciles of the total number of firearm laws and other state-level covariates; P, the laws of interest; μ, the state fixed effect; and τ, the year fixed effect. In this spatial Durbin model, coefficients corresponding to the independent variables are difficult to interpret and, moreover, do not directly correspond to obvious measures of association. To resolve this, an overall association via a total effect is then calculated[26,27] that compares what would happen in the (hypothetical) scenario in which all those 48 contiguous states have that particular law with the (also hypothetical) scenario in which no state has that law. Furthermore, this total effect can be decomposed into within-state (direct effect) and interstate (indirect effect or spillover effect) associations.[27] Details are shown in eMethods and eFigure 1 in the Supplement.

To account for the distance decay of the association between firearm laws and outcome, the inverse distance squared weight matrix was used for the primary analysis, because the contiguity matrix may underestimate the association. First, a basic model without any of the 9 laws of interest was built (ie, equation 1) with $P = 0$. Then each law of interest was added to the basic model one at a time, and we selected laws that resulted both in a decreased Akaike information criterion and $P < .10$ for the likelihood ratio test between the model including this law and the basic model for the final model. Then we built a pairwise correlation matrix for the selected laws to check for the potential collinearity, and highly collinear variables were removed from the final model. The final model was also used for analyzing the secondary outcomes.

We performed the following sensitivity analyses: (1) using state random effects in addition to year and census division[28] fixed effects, (2) using a contiguity matrix instead of an inverse distance squared matrix, and (3) adding a 1-year lagged total firearm-related death term to build a dynamic spatial Durbin model and address potential temporal autocorrelation of firearm-related deaths within state.

For all models, the effect sizes (the number of deaths per 100 000 population) with 95% CIs of the within-state, interstate, and overall associations between firearm laws and firearm-related deaths were reported. Standard errors were clustered within each state. Statistical significance was set at 2-sided $P < .05$. Stata, version 16.1 (StataCorp LLC) was used for all analyses. We built spatial Durbin models using the xsmle package developed by Belotti et al,[29] which had been used for spatial analysis in the previous literature.[30,31]

Results

Baseline variables are summarized in **Table 1**. We identified 662 883 firearm-related deaths of all intents, which translated to a rate of 10.80 firearm-related deaths per 100 000 population during the study period. For this period, the median number of implemented firearm laws was 15 (range, 1-111). The distribution of how many of the 9 laws of interest were implemented for each state and the

Table 1. State Characteristics From 2000 to 2019[a]

State characteristic	Sample, median (IQR) Pooled	2000	2019	P value[b]
Death rate per 100 000 population				
Total firearm-related death	11.47 (8.94 to 14.45)	10.45 (7.94 to 13.35)	13.05 (10.76 to 16.35)	<.001
Firearm-related homicide	3.61 (1.90 to 5.00)	3.45 (1.94 to 5.23)	3.92 (1.82 to 6.22)	.62
Firearm-related suicide	7.65 (5.81 to 9.69)	7.03 (5.35 to 8.47)	9.52 (7.41 to 11.06)	<.001
Total No. of firearm laws	15.50 (10.00 to 29.00)	15.00 (10.50 to 24.00)	19.50 (9.50 to 39.50)	.75
Population 65 y or older, %	13.40 (12.40 to 14.70)	12.75 (11.55 to 13.65)	16.05 (15.35 to 16.84)	<.001
White population, %[c]	84.93 (77.45 to 90.51)	86.99 (79.63 to 91.94)	80.99 (71.00 to 88.90)	<.001
Poverty rate, %	13.05 (11.00 to 15.60)	11.80 (9.00 to 13.35)	12.85 (10.66 to 14.55)	<.001
Unemployment rate,	6.20 (5.00 to 7.50)	3.90 (3.10 to 4.40)	5.20 (4.20 to 5.75)	<.001
Population aged ≥25 y without high school diploma, %	12.70 (10.20 to 15.60)	14.10 (11.85 to 17.65)	10.03 (8.42 to 12.86)	<.001
Property crime, cases per 100 population	2.84 (2.31 to 3.51)	3.61 (2.89 to 4.12)	2.07 (1.55 to 2.53)	<.001
Hunting license holder, %	6.57 (3.18 to 10.69)	7.04 (3.73 to 10.93)	7.07 (3.03 to 10.12)	.17
Licensed gun dealer, No. per 100 000 residents	22.05 (14.85 to 33.60)	28.94 (20.76 to 41.66)	20.85 (14.91 to 31.62)	<.001
Vote share differences between the Republican and the Democratic presidential candidates, %[d]	2.18 (−10.33 to 18.34)	3.71 (−5.12 to 15.79)	0.56 (−14.72 to 18.83)[e]	.63

[a] Test was performed for the whole study period.

[b] Calculated as rank-sum test for trend.

[c] Extracted from US Census Bureau American Community Survey basic race alone table.

[d] Uses original data (without interpolation).

[e] Uses 2020 data.

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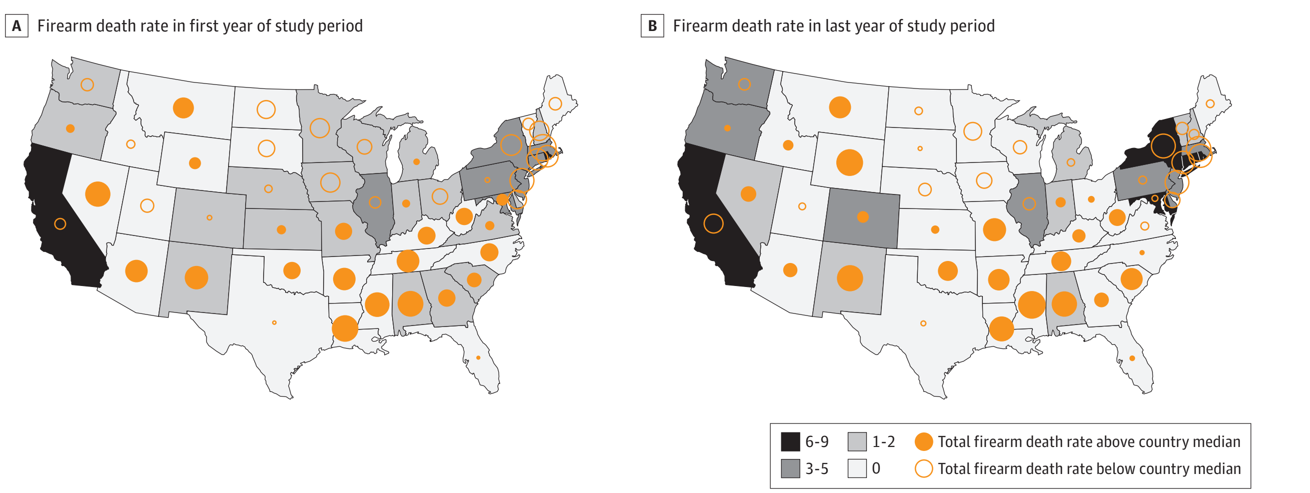
rates of firearm-related deaths of all intents in that state compared with the national median are shown for the first and last year of the study period in the **Figure**.

The effect sizes of within-state, interstate, and overall associations between each law and total firearm-related deaths rate from models where those laws were included individually are shown in eTable 1 in the Supplement. The permit (effect size, −16.72 [95% CI, −25.87 to −7.58]), record-keeping (effect size, −8.54 [955 CI, −15.49 to −1.59]), and violence prohibition (effect size, −8.55 [95% CI, −15.34 to −1.75]) laws showed interstate association with decreased firearm-related deaths in adjacent states. Permit (effect size, −2.22 [95% CI, −3.35 to −1.49]) and violence prohibition (effect size, −1.37 [95% CI, −2.07 to −0.68]) laws also showed within-state association. Permit (effect size, −19.14 [95% CI, −28.82 to −9.46]) and violence prohibition (effect size, −9.92 [95% CI, −17.11 to −2.73]) laws, in addition to the record-keeping (effect size, −9.27 [95% CI, −16.12 to −2.43]) and may-issue (effect size, −5.53 [95% CI, −10.76 to −0.29]) laws, were also associated with a decreased total firearm-related death rate.

The following 5 laws were included in the final model: (1) permit, (2) gun show, (3) violence prohibition, (4) relinquishment, and (5) may-issue (eTables 2-4 in the Supplement). As shown in **Table 2**, on average, the permit laws had within-state association (effect size, −1.79 [95% CI, −2.73 to −0.84]), interstate association (effect size, −10.60 [95% CI, −17.63 to −3.56]), and overall association (effect size, −12.38 [95% CI, −19.93 to −4.83]) per 100 000 population decrease in total firearm-related deaths. The violence prohibition laws had within-state association (effect size, −0.75 [95% CI, −1.37 to −0.12]) and overall association (effect size, −5.28 [95% CI, −10.33 to −0.24]) per 100 000 population decrease in total firearm-related death rate. The interstate association between this law and total firearm-related death rate showed no statistical significance (effect size, −4.54 [95% CI, −9.29 to 0.22] per 100 000 population; *P* = .06). The effect sizes of the associations reflect the differences of the outcome in the hypothetical scenario when all 48 contiguous states have that law vs none of those states have that law. eFigures 2 and 3 in the Supplement provide illustrative examples of the effect size when selected groups of states adopt the law. The results for sensitivity analyses are listed in eTables 5 to 7 in the Supplement, which were substantively similar to findings from the primary analysis.

For the secondary outcomes, 5 states (New Hampshire, Vermont, South Dakota, North Dakota, and Wyoming), all of which had 50% or more observations missing, were removed from the analysis of firearm homicide (additional details are provided in the eMethods in the Supplement). The within-state, interstate, and overall associations among the laws of interest, the index for the general strictness of firearm regulation, and firearm-related homicide and suicide are shown in **Table 3**. The

Figure. Rates of Firearm-Related Deaths of All Intents in the 48 Contiguous States Compared With the National Median for the First and Last Years of the Study Period



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permit laws had within-state association (−1.26 [95% CI, −1.72 to −0.80]), interstate association (−9.01 [95% CI, −15.00 to −3.02]), and overall association (−10.27 [95% CI, −16.53 to −4.01]) per 100 000 population decrease in firearm-related homicide rate. For firearm-related suicide, the

Table 2. Effect Sizes of Within-State, Interstate, and Overall Association Among State Firearm Laws, State Covariables, and Total Firearm-Related Death Rates[a]

	Within-state association		Interstate association		Overall association	
State covariable	Effect size (95% CI)	P value	Effect size (95% CI)	P value	Effect size (95% CI)	P value
State firearm laws						
Permit	−1.79 (−2.73 to −0.84)	<.001	−10.60 (−17.63 to −3.56)	.003	−12.38 (−19.93 to −4.83)	.001
Relinquishment	−0.81 (−1.90 to 0.29)	.15	5.96 (−1.72 to 13.63)	.13	5.15 (−3.07 to 13.37)	.22
Violence prohibition	−0.75 (−1.37 to −0.12)	.02	−4.54 (−9.29 to 0.22)	.06	−5.28 (−10.33 to −0.24)	.04
Gun show	0.15 (−0.52 to 0.82)	.66	−3.23 (−7.92 to 1.46)	.18	−3.08 (−7.88 to 1.72)	.21
May-issue	−0.29 (−0.82 to 0.24)	.28	−0.36 (−4.27 to 3.55)	.86	−0.65 (−4.37 to 3.07)	.73
Index of strictness of firearm regulation[b]	−0.10 (−0.26 to 0.06)	.21	0.01 (−0.02 to 0.04)	.47	−0.09 (−0.23 to 0.05)	.22
State characteristics, %						
Population 65 y or older	0.29 (−0.01 to 0.59)	.06	−0.03 (−0.09 to 0.04)	.40	0.26 (−0.02 to 0.54)	.07
Unemployment rate	−0.08 (−0.28 to 0.11)	.41	0.01 (−0.02 to 0.04)	.56	−0.07 (−0.25 to 0.10)	.41
Cases of property crime per 100 population	1.00 (0.56 to 1.44)	<.001	−0.10 (−0.29 to 0.09)	.29	0.90 (0.49 to 1.31)	<.001
Poverty rate	−0.03 (−0.13 to 0.07)	.58	0.00 (−0.01 to 0.02)	.75	−0.03 (−0.12 to 0.07)	.58
White population[c]	0.18 (−0.01 to 0.37)	.06	−0.02 (−0.06 to 0.02)	.38	0.16 (−0.01 to 0.33)	.06
Population aged ≥25 y without high school diploma	0.05 (−0.08 to 0.18)	.46	−0.01 (−0.03 to 0.01)	.59	0.04 (−0.07 to 0.16)	.47
Hunting license holder	0.11 (0.01 to 0.20)	.03	−0.01 (−0.04 to 0.01)	.36	0.09 (0.01 to 0.18)	.03
Licensed gun dealer per 100 000 residents	−0.05 (−0.09 to −0.00)	.04	1.00 (−0.01 to 0.01)	.39	−0.04 (−0.09 to 0.00)	.06
Population density, log-transformed, person per square mile	1.41 (−3.00 to 5.82)	.53	−0.15 (−0.80 to 0.50)	.65	1.26 (−2.73 to 5.25)	.54
Vote share differences between the Republican and the Democratic presidential candidates, 10%	0.35 (0.10 to 0.59)	.005	−0.03 (−0.10 to 0.03)	.33	0.31 (0.08 to 0.54)	.008

[a] Effect sizes are shown as per 100 000 population.

[b] Expressed as the decile of the total number of state firearm laws.

[c] Extracted from US Census Bureau American Community Survey basic race alone table.

Table 3. Effect Sizes of Within-State, Interstate, and Overall Associations Between State Firearm Laws and Firearm-Related Homicide and Suicide Rates[a,b]

	Within-state association		Interstate association		Overall association	
Firearm law	Effect size (95% CI)	P value	Effect size (95% CI)	P value	Effect size (95% CI)	P value
Firearm-related homicide						
State firearm laws						
Permit	−1.26 (−1.72 to −0.80)	<.001	−9.01 (−15.00 to −3.02)	.003	−10.27 (−16.53 to −4.01)	.001
Relinquishment	−0.38 (−1.07 to 0.32)	.29	1.75 (−3.80 to 7.30)	.54	1.37 (−4.51 to 7.26)	.65
Violence prohibition	0.11 (−0.33 to 0.55)	.63	1.41 (−2.71 to 5.53)	.50	1.52 (−2.84 to 5.87)	.49
Gun show	0.06 (−0.47 to 0.60)	.82	−4.75 (−9.81 to 0.31)	.07	−4.69 (−9.91 to 0.53)	.08
May-issue	−0.29 (−0.66 to 0.07)	.12	−1.29 (−4.63 to 2.06)	.45	−1.58 (−4.82 to 1.65)	.34
Index of strictness of firearm regulation[c]	−0.03 (−0.17 to 0.12)	.72	0.00 (−0.03 to 0.03)	.89	−0.03 (−0.19 to 0.13)	.72
Firearm-related suicide						
State firearm laws						
Permit	−0.52 (−1.23 to 0.19)	.15	−1.10 (−5.71 to 3.51)	.64	−1.62 (−6.54 to 3.29)	.52
Relinquishment	−0.44 (−0.94 to 0.06)	.08	3.02 (−0.37 to 6.41)	.08	2.58 (−1.10 to 6.26)	.17
Violence prohibition	−0.86 (−1.23 to −0.50)	<.001	−5.75 (−8.27 to −3.22)	<.001	−6.61 (−9.28 to −3.95)	<.001
Gun show	0.03 (−0.27 to 0.32)	.85	0.91 (−1.86 to 3.69)	.52	0.94 (−1.85 to 3.74)	.51
May-issue	0.02 (−0.27 to 0.32)	.87	0.82 (−1.19 to 2.83)	.42	0.85 (−1.07 to 2.76)	.39
Index of strictness of firearm regulation[c]	−0.07 (−0.14 to 0.00)	.06	0.01 (−0.01 to 0.03)	.23	−0.06 (−0.12 to 0.00)	.07

[a] Effect sizes are shown as per 100 000 population.

[b] Models were adjusted for the following state-level time-varying variables: population size, proportion 65 years or older, race and ethnicity, unemployment rate, poverty rate, proportion 25 years or older without a high school diploma, the rates of crime against property, the percentage of state's population holding a hunting license, number of licensed gun dealers per 100 000 residents, and the vote share difference between the Republican and Democratic candidates in the presidential election (linearly interpolated), in addition to state and year fixed effect.

[c] Expressed as the decile of the total number of state firearm laws.

violence prohibition laws had within-state association (effect size, −0.86 [95% CI, −1.23 to −0.50]), interstate association (effect size, −5.75 [95% CI, −8.27 to −3.22]), and overall association with (effect size, −6.61 [95% CI, −9.28 to −3.95]) per 100 000 population decrease in firearm-related suicide rate.

Discussion

In this cross-sectional study, we used data from 2000 to 2019 to investigate the association between firearm laws and firearm-related deaths both within state and interstate. Our findings suggest that having a permit requirement for purchasing all firearms was associated with a decrease of any firearm-related death and firearm-related homicide within state, interstate, and overall. The prohibition of firearm possession for individuals who have committed a violent misdemeanor had within-state and overall associations with decreased total firearm-related death rates. This law also had within-state, interstate, and overall associations with decreased firearm-related suicide rates.

Firearm laws vary substantially across states in the US. A rich literature has established associations between stricter state firearm laws and reduced firearm-related violence within those states.[17,32-34] States with strict laws also host fewer firearm-manufacturing establishments than states with relatively permissive laws.[35] However, firearms are easily transported across state lines, and crime guns in states with restrictive firearm laws often originate in states with more permissive rules,[3,5] with stronger trafficking flows detected when such states are near each other.[4,36] Hence, a small but growing literature[6-9] has started exploring whether permissive firearm laws in one state have spillover effects on measures of firearm violence in other states. More recently, Morrison et al[36] used county-level firearm-related homicide data to evaluate the spillover effects of different categories of firearm laws. They found that the benefits of within-state firearm laws in reducing firearm-related homicide were not independent of firearm laws in nearby states, which is supported by our study findings.

Our study adds to this literature by evaluating specific firearm laws individually rather than as an aggregated index. Particularly, our findings suggest that permit-to-purchase laws, which research finds to be protective against within-state firearm-related deaths,[17] are also protective for neighboring states, suggesting that more restrictions on the eligibility of obtaining a gun also discourage out-of-state persons from buying firearms from those states. Further, the laws prohibiting firearm possession for people who have committed a violent misdemeanor were associated with decreased firearm-related suicide rates within state, interstate, and overall and with decreased total firearm-related death rates both within state and overall. Prior studies have found that safe storage laws[37] and alcohol regulation[38] were associated with within-state declines in firearm suicides. At the same time, other studies[39,40] have established correlations between committing acts of violence and inflicting self-harm,[39,40] and our findings imply that regulations preventing firearm possession among those who commit violence in turn also reduce extreme self-harm in both within-state and nearby state populations. We speculate that spillover protective effects occur because the presence of these laws disincentivizes gun traffickers from acquiring guns in these states to send to neighboring states and disincentivizes individuals in neighboring states from crossing state borders and purchasing a weapon.

In models that included laws individually with other state covariates, may-issue and record-keeping laws also showed associations with total firearm-related deaths. However, collinearity issues (eTable 3 in the Supplement) and a tendency among states to concurrently implement regulations regarding gun show, background check, and record-keeping laws (eTables 8 and 9 in the Supplement) limited our ability to include them in the final model. Notably, some of the firearm laws that were intended to reduce firearm-related deaths did not show any conclusive association. This could be either a true nonassociation or an association that could not be detected by our method owing to limited sample size, rarity of states that have such laws, and insufficient time variability of those laws during our study period.

Limitations

We acknowledge several limitations to this study. First, our analytical strategy used state fixed effects to minimize the effect of time-invariant state-level confounders and hence relied on within-state variation in firearm laws to estimate effect sizes; however, many states had minimal variations in firearm laws during the study period, and states implementing laws such as background check and record keeping often implemented them at similar times, leading to collinearity issues. These factors may have limited the ability of our model to detect statistical effects for certain laws. Second, the presence of laws per se may not indicate the diligence with which laws are enforced in different states. Third, results may be sensitive to alternate approaches to selecting or grouping firearm laws of primary interest. Fourth, the effect sizes can be affected by the matrix accounting for the geographic correlation. Moreover, the weight matrix used in this study solely focused on the distance. Combination of distance with other factors, such as population, firearm manufacturing facilities, and number of interstates and other highways, might be more accurate to describe the attractiveness of firearms for a state and the ease of firearm movement between states. Fifth, because the analysis of firearm-related homicide did not use data from all states, caution should be used when generalizing the findings to the whole country. Last, as in the case of all ecological studies, caution should be exercised when drawing causal inferences from the results.

Conclusions

In this pooled cross-sectional analysis of firearm laws and firearm-related deaths from 2000 to 2019, we found that permit-to-purchase laws were associated with decreased firearm-related death rates both within state and interstate. The presence of interstate association between firearm laws and firearm-related deaths suggests that policy initiatives to reduce gun trafficking—such as those adopted by the Biden-Harris administration—are an important component of eliminating firearm violence. It also underlines the importance of synergic legislative action to implement laws such as permit requirements in proximate states as an effective approach to reduce firearm-related deaths.

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SUPPLEMENT.

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Purchaser Licensing, Point-of-Sale Background Check Laws, and Firearm Homicide and Suicide in 4 US States, 1985–2017

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Objectives. To estimate and compare the effects of state background check policies on firearm-related mortality in 4 US states.

Methods. Annual data from 1985 to 2017 were used to examine Maryland and Pennsylvania, which implemented point-of-sale comprehensive background check (CBC) laws for handgun purchasers; Connecticut, which adopted a handgun purchaser licensing law; and Missouri, which repealed a similar law. Using synthetic control methods, we estimated the effects of these laws on homicide and suicide rates stratified by firearm involvement.

Results. There was no consistent relationship between CBC laws and mortality rates. There were estimated decreases in firearm homicide (27.8%) and firearm suicide (23.2%–40.5%) rates associated with Connecticut's law. There were estimated increases in firearm homicide (47.3%), nonfirearm homicide (18.1%), and firearm suicide (23.5%) rates associated with Missouri's repeal.

Conclusions. Purchaser licensing laws coupled with CBC requirements were consistently associated with lower firearm homicide and suicide rates, but CBC laws alone were not.

Public Health Implications. Our results contribute to a body of research showing that CBC laws are not associated with reductions in firearm-related deaths unless they are coupled with handgun purchaser licensing laws. (*Am J Public Health.* 2020;110:1546–1552. doi:10.2105/AJPH.2020.305822)

Firearms were the second-leading mechanism of death by injury in the United States in 2018, resulting in 39 740 deaths.[1] Laws intended to keep firearms from individuals at the highest risk of harming themselves or others may reduce firearm-related deaths, but they rely on background checks and other systems for vetting those seeking to acquire firearms.

Although federal law requires individuals who purchase firearms from federally licensed dealers to pass a background check, no background check is required for purchases from private sellers. As of January 2020, 21 states required a background check for at least some private firearm sales. These state laws can be sorted into 2 broad categories: point-of-sale comprehensive background check (CBC) laws and purchaser licensing laws. Both categories require firearm purchasers to pass a background check prior to a sale or transfer, but they differ with respect to timing and process.

CBC laws require a background check for private purchasers at the point of sale. Prospective purchasers and sellers typically go to federally licensed dealers who process the transfer by submitting applications to the Federal Bureau of Investigation or state law enforcement agencies to determine whether the applicant is legally qualified to acquire a firearm. Under purchaser licensing laws, a prospective purchaser is required to apply for a license directly to a state or local law enforcement agency that vets the application and initiates a background check, often aided by mandated fingerprinting. Private sellers and federally licensed dealers can sell handguns only to individuals with valid licenses. Absent a CBC law, residents of states with a licensing law may not need to undergo a point-of-sale background check if they have a valid license to purchase. In some states, a valid permit to carry a concealed handgun can substitute for a license to purchase or a point-of-sale background check.

Although individual-level studies of background checks suggest that they are effective,[2–4] recent state-level research casts doubt on the population-level effectiveness of CBC laws alone in reducing firearm-related deaths.[5–7] Studies suggesting CBC law effectiveness have methodological limitations including cross-sectional designs[8] and exclusion of CBC laws that apply only to handguns.[9] In 2018, handguns accounted for 90% of the firearms used in homicides in which the type of firearm was specified.[10]

Studies in several US states have shown that firearm purchaser licensing laws are

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associated with reductions in firearm homicides.[3,8] Connecticut enacted a handgun purchaser licensing law in 1995 that was associated with significant decreases in rates of firearm homicides[11] and firearm suicides.[12] After the 2007 repeal of Missouri's handgun purchaser licensing law that also functioned as a point-of-sale CBC law, rates of firearm homicides[13,14] and suicides[12] increased in the state, as did indicators of guns diverted for criminal use.[15] Critics of these studies identified the relatively short periods of postlaw data in Missouri and Connecticut and possible overreliance on Rhode Island as a point of comparison with Connecticut's trends.[16]

In this study, we improved on prior analyses of purchaser licensing laws in Connecticut and Missouri and applied similar methods to analyze point-of-sale-only laws in Maryland and Pennsylvania, which adopted typical CBC laws in 1996 and 1995, respectively. We lengthened the period of observation for Connecticut and Missouri and applied a uniform analytic approach across all 4 states, comparing the findings with respect to CBC and licensing policies.

METHODS

Following the example of some earlier studies of licensing and CBC laws,[6,7,11,13] we used the synthetic control method[17] to compare each state's homicide and suicide rates with estimates of the counterfactual: each intervention state's forecasted homicide and suicide rates had the law not been enacted. In accord with the synthetic control method, we used a series of preintervention outcomes and other covariates to construct a convex combination of weighted donor states that best approximated the pretreatment outcome and covariate trends in the treated state (the state with the relevant policy change). The weights were determined on the basis of their capability to minimize the prediction error during the period prior to the law change being evaluated. The donor pool of potential controls contained states that did not have the law of interest in place during the study period. This weighted combination of donor states—the synthetic control—was compared with the treated state in the posttreatment period to estimate the effect of the intervention. We present the mean square predicted error (MSPE) for the preintervention period as a measure of model fit.

Each state law change was evaluated for its association with rates of firearm homicides, nonfirearm homicides, firearm suicides, and nonfirearm suicides. Each prelaw period was 10 years; the postlaw period was determined by the amount of postlaw data available after the law change and the legal environment of each state. The time period for Pennsylvania's 1995 CBC law ran from 1985 to 2017. For Maryland's 1996 CBC law, the postlaw period was truncated at 2013 because the state adopted a handgun purchaser licensing law late that year. The study period for Missouri's repeal of its 2007 licensing law started in 1997 and ended in 2016 because Missouri began allowing permitless concealed carry on January 1, 2017. Prior work has shown an association between less restrictive concealed carry laws and violent crime.[18] For Connecticut, we present data through 2017 but also provide estimates that exclude 2013 to 2017 because of a state program under which several cities began implementing focused deterrence programs to curb gang violence.[19]

The donor pools of potential controls for Pennsylvania (29 states), Maryland (33 states), and Connecticut (39 states) consisted of states that did not have the law of interest in place throughout the study periods just described. Missouri's donor pool (8 states) consisted of states that had a purchaser licensing law for the entirety of the study period.

For each model, the effect was estimated by determining the difference in postlaw means between the treated state and the synthetic control and calculating the percentage increase or decrease from the synthetic control. To assess whether the estimated effects of CBC and purchaser licensing laws were unusual with respect to effects that would be estimated in other states, we performed placebo tests with all states in the donor pool for each law change.[17] The estimated effect for the treated state was compared with the placebo effect distribution estimated from the donor states. To make a reliable inference, we had to find that only a small proportion of control states had a more extreme placebo effect estimate than the effect estimated for the true treated state. We used this proportion as a permutation distribution pseudo *P* value. Because a synthetic control that adequately fit the preintervention data could not be estimated for each donor state, we restricted the placebo tests to the subset of donor states with prelaw MSPEs less than 5 times the treated state's prelaw MSPE to avoid comparisons with synthetic controls that had poor fits.

We used death certificate data obtained from the National Center for Health Statistics through the CDC WONDER database to generate homicide and suicide mortality rates.[20] Because annual state suicide data are often volatile, we smoothed suicide mortality rates by analyzing 3-year moving averages. Annual state-level predictors were chosen on the basis of prior research and theoretical relationships between sociodemographic variables and the dependent variables of interest.

For homicide, state-level predictors were population size, law enforcement expenditures per capita, law enforcement officer population, percentage of the population identifying as Black, percentage of the population identifying as Latino, the Gini coefficient (a measure of income inequality), percentage of the population 15 to 24 years of age, percentage of the population 0 to 18 years of age, percentage of the population living in a metropolitan statistical area, robbery rate, population density, poverty rate, jobs per capita, average individual income per capita, unemployment rate, and incarceration rate.

For suicide, the predictors were unemployment rate, poverty rate, percentage of the population identifying as male, percentage of the population reporting being married, percentage of the population identifying as Black, percentage of the population identifying as a veteran, percentage of the population living in a metropolitan statistical area, ethanol consumption per capita, religious adherence, educational attainment, and overdose rate.

Each model included prelaw averages for all of these predictors and values of the outcome variable for every other prelaw year. When necessary, missing predictor data from intercensal years were interpolated. These data were obtained from the Bureau of Economic Analysis,[21] the Bureau of Labor Statistics,[22] the Census Bureau,[23] and the Federal Bureau of Investigation's Uniform Crime Report.[24]

RESULTS

The synthetic control models revealed no consistent relationship between comprehensive background check laws and firearm mortality in Maryland and Pennsylvania. There were, however, consistent relationships between firearm mortality and purchaser licensing laws in Connecticut and Missouri. Measures of synthetic control model fit, donor states contributing to each synthetic control, and donor weights are presented in Appendix Table A (available as a supplement to the online version of this article at http://www.ajph.org). The placebo results we report are the proportions of control states that had a more extreme placebo effect estimate than the effect estimated for the true treated state. We also report these proportions as fractions, with the number of states with a more extreme placebo effect estimate in the numerator and the number of total control states in the denominator. We restricted the denominator to the subset of donor states with prelaw MSPEs less than 5 times the treated state's prelaw MSPE.

Comprehensive Background Check Laws

Results for Maryland and Pennsylvania are presented in Table 1. After implementation of a CBC law (1996–2013), Maryland saw a 17.5% increase in firearm homicide rates relative to its synthetic control (placebo = 0.06; 2/32) and a 33.2% increase in nonfirearm homicide rates (placebo = 0.06; 2/33). Maryland's firearm suicide rate was 15.4% lower than that of its synthetic control following the state's passage of a CBC law (placebo = 0.13; 3/24), but there was also a 21.8% decrease in nonfirearm suicides (placebo = 0.03; 1/32) relative to the synthetic control.

Pennsylvania's firearm homicide rate was 21.5% higher than that of its synthetic control for the post–CBC law period 1996 to 2017 (placebo = 0.13; 3/23), whereas its nonfirearm homicide rate was 10.0% lower (placebo = 0.26; 5/19). During the same period, Pennsylvania saw a 5.3% increase in firearm suicides relative to its synthetic control (placebo = 0.21; 4/19) and an 11.8% decrease in nonfirearm suicides (placebo = 0.09; 1/11).

We performed post hoc analyses to determine whether these results might be partially explained by factors unique to the largest cities in Maryland and Pennsylvania, which accounted for a substantial share of homicides in the 2 states. When Baltimore data were excluded from the Maryland model, the CBC law was associated with insignificant increases in both firearm (3.1%; placebo = 0.34; 11/32) and nonfirearm (10.8%; placebo = 0.17; 4/24) homicides. However, the estimated effect of the CBC law in Pennsylvania on firearm homicides did not diminish when Philadelphia data were excluded (23.9%; placebo = 0.14; 2/14). Nonfirearm homicides increased 4.1% in the model without Philadelphia (placebo = 0.33; 5/15).

Purchaser Licensing Laws

Purchaser licensing laws were more clearly associated with changes in firearm homicide rates (Table 2 and Figure 1). After implementation of Connecticut's licensing law, there was a 27.8% decrease in firearm homicides relative to the state's synthetic control from 1995 to 2017 (placebo = 0.03; 1/38). This effect was similar when deaths from the 2012 Newtown school shooting were removed from homicide counts (Appendix Table J, available as a supplement to the online version of this article at http://www.ajph.org; change = –24.2%; placebo = 0.00; 0/35). The estimate for the effect of Connecticut's licensing law is somewhat smaller if the data extend only to 2012, before focused deterrence programs curbed urban gang violence in several of the state's cities (Appendix Table I, available as a supplement to the online version of this article at http://www.ajph.org; change = –19.9%; placebo = 0.03; 1/34). Nonfirearm homicide rates did not change relative to the synthetic control over the period from 1995 to 2017 (placebo = 0.61; 20/33).

From the 1995 implementation of its law through 2017, Connecticut saw a 32.8% decrease in firearm suicides (Table 2 and Figure 2; placebo = 0.06; 2/35) and a 3.3% decrease in nonfirearm suicides (placebo = 0.60; 15/25) relative to its synthetic control. In 1999, Connecticut adopted a law akin to an extreme risk protection order law. Under this law, police are authorized to temporarily take guns from individuals when there is probable cause to believe that they are at imminent risk of injuring themselves or

TABLE 1—Overall Synthetic Control Results for Point-of-Sale Comprehensive Background Check (CBC) Laws: Maryland and Pennsylvania, 1995 and 1996

	Firearm			Nonfirearm		
Model	MSPE	Effect, %	Placebo No./Total No. (%)[a]	MSPE	Effect, %	Placebo No./Total No. (%)[a]
Homicide						
Maryland 1996 CBC law	0.531	+17.5	2/32 (0.06)	0.406	+33.2	2/33 (0.06)
Maryland 1996 CBC law (excluding Baltimore)	0.440	+3.1	11/32 (0.34)	0.055	+10.8	4/24 (0.17)
Pennsylvania 1995 CBC law	0.167	+21.5	3/23 (0.13)	0.057	−10.0	5/19 (0.26)
Pennsylvania 1995 CBC law (excluding Philadelphia)	0.044	+23.9	2/14 (0.14)	0.027	+4.1	5/15 (0.33)
Suicide						
Maryland 1996 CBC law	0.060	−15.4	3/24 (0.125)	0.053	−21.8	1/32 (0.03)
Pennsylvania 1995 CBC law	0.024	+5.3	4/19 (0.21)	0.003	−11.8	1/11 (0.09)

Note. MSPE = mean square predicted error.

[a]The placebo results reported are the proportions of control states that had a more extreme placebo effect estimate than the effect actually estimated for the true treated state. We restricted the denominator to the subset of donor states with prelaw MSPEs less than 5 times the treated state's prelaw MSPE.

TABLE 2—Overall Synthetic Control Results for Purchaser Licensing Laws: Connecticut and Missouri, 1995 and 2007

	Firearm			Nonfirearm		
Model	MSPE	Effect, %	Placebo No./Total No. (%)[a]	MSPE	Effect, %	Placebo No./Total No. (%)[a]
Homicide						
Connecticut 1995 purchaser licensing	0.371	−27.8	1/38 (0.03)	0.089	−0.7	20/33 (0.61)
Missouri 2007 purchaser licensing repeal	0.257	+47.3	0/6 (0.00)	0.037	+18.1	0/8 (0.00)
Suicide						
Connecticut 1995 purchaser licensing (through 2017)	0.109	−32.8	2/35 (0.06)	0.008	−3.3	15/25 (0.60)
Connecticut 1995 purchaser licensing (through 2006)		−23.2			−3.2	
Connecticut 1995 purchaser licensing (2007–2017)		−40.5			−3.4	
Missouri 2007 purchaser licensing repeal	0.208	+23.5	0/7 (0.00)	0.065	+6.9	1/4 (0.25)

Note. MSPE = mean square predicted error.
[a]The placebo results reported are the proportions of control states that had a more extreme placebo effect estimate than the effect actually estimated for the true treated state. We restricted the denominator to the subset of donor states with prelaw MSPEs less than 5 times the treated state's prelaw MSPE.

others. Despite this law, very few gun removals were carried out until 2007, after the mass shooting at Virginia Tech.[25] Research has shown that individuals subjected to these orders are more often suicidal than homicidal and that the removal law is associated with decreases in firearm suicides.[26,27]

To examine the possible effects of the removal law on our models of firearm and nonfirearm suicides in Connecticut, we split the effect estimate into 2 periods: 1995 to 2006 and 2007 to 2017. From 1995 to 2006, there was a 23.2% decrease in firearm suicides and a 3.2% decrease in nonfirearm suicides in Connecticut relative to the synthetic control. From 2007 to 2017, there was a 40.5% decrease in firearm suicides and a 3.4% decrease in nonfirearm suicides.

From 2007 to 2016, following the repeal of its purchaser licensing law, Missouri's firearm homicide rate rose 47.3% relative to its synthetic control (Table 2 and Figure 1; placebo = 0.00; 0/6). Over the same period, there was an 18.1% increase in nonfirearm homicides relative to the synthetic control (placebo = 0.00; 0/8). The estimated effect on firearm homicides was 2.6 times larger than that for nonfirearm homicides. There was an abrupt increase in firearm homicides immediately after the law's repeal and no such change in nonfirearm homicides (Figure 1 and Appendix Figure F, available as a supplement to the online version of this article at http://www.ajph.org). Missouri's repeal of handgun purchaser licensing was associated with a 23.5% increase in firearm suicides (placebo = 0.00; 0/7) and a 6.9% increase in nonfirearm suicides (placebo = 0.25; 1/4) relative to the synthetic control (Table 2). Full truncated 10-year model results for Connecticut, Maryland, and Pennsylvania, as well as additional figures for all 4 states, are available in the appendix.

DISCUSSION

Across the 4 state law changes examined in this study, purchaser licensing laws were consistently associated with lower rates of both firearm homicides and firearm suicides, but point-of-sale CBC laws were not. Relative to Connecticut's synthetic control, we estimated a 27.8% overall decrease in the state's firearm homicide rate and a 32.8% overall decrease in its firearm suicide rate. The decrease in firearm suicides was somewhat greater after the 2007 implementation of a risk-based firearm removal law. Although this could indicate complementary effects of Connecticut's purchaser licensing and gun removal laws, the number of removal orders is likely too small to achieve population-wide effects. A more plausible explanation is that suicide mortality continued to decrease because of a growing effect of licensing stemming from reduced access to firearms in the state. For Missouri, we estimated a 47.3% overall increase in firearm homicides and a 23.5% increase in firearm suicides. In tandem, the estimates for Connecticut and Missouri suggest that purchaser licensing laws are protective.

Our results are consistent with prior studies that also revealed protective effects of Connecticut's and Missouri's handgun purchaser laws.[11–14] Our study provides additional years of data and new statistical models that indicate larger protective effects for suicides in both states. In comparison with previous studies, our estimates of changes in firearm homicide rates associated with purchaser licensing were larger in the case of Missouri and smaller in the case of Connecticut. Other studies designed to estimate average associations across many law changes have also shown that licensing laws are associated with lower rates of firearm-related homicides[5] and suicides,[12] fewer fatal mass shootings,[28] and fewer instances of law enforcement officers shot in the line of duty.[29]

Although there were increases in Missouri in both firearm and nonfirearm mortality, the differences in firearm mortality were 2.6 times larger. The increase in nonfirearm homicides coincident with the repeal of Missouri's licensing law may indicate that other factors affected mortality rates in Missouri after the repeal of its licensing law and that the actual effect on firearm mortality was somewhat smaller than our estimate. In a recent study incorporating data through 2016, there was an estimated 27% increase in firearm homicides when changes in Missouri were compared with those in states from the region with similarly high baseline homicide rates.[14]

Maryland's CBC law was associated with increases in homicide rates; however, the increases were specific to Baltimore and were

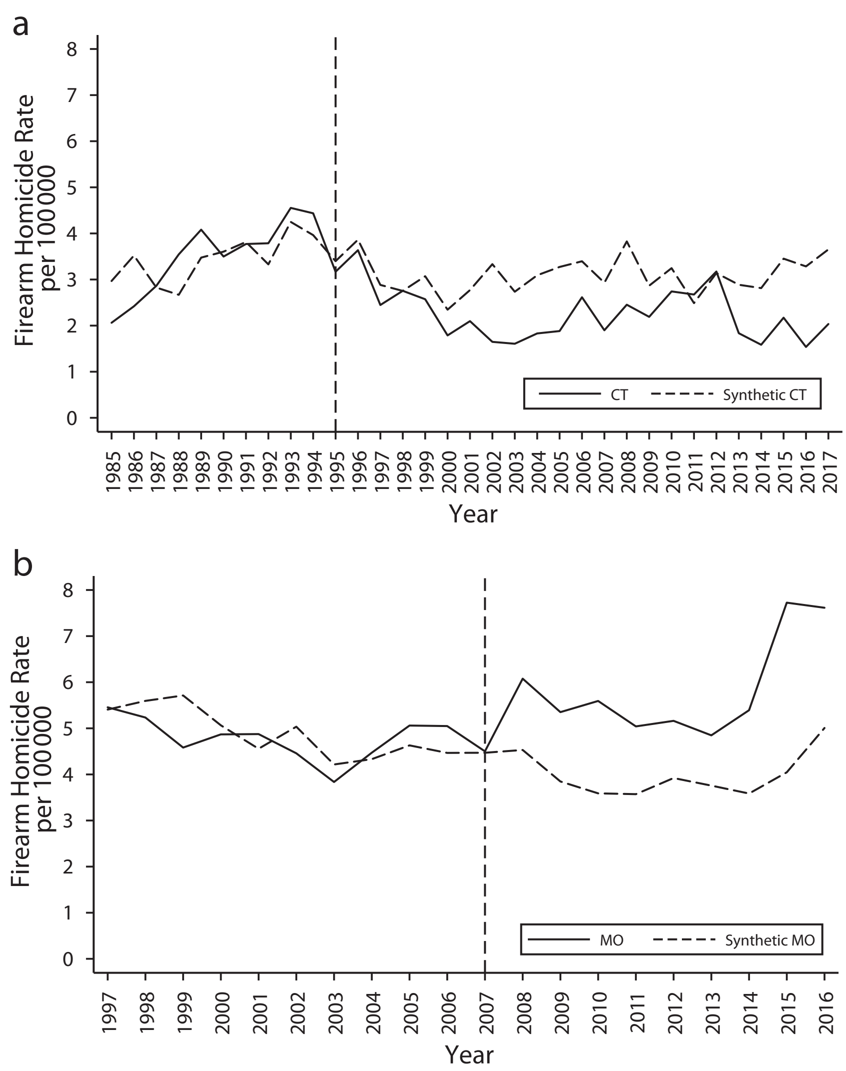

FIGURE 1—Effects of Purchaser Licensing Laws on Firearm Homicides in (a) Connecticut (Adopted 1995) and (b) Missouri (Repealed 2007)

not evident in the rest of the state. This suggests that either conditions in Baltimore modified the law's effect or the estimate of the law's effect was biased by unmeasured confounders. It is unclear how to interpret the positive association between Pennsylvania's CBC law and homicide rates. If the law substantially limited the ability of potential homicide victims to access firearms and successfully defend themselves, one would expect an even greater harmful effect of licensing. Yet, licensing laws were linked to lower homicide rates.

Consistent with previous longitudinal studies,[6,7] CBC laws in Maryland and Pennsylvania did not appear to reduce firearm suicides. Although Maryland experienced a decrease in firearm suicides after implementation of a CBC law, there was an even larger percentage decrease in nonfirearm suicides. This latter drop was more unusual in contrast to placebo states, suggesting that other factors may have been contributing to changing suicide rates in Maryland.

Comprehensive background check requirements may be necessary to prevent prohibited individuals from accessing firearms; without purchaser licensing requirements, however, they may be insufficient to achieve this objective and prevent lethal gun violence. The effectiveness of CBC laws could be enhanced by more robust efforts to enforce the laws and promote compliance, broader prohibiting conditions, better record keeping, and expanded time to complete the checks.[30] A prior study documented infrequent enforcement of Maryland's and Pennsylvania's CBC laws,[31] which weakens the laws' capacity to deter illegal transfers of firearms. When Maryland added handgun purchaser licensing requirements to its CBC law in 2013, diversions of guns for criminal use shortly after retail sales dropped dramatically.[32] This suggests that point-of-sale CBC requirements in Maryland were an insufficient deterrent to illegal diversions without purchaser licensing.

There are multiple reasons that firearm purchaser licensing might be more effective than point-of-sale CBC laws without licensing. Purchaser licensing requires vetting procedures that are more robust than is the case for point-of-sale CBC laws. This may deter individuals who might otherwise buy guns with the intention of criminal misuse or for transfer to a prohibited individual. States with purchaser licensing laws allow more time for vetting purchase applications and often check more complete sources of state data on prohibiting conditions than is the case under point-of-sale CBC laws. Firearm purchaser licensing also makes it easier for private sellers to verify that a prospective buyer is not prohibited from purchasing a firearm. Finally, licensing increases the real cost of purchasing firearms with additional time commitments and licensing fees. This likely reduces firearm ownership and the number of guns within a population.

The process required to obtain a purchaser license may also be protective with respect to suicide. It is much more difficult for individuals to make an impulsive decision to purchase a firearm if they need to secure a license first. Many suicide attempts occur within minutes or hours of initial suicidal ideation.[33] Longer waiting periods between applying to purchase firearms and receiving the firearms are associated with lower rates of firearm homicides and suicides.[34]

This study has potential limitations. First, we examined a limited number of law changes. For purchaser licensing, we assessed the only 2 law changes for which there were at least 5 years of postlaw data available. For CBC law changes, prior law changes since

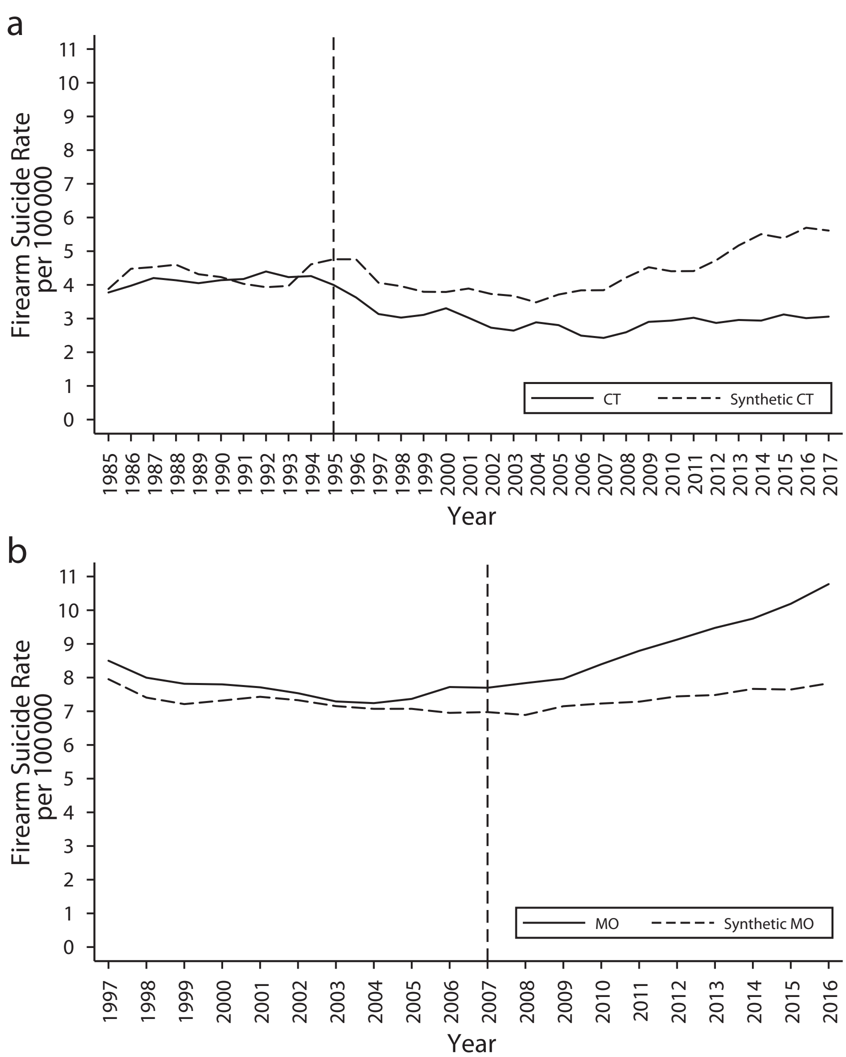

FIGURE 2—Effects of Purchaser Licensing Laws on Firearm Suicides in (a) Connecticut (Adopted 1995) and (b) Missouri (Repealed 2007)

1990 had already been evaluated,[9] and recent changes provided few postlaw data points. Second, although the synthetic control method is a robust strategy for estimating policy effects, the control pool for our analyses was somewhat limited in the case of Missouri.

Third, we sought to expand on previous work by extending the time period for each model to include the latest possible year of data. Our results are, therefore, more informative, but longer postlaw periods may create some uncertainty with respect to the capability of the models to accurately estimate the counterfactual. Finally, visual analysis of some of our synthetic control plots revealed that although the prelaw MSPE was minimized, there was a separation between the synthetic control and the treated state just before a law change. Such separation prior to a change could be random variation or could be indicative of unmeasured factors influencing trends between prelaw and postlaw change periods that might bias effect estimates.

Despite these limitations, our analyses have many strengths. We used a rigorous statistical method that minimizes errors in model prediction. We contrasted the patterns of estimated law effects across firearm and nonfirearm homicides and suicides to assess whether estimated effects were specific to deaths involving firearms. The CBC laws and one of the purchaser licensing laws were all adopted in 1995 or 1996, allowing for comparisons within the same historical period. We offered a fourth law change, Missouri's repeal of purchaser licensing during a time of relatively stability in homicide trends in Missouri and nationwide, to contrast with Connecticut's implementation of purchaser licensing in a different region and time period.

Although data on public support for firearm policies reveal somewhat broader support for CBC laws than is the case for purchaser licensing, a 2019 national survey reported 77% support for handgun purchaser licensing.[35] CBC laws are critical for keeping firearms from high-risk individuals, but they may be insufficient to significantly reduce firearm mortality without purchaser licensing. AJPH

CONTRIBUTORS

A. D. McCourt led the writing and analyses. A. D. McCourt, C. K. Crifasi, E. A. Stuart, J. S. Vernick, and D. W. Webster designed the study and statistical analyses. R. M. C. Kagawa and G. J. Wintemute provided critical review and interpretation of the data, analyses, and findings. All of the authors contributed to data interpretation and critical revisions of the article.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

HUMAN PARTICIPANT PROTECTION

No protocol approval was needed for this study because secondary data sources were used to analyze aggregated mortality rates.

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The Impact of State Firearm Laws on Homicide Rates among Black and White Populations in the United States, 1991–2016

Anita Knopov, Michael Siegel, Ziming Xuan, Emily F. Rothman, Shea W. Cronin, and David Hemenway

This study aimed to investigate the potential differential effects of state-level firearm laws on black and white populations. Using a panel design, authors examined the relationship between state firearm laws and homicide victimization rates among white people and black people in 39 states during the period between 1991 and 2016. Authors modeled homicide rates using linear regression with year and state fixed effects and controlled for a range of time-varying, state-level factors. Results showed that universal background check laws and permit requirement laws were associated with lower homicide rates among both white and black populations, and "shall issue" laws were associated with higher homicide rates among both white and black populations. Laws that prohibit firearm possession among people convicted of a violent misdemeanor or require relinquishment of firearms by people with a domestic violence restraining order were associated with lower black homicide rates, but not with white homicide rates. Author identification of heterogeneity in the associations between state firearm laws and homicide rates among different racial groups has implications for reducing racial health disparities.

KEY WORDS: *firearms; homicide; racial groups; violence prevention*

Although firearm violence affects people in all countries, 82 percent of all firearm homicides in high-income countries occur in the United States (Grinshteyn & Hemenway, 2016). In 2016, there were 14,415 firearm-related homicide deaths in the United States (Centers for Disease Control and Prevention [CDC], 2018). The risk of firearm-related homicide victimization is elevated for black individuals as compared with white individuals (CDC, 2018; Light & Ulmer, 2016; Phillips, 1997; Ulmer, Harris, & Steffensmeier, 2012). Black men ages 15 through 34 are six times more likely to die from homicide than white men of the same age, and 91 percent of homicides of black men are the result of gun violence (Hennekens, Drowos, & Levine, 2013). In 2016, the rate of firearm homicide victimization among black individuals in the United States (18.6 per 100,000) was more than eight times higher than among non-Hispanic white individuals (2.2 per 100,000) (CDC, 2018). Despite constituting only 14 percent of the U. S population, black people comprise 59 percent of firearm homicide victims (CDC, 2018).

Engaging in the promotion of evidence-based policies, in particular those that address racial disparities in firearm violence, is a critical focus of social work practice (National Association of Social Workers [NASW], 2018; Social Work Policy Institute, 2017; Van Soest & Bryant, 1995). NASW has issued a call for firearm violence to be declared a public health epidemic (Arp, Gonzalez, Herstand, & Wilson, 2017). In addition, NASW (2018) has implored public health social workers to promote effective firearm policies:

> The National Association of Social Workers stands by our previous statements that call for declaring all forms of gun violence—including mass shootings—to be declared a public health epidemic.
>
> Accordingly, we continue to urge public health officials to mobilize federal and state resources to prevent gun violence. NASW also continues to implore politicians to enact reasonable and effective gun laws, which would greatly reduce gun-related fatalities and injuries. (paras. 4–5)

doi: 10.1093/hsw/hlz024

Many states have addressed the problem of firearm-related homicide by enacting firearm laws. Although numerous studies have examined the impact of state firearm laws on overall homicide rates, we are aware of only one study (McClellan & Tekin, 2012) that explored whether there may be a differential impact of *individual* firearm laws on black people compared with white people, and this study examined only a single type of firearm law ("stand your ground" laws). It is important to understand whether particular laws have a differential impact on the white versus black population to ensure that our laws not only reduce overall homicide, but also address the racial disparity in firearm homicides. Reducing the racial disparity in health outcomes is a stated objective of Healthy People 2020, which declares the following goal: "to achieve health equity, eliminate disparities, and improve the health of all groups" (Healthy People 2020, n.d., para. 3).

Two previous articles examined the relationship between the *total number* of laws and the black versus the white firearm homicide rates by state (Phillips, 2002; Resnick & Randi, 2017). One found that the total number of laws was significantly related only to the white firearm homicide rate, whereas the total number of laws had no effect on the black firearm homicide rate (Resnick & Randi, 2017). The other study failed to find a significant relationship between the firearm law index and either white or black homicide rates (Phillips, 2002). Although they advance the field, these studies do not help us identify which specific laws may be affecting homicide rates, so their implications for public policy are limited.

There are a number of reasons to believe that firearm laws may have a differential effect on black and white people. First, the patterns of homicide victimization between white people and black people are strikingly different, suggesting different precursors (Cooper & Smith, 2011). If the underlying causes of firearm homicide differ by race, then so may the impact of firearm policies. Second, there is evidence that the use of illegal firearms in homicides with black victims may be substantially higher than in homicides with white victims, especially in street crimes in urban areas (Kamm, 2014; Kennedy, Piehl, & Braga, 1996; Leovy, 2015). Third, existing literature reports a racial disparity in estimated household firearm ownership, with black people only half as likely as white people to report having a firearm in their household (Pew Research Center, 2016). Fourth, there is preliminary evidence of a differential impact of firearm legislation on white homicide rates compared with black homicide rates (McClellan & Tekin, 2012). McClellan & Tekin (2012) reported that "stand your ground" laws—that is, laws allowing people who perceive a threat of bodily harm to use deadly force without a duty to retreat—were associated with a significant increase in homicides among white individuals, but no change in homicides among black individuals.

Our article aims to evaluate the potential differential effects of individual state-level firearm laws on the black and white populations. Identifying heterogeneity in the effects of these laws on two racial groups may have implications for reducing existing racial disparities. We explore the relationship between multiple state firearm laws and black and white homicide rates across 39 states during the period between 1991 and 2016.

Previous studies tended to explore the impact of only a single law at a time because of the lack of a consistent data source that tracked state firearm laws over time. This is problematic because firearm laws tend to be enacted together and one cannot be certain that the observed relationship between one law and an outcome is not due to the simultaneous presence of another law. We took advantage of a new state firearm law database (http://www.statefirearmlaws.org) that allowed us to assess the independent effect of a law while controlling for the presence of other laws.

METHOD

Design Overview

Using a panel design, we analyzed serial cross-sectional data for the 26-year period between 1991 and 2016. This design allowed us to take advantage of changes in state laws over time to explore the relationship between specific types of laws (see Table 1) and homicide victimization rates among white people and black people. We modeled homicide rates using linear regression with log-transformed homicide rates as the outcome variable. We included year and state fixed effects. We also controlled for a range of time-varying, state-level factors and for race-specific measures of absolute deprivation in education, economic status, employment, and housing.

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Table 1: Laws Analyzed, Detailed Descriptions, and Law Changes during Study Period

Law	Description	Number of States with Law in Effect		State (Year) When Law Took Effect
		1991	2016	
Universal background checks	Universal background checks are required for all firearm sales	2	8	CO (2013), CT (1999), DE (2013), NY (2013), OR (2015), WA (2014)
Permit-to-purchase requirement	Permits are required to obtain all firearms	5	7	CA (2015), CT (2014)
Prohibitions for violent offenders	Law prohibits handgun possession by people convicted of a violent misdemeanor crime or people who are subject to a domestic violence restraining order (and requires surrender of firearms)	2	15	CO (2013), CT (1994), IL (1995), IA (2010), MD (2009), MA (1994), MN (2014), NH (2000), NY (1996), NC (2003), TN (2009), WA (1994), WI (1996)
"Shall issue"	Law provides authorities with no discretion in deciding whether to grant a concealed carry permit	14	32	AL (2013), AK (1994), AZ (1994), AR (1995), CO (2003), IL (2013), IA (2011), KS (2007), KY (1996), LA (1996), MI (2001), MN (2003), MO (2003), NE (2007), NV (1995), NM (2001), NC (1995), OH (2004), OK (1995), SC (1996), TN (1994), TX (1995), UT (1995), VA (1995), WV (2016), WI (2011), WY (1994)
"Permitless carry"	No permit is required to carry a concealed handgun	1	9	AK (2003), AZ (2010), ID (2016), KS (2015), ME (2015), MS (2015), WV (2016), WY (2011)
"Stand your ground" law in place	State has a law that allows use of deadly force without a duty to retreat when threatened	0	24	AL (2006), AK (2013), AZ (2010), FL (2005), GA (2006), IN (2006), KS (2006), KY (2006), LA (2006), MI (2006), MS (2006), MO (2016), MT (2009), NV (2011), NH (2011), NC (2011), OK (2006), PA (2011), SC (2006), SD (2006), TN (2007), TX (2007), UT (1994), WV (2008)
Trafficking prohibited	No person may purchase a firearm with the intent to resell to a person who is prohibited from buying or possessing a firearm	5	13	CA (1994), CO (2000), CT (1993), DE (1994), IL (2000), MN (2015), NY (2000), UT (1994)

Notes: Laws analyzed in this research study. A description of each law is provided as well as the total number of states that had the respective law in 1991 and the total number of states that had the respective law in 2016. Also shown are the states that implemented the law during the study period and the year the law change took effect.

Variable and Data Sources

Outcome Variables. The main outcome variable was the age-adjusted homicide rate in each year, stratified by race (white or black), without regard to ethnicity. Homicide rates were obtained from the CDC's (2018) Web-based Injury Statistics Query and Reporting Systems database. Rates were age-standardized to the 2000 national population. Because the CDC does not report rates when there are fewer than 10 homicides in a given year and because of the small black population in certain states, there were insufficient data on black homicide rates in 11 states (Alaska, Idaho, Maine, Montana, New Hampshire, North Dakota, Rhode Island, South Dakota, Utah, Vermont, and Wyoming). Therefore, our analyses are based on data from 39 states.

Main Predictor Variable. We created a database representing the presence or absence of 133 provisions of firearm laws covering 14 categories in each state during the period between 1991 and 2016 using historical state statutes and session laws through Thomson Reuters Westlaw (the codebook is available online at http://www.statefirearmlaws.org). The impact of laws was assessed starting in the first full year they were in effect, following the approach of Lott and Mustard (1997). In other words, we lagged the state laws by one year. This

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Variable	Component 1 Loadings	Component 2 Loadings	Component 3 Loadings
Incarceration rate	**.50**	−.13	−.03
Single-parent households	**.47**	.01	.09
Unemployment rate	**.46**	−.03	.13
Rental housing	**.45**	.06	−.37
Poverty rate	**.35**	.16	.17
Median income	.02	**−.72**	.04
No college degree	.01	**.66**	.04
Labor nonparticipation	.02	.00	**.89**
Eigenvalue	3.92	1.97	**1.19**

Table 2: Loadings from Principal Components Analysis Used to Derive Uncorrelated Composite Measures of Race-Specific Deprivation Variables

Notes: Total variance explained: 88.4 percent. Boldface values indicate variables whose loadings are most clearly associated with each of the components.

ensured that any impact of the law was assessed after its implementation.

Although we coded 133 provisions, most of these were detailed operative provisions within a single type of law, such as an assault weapon ban or background check law. We selected laws for analysis by considering laws that might be expected to affect overall homicide rates or that have been studied in previous research and choosing only laws for which there is enough variation over time to make analysis meaningful. Based on these criteria, we selected seven laws for analysis: (1) universal background checks for all firearms, (2) permits required to purchase all firearms, (3) prohibition of firearm possession by people with a history of a violent misdemeanor crime or relinquishment of firearms by people who are subject to a domestic violence restraining order, (4) "shall issue" laws; (5) "permitless carry" laws, (6) "stand your ground" laws, and (7) laws that prohibit firearm trafficking (see Table 1).

Control Variables. We controlled for nine state-level factors: percentage population that was black, percentage population that was Hispanic, percentage of young adult men (ages 18 through 29), total population, population density, per capita alcohol consumption, the nonhomicide violent crime rate (aggravated assault, robbery, and forcible rape), per capita number of law enforcement officers, and household firearm ownership, estimated using a well-established proxy—the proportion of suicides committed with a firearm—that has been validated for use at the state level (Azrael, Cook, & Miller, 2004). Note that although this proxy has been validated for cross-sectional analysis, no validated measure exists for time series analysis. We also included the lagged independent variable (the lag of the appropriate homicide rate). These variables were obtained from the U.S. Census Bureau (population and demographics), National Institute on Alcohol Abuse and Alcoholism (alcohol consumption), Uniform Crime Reports (crime rates and law enforcement officers), and the CDC (firearm ownership proxy).

In addition, we controlled for eight race-specific socioeconomic factors: incarceration rates, lack of a college degree, poverty rates, labor force nonparticipation rates, proportion of children living in single-parent households, percentage of the population in rental housing, median household income, and unemployment rates. Because of multicollinearity among these variables, we could not include all eight of them in the regressions. Therefore, we used principal components analysis to create composite measures consisting of a smaller number of uncorrelated components that captured the maximum amount of the variance in the eight variables. Using the criterion of achieving eigenvalues above 1.0, we retained the first three components, obtained after orthogonal rotation. The variables that loaded most heavily on each component were component 1 (poverty, incarceration, unemployment, rental housing, and single-parent households), component 2 (income and education), and component 3 (labor nonparticipation) (see Table 2). These three component scores were entered into the model to control for race levels of specific deprivation.

Analysis

As homicide victimization rates are not normally distributed, but skewed and overdispersed, we modeled the log-transformed homicide rates following the approach taken in previous work

Table 3: Final Model: Association of State Firearm Laws with Race-Specific Total Homicide Rates

Variable	Percentage Change in Homicide Rate and 95% CI		
	White	Black	Overall
Lagged firearm homicide rate	5.5* [3.1, 8.0]	1.3* [0.8 1.9]	
Population (per 1 million)	−1.2 [−3.3, 0.9]	−4.2* [−6.9, −1.4]	
Population density (per 10 square miles)	1.2 [−0.3, 2.6]	3.8* [1.0, 6.6]	
Percent black			−1.0 [−4.4, 2.4]
Percent Hispanic	−0.3 [−1.0, 0.4]	−0.6 [−1.7, 0.5]	
Percent young male	1.6 [−0.4, 3.7]	−3.1* [−6.0, −0.0]	
Per capita alcohol consumption			10.9 [−3.0, 27.4]
Violent crime rate	4.2* [2.0, 6.4]	1.4 [−1.0, 3.9]	
Per capita law enforcement			−5.2* [−9.8, −0.3]
Household firearm ownership			0.0 [−0.3, 0.3]
Socioeconomic deprivation component 1	1.5 [−1.0, 4.2]	−3.2 [−6.9, 0.7]	
Socioeconomic deprivation component 2			2.1 [−1.9, 6.2]
Socioeconomic deprivation component 3	−4.9 [−10.0, 0.7]	3.5 [−0.5, 7.6]	
Universal background checks (all firearms)			−11.2* [−19.0, −2.8]
Permit-to-purchase requirement			−11.3* [−20.0, −1.5]
Prohibitions for violent offenders	−3.2 [−8.4, 2.3]	−12.8* [−19.4, −5.6]	
"Shall issue" laws			5.7* [0.4, 11.3]
"Permitless carry" laws			−6.3 [−14.3, 2.4]
"Stand your ground" laws			2.9 [−3.2, 9.3]
Trafficking prohibited	−5.4* [−10.4, −0.1]	3.4 [−5.9, 13.7]	
R^2	0.98		

Note: All models controlled for the variables listed above.
*$p < .05$.

(Siegel et al., 2017). Because we had multiple observations for each state, there was a correlation between these observations over time. To control for this clustering we entered year and state as fixed effects in the regression models. We used cluster robust standard errors that account for the clustering of observations within states, serial autocorrelation, and heteroscedasticity (White, 1980).

Because our primary aim was to assess possible differences in the relationship between firearm laws and homicide victimization rates by white versus black race, we used dummy variables to create interaction terms that allowed the regression coefficients for white and black homicide rates to be compared within a single model (Gujarti, 1970; Weaver & Wuensch, 2013). We created an indicator variable, δ, that was 0 for white homicide rates and 1 for black homicide rates. We used this indicator variable to create a series of interaction terms whereby each of the predictor variables was multiplied by δ. These interaction terms allowed us to estimate separate regression coefficients for each predictor variable for white and black homicide rates and to test the statistical significance of differences in these coefficients. The coefficients of primary interest were the interaction term for the law variables. For example, the interaction term for universal background checks (UBCs) was $\delta \times \text{UBC}$ where $\text{UBC} = 1$ if a UBC law was present and $\text{UBC} = 0$ if such a law was not in effect. The statistical significance of the coefficient for this interaction term was used to assess whether or not the regression coefficients for UBC for white versus black homicide rates were statistically different. We developed a final model in which we included only those interaction terms that were statistically significant at the .10 level. We simultaneously included all of the law variables in this final model to estimate the independent association of each law with the homicide rate.

Because we defined the interaction term as being 1 for black homicide rates and 0 for white homicide rates, the race-specific association of each variable and the white homicide rate was simply the regression coefficient for the variable itself (without the interaction term). The association of each variable and the black homicide rate was the sum of the regression coefficient for the variable

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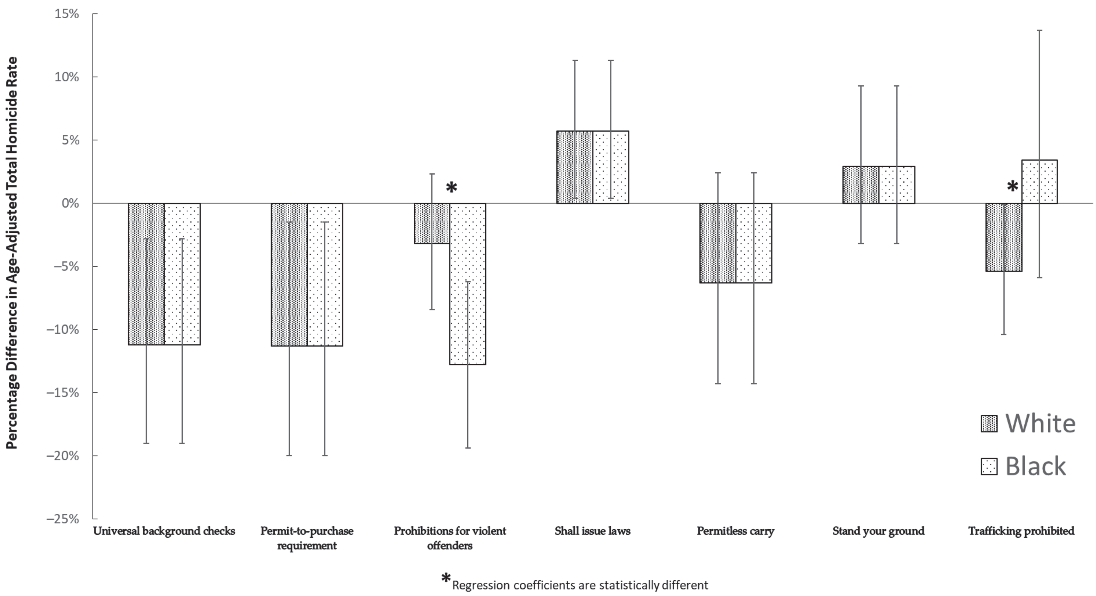
Figure 1: Percentage Change in Homicide Rate Associated with State Firearm Laws, by Race (Fully Adjusted Results)



itself and the regression coefficient for the interaction term.

Because the outcome variable was log-transformed, to generate estimates of the percentage change in the homicide rate associated with a law, we first exponentiated the regression coefficient for that law, then subtracted 1, and finally, multiplied by 100. Thus, the regression coefficients are reported as the percentage difference in homicide rate for states with a particular law compared with states without that law. We conducted analyses using STATA version 15.

Validity Check

If the association between a law and lower overall homicide resulted from a true effect of the law, then one would expect that relationship to be driven by a lowering of the firearm homicide rate, not the nonfirearm homicide rate. For laws that we found to be associated with overall homicide rates, we examined their relationship with firearm and nonfirearm homicide rates as a validity check, as we would not expect these laws to decrease nonfirearm homicide rates. The finding of such a relationship would lead us to question the validity of an observed relationship between a law and the overall homicide rate.

RESULTS

An important first finding was that within states, the presence or absence of particular firearm laws varied over time (see Table 1). For example, in 1991 no states had a "stand your ground" law. In 2016, 24 states had adopted this law.

In the regression analysis, two laws were significantly associated with lower homicide rates among both white and black populations: universal background checks (rate difference percent [RD]: –11.2; 95% confidence interval [CI]: –19.0, –2.8) and permit-to-purchase requirements (RD: –11.3; 95% CI: –20.0, –1.5) (see Table 3) (fully adjusted results displayed in Figure 1). "Shall issue" laws were significantly associated with higher homicide rates among both white and black populations (RD: 5.7; 95% CI: 0.4, 11.3).

Two laws had significantly different associations with white compared with black homicide rates. Prohibitions for violent offenders were negatively related to black homicide rates (RD: –12.8; 95% CI: –19.4, –5.6), but not to white homicide rates. Laws prohibiting firearm trafficking were negatively related to white homicide rates (RD: –5.4; 95% CI: –10.4, 0.1), but not black homicide rates. "Permitless carry" laws and "stand your ground" laws were not associated with homicide rates among either the white or the black population.

Table 4: Association of State Firearm Laws with Race-Specific Firearm and Nonfirearm Homicide Rates

	Percentage Change in Homicide Rate					
	Firearm			Nonfirearm		
Variable	**White**	**Black**	**Overall**	**White**	**Black**	**Overall**
Universal background checks (all firearms)			–14.2*			–5.0
Permit-to-purchase requirement			–18.4*			6.4
Prohibitions for violent offenders	–5.2	–12.2*		–3.8	–3.7	
“Shall issue” laws			6.8*			1.1
“Permitless carry” laws			–4.3			–1.9
“Stand your ground” laws			3.7			1.0
Trafficking prohibited	–5.3	–0.6		0.2	–5.7	

Note: All models controlled for the lagged firearm homicide rate, population, population density, percent black, percent Hispanic, percent young male, per capita alcohol consumption, violent crime rate, per capita law enforcement, household firearm ownership, and the three socioeconomic deprivation component scores.
*$p < .05$.

In the validity check, universal background checks, permit requirements, and prohibitions on firearm possession by violent offenders were all significantly associated only with the firearm homicide rate, not the nonfirearm homicide rate (see Table 4). However, firearm trafficking prohibition laws were not significantly associated with firearm homicide rates.

DISCUSSION

This article is one of the first to examine the extent to which specific firearm provisions affect race-specific homicide rates in an effort to inform policy development and the understanding of disparities in violence. Our research introduces several important findings.

First, most specific firearms laws examined here show no differential association with black and white homicide rates, suggesting that they provide uniform violence reduction benefits or harms. Provisions for universal background check laws, permit-to-purchase laws, and “shall issue” laws demonstrated consistent associations with homicide rates. The negative association between universal background check laws and homicide rates observed here confirms prior research demonstrating reductions in homicide outcomes (Ruddell & Mays, 2005; Sumner, Layde, & Guse, 2008) and adds that these associations are present across racial groups. The finding that states with “shall issue” provisions, compared with the more restrictive “may issue” provisions, had significantly higher black and white homicide rates is consistent with prior research (Kennedy et al., 1996), adding that this association is not race-specific.

One legal provision has a differential association with homicide rates when disaggregated by race. Specifically, laws containing provisions requiring relinquishment of weapons by people subject to domestic violence restraining orders or prohibiting firearm possession among all people convicted of a violent misdemeanor had a greater magnitude of association with the black firearm homicide rate than the white firearm homicide rate. These findings add to previous research reporting that laws prohibiting firearm possession by people convicted of a violent misdemeanor were associated with decreased overall homicide rates (Frattaroli & Teret, 2016; Wintemute, Frattaroli, Claire, Vittes, & Webster, 2014; Zeoli et al., 2018) by suggesting that these laws may have a stronger relationship with the black homicide rate than the white homicide rate. As a result, it appears that policy innovation that is grounded on the principle of keeping firearms out of the hands of people who have been convicted of violent crimes may be especially protective for the black population, although the reason for this is not clear.

One possible explanation for the differential relationships observed here with regard to laws that require relinquishment of weapons by people subject to restraining orders or convicted of violent misdemeanors may have more to do with racial inequities in the criminal justice system than with the legal provision itself. There is reason to suspect that when a person of color is accused of a violent misdemeanor, there is a greater likelihood of both arrest and conviction than when a person is white. Stevenson and Mayson (2018) reported a profound racial disparity in arrests for misdemeanor crimes, exactly the ones that are prohibiting for firearm possession in the laws we found to be associated with lower black homicide rates. Harris, Steffensmeier, Ulmer, and Painter-Davis (2009) found that white defendants are significantly less likely to be convicted after an arrest for aggravated assault than defendants who are black. Thus, it is possible that laws that keep firearms out of the hands of people convicted of a violent misdemeanor are more effective in reducing black homicide rates because black perpetrators of violent misdemeanors are more likely than white perpetrators to be convicted and therefore subject to the firearm prohibition.

Although we found a relationship between firearm trafficking laws and lower overall homicide rates, this finding failed the validity check, as these laws were not significantly associated with firearm homicide rates. This is not surprising, as a state's trafficking laws would be more likely to reduce the trafficking of guns *out* of that state.

Finally, our findings failed to confirm those of McClellan and Tekin (2012), who reported that "stand your ground" laws significantly increase homicides among white, but not black people. Here, we find no association between "stand your ground" laws and firearm homicide rates among either the white or the black population. One possible reason for this difference in findings is that the previous study examined only the decade of 2000–2010, during which the early "stand your ground" laws were enacted. When we restrict our analysis to the period prior to 2007, we obtain similar results. It may be that the early "stand your ground" laws had a greater impact than more recent ones because they received widespread publicity, unlike more recent laws that were enacted under the radar of most of the public.

Limitations

This study has several limitations. First, the study does not consider the differential effect of legal provisions on Hispanic or Latino homicide rates. Second, the study tests the relationships using state-level data. Considering how legal provisions intersect with city or neighborhood context in which homicide occurs should be explored by future research more directly. Third, the study does not seek to disaggregate further by other characteristics of the homicide event (for example, victim–offender relationship, motivation, gender). To the extent that these characteristics differ by race, they may confound the findings observed here and would be important to consider in their own right. Finally, the proxy used for household firearm ownership has not been validated for use in time series analysis, which may help explain why gun ownership was not found to be related to homicide rates in our analysis.

Public Health Social Work Implications

In evaluating public policy, it is important to determine not only what works but what works for whom. Our article demonstrates that for one law there are differential relationships with firearm homicide rates based on race. Although not significantly associated with white firearm homicide rates, violent misdemeanor laws are associated with reduced black firearm homicide rates. Universal background checks, permit requirements, and "shall issue" laws are associated with both white and black homicide rates.

Reducing racial disparities in health is a recognized priority for public health social workers (Keefe, 2010). Social workers should promote firearm laws that are associated with reduced risk of death for the entire population, but should be particularly mindful that one strategy for reducing disproportionate black homicide victimization may be advocating for provisions that prevent those subject to domestic violence restraining orders, or who have been convicted of violent misdemeanors, from having access to firearms. Public health social workers can play a critical role in promoting evidence-based firearm policies to reduce overall rates of firearm violence and to lessen the enormous racial gap in these rates. HSW

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ORIGINAL ARTICLE

The Impact of State Firearm Laws on Homicide Rates in Suburban and Rural Areas Compared to Large Cities in the United States, 1991-2016

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Abstract

Purpose: This article aims to examine whether state firearm laws impact homicide rates differently in suburban and rural areas compared to large cities in the United States.

Methods: We analyzed serial, cross-sectional data for the 26-year period 1991-2016 using a panel design. We examined the relationship between 6 specific state firearm laws and homicide rates in large cities (those with greater than 100,000 people in 1990) and in all geographic areas outside of these cities. Using a city-level fixed effects negative binomial regression, we modeled the number of homicides as a function of state firearm laws, while controlling for time fixed effects and time-varying state- and city-level sociodemographic factors.

Findings: Two policies—universal background checks and "may issue" laws that required a heightened showing of suitability for concealed carry—were associated with lower firearm homicide rates in large cities but were not associated with firearm homicide rates in suburban and rural areas. In contrast, laws that prohibited gun possession by people convicted of a violent misdemeanor were associated with lower firearm homicide rates in suburban and rural areas, but were not associated with firearm homicide rates in large cities. Permit requirements were associated with lower firearm homicide rates in both large cities and suburban and rural areas.

Conclusions: This article provides the first evidence that state firearm laws may have a differential impact on firearm homicide rates in suburban and rural areas compared to urban areas in the United States.

Key words firearm laws, firearms, homicide, rural health, urban health.

During the period 1999-2016, there were 213,175 firearm-related homicides in the United States.[1] According to the Centers for Disease Control and Prevention's (CDC) Web-Based Injury Statistics Query and Reporting Systems (WISQARS), 89.8% of these homicides occurred in "metropolitan" areas,[1] defined by CDC as counties located in a Metropolitan Statistical Area.[2,3] In response to the problem of firearm violence, many states have passed laws regulating the sale, purchase, and possession of firearms.[4] Several studies have demonstrated that both the rates and trends in firearm homicide differ between urban and nonurban counties,[5-9] yet no study has specifically tested the effect of state firearm laws in urban compared to nonurban spaces. This article aims to examine whether state firearm laws impact homicide rates differently in large cities versus smaller localities in the United States.

To our knowledge, only 2 previous studies, focused exclusively on stand your ground laws, have examined the comparative effects of state firearm laws in both urban and nonurban areas.[10,11] Ukert and associates found that Florida's stand your ground law was associated with an increase in homicide rates only in urban and suburban counties, not in rural counties.[10] Similarly, Munasib and colleagues reported that stand your ground laws across US states were associated with increases in firearm homicides, but only in urban and suburban counties, not in smaller metropolitan or rural counties.[11] These studies are limited because they examined the differential impact of only one type of law, which only regulates the use of firearms in unique situations. We are not aware of any study that has examined the independent effects of multiple firearm laws while also disaggregating homicide rates by urbanicity. Little is known about whether the effectiveness of laws frequently studied at the state level is conditioned on the setting of the violence that the laws seek to prevent.

Three prior studies have reported the impact of several firearm laws among large urban areas.[12,14,15] Crifasi and associates studied the relationship between 5 state firearm laws and homicide rates in heavily populated US counties during the period 1984-2015.[12] They found that laws requiring a permit to purchase firearms were associated with an 11% reduction in firearm homicide in these urban counties. Right-to-carry laws, stand your ground laws, and violent misdemeanor prohibitions were associated with increases in firearm homicides of 7%, 8%, and 24%, respectively. Kovandzic and colleagues reported no significant relationship between "shall issue" laws (ie, laws that do not allow any discretion to law enforcement officers in approving concealed carry permit applications) and homicide rates during the period 1980-2000 among all US cities with a population of greater than 100,000.[14] Kleck and Patterson reported no significant association between several state firearm laws and homicide rates during 1980 among all US cities with a population of greater than 100,000.[15] Although these studies inform our understanding of the effect of firearm laws in large urban places, they do not examine questions about the possible differential impact of state firearm laws in other types of localities. Nonurban areas are largely neglected in the study of firearm violence and nearly absent from research on the effectiveness of state firearm laws. In this study, we provide the first evaluation of the impact of state firearm laws in both urban and nonurban areas.

There are many ways in which urban and nonurban areas may be defined, and Hall et al emphasize that such a decision "should be guided by a clear idea of what aspects of the urban and rural context are suspected to have influence."[16(p 163)] With respect to the nature and extent of firearm-related crime, the key differentiating geographical factor appears to be the unique environment of large cities. Crime is rooted to a large degree in social and economic processes operating at the neighborhood and city level,[17] and since neighborhood-level data on crime are not available to test the effect of laws, disaggregating states by city-level characteristics provides the best alternative and offers several advantages.

First, densely populated urban areas have been uniquely associated with phenomena such as street crime,[18] gang violence,[16] and a high rate of illegal gun trafficking,[19,20] but lower rates of intimate partner homicide,[21] all of which may modify the impact of firearm legislation. Second, the causes of crime may vary depending on geographical context.[22] If the underlying causes of crime differ across place, the effect of laws and other interventions may vary as well. Third, crime rates in general are much higher in large cities compared to either small cities or rural areas,[18] which is also true for firearm homicide specifically. Between 1999 and 2016, the crude firearm homicide rate was almost the same in counties located in large fringe metro areas (2.6 per 100,000) as it was in rural areas (2.7 per 100,000).[2] Only in counties located in large central metro areas (exclusively counties that contain large cities) was there a substantial difference in the firearm homicide rate (6.4 per 100,000).[2] Fourth, proximity to metro areas, which is often an inherent part of coding schemes used in prior research, has no relationship to crime rates.[23] The characteristics of the place are what matters. For these reasons, we chose to categorize locations as urban or nonurban based on differentiating between large cities and all other areas. Specifically, we defined large cities as those having a population greater than 100,000 in the year 1990, while all other locations were classified as being nonurban areas.

An important contribution of the present study is the use of cities, rather than counties, as the basis for disaggregation of homicide rates. Most of the public health literature on homicide classifies urbanicity at the county level using coding schemes developed by CDC or US Department of Agriculture (USDA) (Table A1; available online only).[5-12] Isserman highlights a problem (which he terms the "county trap") of classifying urbanicity based on counties because these designations capture integration rather than separation.[24] Research that uses CDC or

USDA distinctions are classifying many counties as urban because they are tied to metropolitan areas even if the qualities of the areas making up the county being classified are decidedly nonurban on their own. For example, Miami County, Kansas, is categorized as "Metro - Counties in metro areas of 1 million population or more" in the USDA scheme and as "Large Fringe Metro" in the CDC scheme because of its proximity to Kansas City, Missouri, even though it has a population of under 33,000 and a population density of just 57 people per square mile. On the other hand, larger cities within less populous counties outside of a metropolitan area are sometimes not classified as urban when it would be reasonable to do so. For example, Springfield, Massachusetts, is classified only as a "Medium Metro" area in the CDC scheme although it has a population of more than 150,000 and a population density of over 4,800 people per square mile. Classifying urbanicity based on city-level population data avoids both of these potential forms of misclassification.

Although characteristics (eg, built environment, density) of any level of analysis vary across smaller units of analysis, making distinctions based on county-level data worsens the problem. Large counties often have stark differences between the central city of the county and the remaining places outside. For example, Salinas in Monterey County, California, has a population density that is 78 times that of the remaining county areas, yet it makes up only 36% of the population of the county. Classifying the city differently from the remaining county distinguishes these locations more accurately than lumping together the entire county.

Finally, there are methodological reasons to classify by city and aggregate less populous areas together. Pridemore cautions researchers about the limitations of analyzing homicide data at the county rather than city level due to small population counts, infrequency of homicides, and poor agency reporting practices, particularly within smaller counties.[25] For example, although data from the FBI Supplemental Homicide Reports may be interchangeable in large urban counties with other data sources of homicide, correlates of crime vary by data source for rural counties.[26]

In this article, we examine the relationship between 6 specific state firearm laws and homicide rates in large cities compared to smaller localities. Although most gun laws are state-specific, the factors that influence gun violence extend beyond state-level characteristics, going down to the city, community, and even neighborhood level.[18,27,28] This article advances the existing literature by providing the first estimates of the specific effects of state firearm laws in large cities and in smaller localities. The results may have implications for efforts to effectively reduce gun violence in both urban and nonurban areas.

Methods

Design Overview

We analyzed serial, cross-sectional data for the 26-year period 1991-2016 using a panel design. The cross-sectional observations in the panel consist of the 197 most populous cities in the United States in 1990 and all other places (ie, localities other than those cities) aggregated together within each state (Table 1). We employed a difference-in-differences approach (sometimes called a 2-way fixed effects model), which is commonly used for identifying treatment effects when there is staggered policy implementation.[29] As used here, this model compares the difference in homicide rates in a city before and after the implementation of a firearm law in that state to contemporaneous changes in homicide rates in cities located in states without such laws. In a separate analysis, we compared the difference in homicide rates in nonurban areas of a state before and after implementation of a firearm law in that state to contemporaneous changes in homicide rates in states without such a law. This design enabled us to take advantage of changes in state laws over time to examine the relationship between specific state firearm laws and homicide rates in large cities (those with greater than 100,000 people in 1990) and in all other areas (all geographical areas excluding the large cities).

Variables and Data Sources

Outcome Variables

The main outcome variable was the number of homicides—firearm homicides or nonfirearm homicides—in each city or in the aggregated nonurban areas in each state for each year. There is only one publicly available national data source that reports the location of homicides beyond the county level: the FBI's Uniform Crime Reports (UCR).[30-32] The UCR contains data reported by police departments of large cities and most counties. Only homicides that were classified as murder or nonnegligent homicide were included in this analysis.

City-specific homicide counts provided by municipal police departments were classified as occurring in large cities if the city population in 1990 was greater than 100,000. We used 1990 Census data as a parameter because our goal was to be as conservative as possible in classifying homicides as occurring in urban areas, since the major drawback of previous research was the misclassification of sparsely populated areas as being urban.[24]

For homicide counts reported at the county level, we treated all county agencies as not representing cities with 2 exceptions. Jefferson Parish (Louisiana) and Arlington

Table 1 Homicides by State, Stratified by Those Occurring in Medium to Large Cities and Those Not Occurring in Medium to Large Cities, 1991-2016

State	Total Homicides, 1991-2016	Homicides in Medium to Large Cities, 1991-2016	Homicides in All Other Areas, 1991-2016	Average Percentage of Population living in Medium to Large Cities	Average Medium to Large City Homicide Rate (per 100,000)	Average Smaller Locality Homicide Rate (per 100,000)	Average Medium to Large City to Smaller Locality Homicide Rate Ratio
Alabama	9,651	4,575	5,076	17.8	21.8	5.3	4.3
Alaska	1,037	469	568	41.2	6.7	5.7	1.3
Arizona	10,203	6,640	3,563	51.3	9.2	5.1	1.9
Arkansas	5,091	1,057	4,034	6.8	21.9	6.2	3.7
California	64,347	42,186	22,161	41.8	11.3	4.3	2.6
Colorado	4,568	2,495	2,073	30.4	7.2	2.6	2.8
Connecticut	3,322	2,097	1,225	18.0	13.0	1.7	7.9
Florida	24,451	7,400	17,051	15.3	11.9	4.9	2.4
Georgia	16,537	5,198	11,339	9.8	23.9	5.7	4.2
Hawaii	847	536	311	28.8	5.5	1.3	5.0
Idaho	852	90	762	13.9	1.8	2.5	0.8
Illinois	22,052	15,130	6,922	25.2	20.0	3.1	6.4
Indiana	9,796	5,571	4,225	22.1	15.7	3.4	4.9
Iowa	951	245	706	10.9	3.9	1.4	2.9
Kansas	2,020	1,219	801	28.9	9.0	2.4	4.6
Kentucky	5,419	1,822	3,597	17.0	10.3	4.1	2.6
Louisiana	15,441	9,446	5,995	28.8	28.0	7.3	3.9
Maryland	13,019	7,313	5,706	11.9	43.3	4.6	9.7
Massachusetts	3,885	2,066	1,819	16.1	8.4	1.4	6.0
Michigan	18,212	12,542	5,670	18.0	27.1	2.7	10.1
Minnesota	3,185	1,734	1,451	13.1	10.3	1.3	8.1
Mississippi	6,948	1,517	5,431	6.4	32.1	7.9	4.2
Missouri	10,981	7,199	3,782	18.6	26.1	3.1	8.3
Nebraska	1,404	973	431	37.1	5.7	1.5	4.6
Nevada	4,477	3,391	1,086	31.1	19.9	2.9	7.2
New Jersey	9,625	3,599	6,026	9.2	17.7	3.0	5.9
New Mexico	3,835	1,160	2,675	25.3	9.6	7.4	1.4
New York	28,913	23,873	5,040	47.1	10.5	1.9	5.3
North Carolina	15,094	4,333	10,761	18.6	11.0	6.1	1.8
Ohio	13,587	8,056	5,531	19.1	14.8	2.4	6.2
Oklahoma	5,704	2,957	2,747	25.8	12.5	4.1	3.1
Oregon	2,593	935	1,658	23.4	4.5	2.4	1.9
Pennsylvania	17,699	10,830	6,869	16.5	20.3	2.5	8.1
Rhode Island	815	460	355	16.2	10.5	1.6	7.8
South Dakota	477	72	405	17.2	2.0	2.4	1.1
Tennessee	11,368	6,785	4,583	26.6	16.8	4.2	4.1
Texas	38,340	23,694	14,646	39.4	10.7	4.3	2.4
Utah	1,426	339	1,087	7.7	7.2	1.9	3.8
Virginia	11,075	5,480	5,595	24.7	11.7	3.9	2.9
Washington	5,374	1,709	3,665	15.8	6.9	2.8	2.5
Wisconsin	4,860	3,097	1,763	15.1	14.4	1.5	10.1
Total	429,481	240,290	189,191	22.2	13.4	3.5	3.6
Delaware	964	0	964	0	–	4.4	–
Maine	538	0	538	0	–	1.7	–
Montana	658	0	658	0	–	3.0	–
New Hampshire	441	0	441	0	–	1.4	–
South Carolina	8,476	0	8,476	0	–	7.8	–
West Virginia	2,031	0	2,031	0	–	4.3	–
Wyoming	382	0	382	0	–	2.8	–
Grand Total	442,971	240,290	13,490	18.9	13.4	3.5	3.6

County (Virginia) report data primarily for 2 cities of greater than 100,000 population: Metairie, Louisiana, and Arlington, Virginia, respectively. For these cities, we therefore included homicides reported by Jefferson Parish and Arlington County as homicide counts for large cities.

Since there were 197 cities and 26 years, the total possible number of city-specific observations was 197 times 26, or 5,122. However, homicide data were missing for 34 city-year observations, yielding a final city sample size of 5,088.

There were 9 states that did not contain any large or medium cities by the threshold of 100,000 population in 1990 (Delaware, Maine, Montana, New Hampshire, North Dakota, South Carolina, Vermont, West Virginia, and Wyoming). These states were included in the analysis as nonurban areas, with the exception of North Dakota and Vermont, which were excluded because the homicide counts were too low to generate stable rate estimates. Thus, the total possible number of nonurban-specific observations was 48 times 26, or 1,248. There were 15 state-year observations for which no data were reported to the UCR. In addition, there were 14 state-year observations for which at least 1 major city did not report homicide data. (Note that although we were missing data for 34 city-year observations, there were often 2 or more cities missing from the same state, so this resulted in the loss of data for only 14 state-year observations due to missing data for specific cities). These 29 nonurban area-specific observations were also excluded. This yielded a final nonurban area-specific sample size of 1,248 minus 29, or 1,219. The total number of observations, therefore, was 5,088 for large cities plus 1,219 for aggregated nonurban areas within states, or 6,307.

To prevent researchers from having to analyze each year of UCR data separately, Dr. James Fox of Northeastern University has combined data from a supplement to the UCR (the Supplementary Homicide Report [SHR]) into a single file covering all years from 1976 through 2016, which he kindly provided to us.[33] Although this file contains data from the SHR, which only contains approximately 90% of the homicides reported in the UCR, Fox has weighted the data to exactly match the UCR homicide counts for each state. We confirmed that the homicide counts for each city and state matched the UCR counts.

Population totals for each city and state were obtained from the US Bureau of the Census, American Community Survey for 2000-2016, from the decennial Census for 1990, and from the US Census Bureau's postcensal estimates for 1991-1999.[34] The population of the aggregated nonurban areas in each state was calculated by subtracting the combined large city population from the state population.

Main Predictor Variables

We used the State Firearm Law Database, which tracks the presence or absence of firearm laws covering 14 categories in each state during the period 1991-2016 using historical state statutes and session laws obtained through *Thomson Reuters Westlaw*[4] (the codebook is available online at www.statefirearmlaws.org[35]). We lagged the state laws by 1 year so that the impact of these laws was assessed starting in the first full year they were in effect, not when the law was enacted, following the approach of Lott and Mustard.[36]

Based on previous research, we selected 6 laws for analysis: (1) universal background checks for all guns at point-of-sale[37,38]; (2) permits required to purchase or possess any firearm[12,39,40]; (3) ban on firearm possession by people convicted of a violent misdemeanor[41,42]; (4) stringent "may issue" laws ("may issue" laws that require the concealed carry permit applicant to make a heightened showing of having a need to carry a concealed firearm)[12,41,43,44]; (5) "stand your ground" laws[45,46]; and (6) ban on gun trafficking[47] (Table 2).

Control Variables

We controlled for 8 area-specific factors (ie, at the level of either the city or the aggregated nonurban area within a state): (1) percent black population; (2) percent Hispanic population; (3) overall population; (4) population density; (5) property crime rate (burglary, larceny, and motor vehicle theft); (6) proportion of the population with a college degree; (7) poverty rate; and (8) unemployment rate. In addition, we controlled for 4 state-level factors: percent black population, property crime rate, per capita alcohol consumption, and per capita number of law enforcement officers.

Property crime data were obtained from the FBI Uniform Crime Reports.[48,49] Missing data were linearly interpolated or extrapolated. For smaller localities, we subtracted the medium to large city crimes from the state totals. All other area-specific variables were obtained from the US Census Bureau.[50,51] Because data for the years 1991-1999 were not available for these variables at the city level, we interpolated their values from the 1990 and 2000 decennial censuses. For population by race, educational attainment, unemployment, and poverty, data were also unavailable for the years 2001 through 2004. We interpolated these values from the 2000 and 2005 data.

Data Analysis

Since homicide victimization rates are not normally distributed, but skewed and overdispersed, we used a count

Table 2 Laws Analyzed and Detailed Descriptions[a]

General Category	Specific Category	Description	1991	2016
Universal background checks	Universal background checks	Universal background checks are required at point-of-sale for all firearm sales	2	8
Permit-to-purchase requirement	Permit requirement	Permits are required to obtain all firearms	5	7
Possession of firearms by violent offenders	Violent misdemeanor law	Law prohibits firearm possession by people convicted of a violent misdemeanor crime	2	4
Concealed carry permitting	High level of discretion to law authorities in approving concealed carry permits	Law provides authorities with a high level of discretion in deciding whether to grant a concealed carry permit; the applicant must make a heightened showing of a need to carry a concealed firearm	27	7
Stand your ground law	Stand your ground law in place	State has a law that allows use of deadly force without a duty to retreat when a person is threatened	0	24
Gun trafficking	Trafficking prohibited	No person may purchase a firearm with the intent to re-sell to a person who is prohibited from buying or possessing a firearm	5	13

[a]Laws analyzed in this research study, conceptually grouped into general categories. A description of each law is provided as well as the total number of states that had the respective law in 1991 and the total number of states that had the respective law in 2016.

model that is appropriate for overdispersion: a negative binomial regression model. Since a Poisson model assumes that the mean of the outcome variable is equal to the variance, the presence of overdispersion (characterized by the variance being greater than the mean) favors the use of a negative binomial model, which is not based on that assumption.[52] A statistical test of the dispersion parameter confirmed that a negative binomial model was superior to a Poisson model. We used the log of the population as an offset.

Because we had multiple observations for each city (or aggregated nonurban area), there was a correlation between these observations over time. To control for this clustering, we included city (or aggregated nonurban area) fixed effects. This controls for any time-invariant differences between cities, such as overall gun culture. To account for the clustering of cities within states, we used cluster robust standard errors that account for the clustering of observations within states, serial autocorrelation, and heteroscedasticity.[53] We entered year as a fixed effect in the regression models to account for secular changes that occurred nationally, such as changes in federal gun laws or nationwide economic conditions.

The number of homicides in each city (or nonurban areas within a state) was modeled as:

$$\ln(h_{ct}) = \alpha + \beta_1 L_{st} + \beta_2 C_{ct} + \beta_3 C_{st} + F + T + e, \quad (1)$$

where h_{ct} is the number of homicides in city c in year t, L is a series of dummy variables for the presence of a particular firearm law in state s in year t, C is a vector of control variables at the city level (C_c) or state level (C_s), F represents city fixed effects, and T represents year fixed effects.

Because our primary aim was to assess possible differences in the relationship between firearm laws and homicide victimization rates in urban compared to nonurban areas, we ran separate regressions modeling urban homicide rates and nonurban homicide rates and compared the regression coefficients for the law dummy variable between the 2 models. The question of interest was whether or not the regression coefficients for the law variables were significantly different for urban homicide rates and nonurban homicide rates. The standard method to do this is to compute a Z-statistic by dividing the difference between the coefficients by the standard error of the population distribution of the difference in coefficients.[54,55] To assess whether the regression coefficients significantly differed, we used a one-sided Z test with $\alpha = 0.10$.

Because we used a negative binomial model, we reported the regression coefficients as incidence rate ratios (IRR), which indicate the percentage change of the homicide rate for each unit change in the independent variable. Thus, the IRRs can be interpreted in terms of the percentage difference in homicide rate for areas with a particular law compared to areas without that law. To make it easier to interpret the IRRs for the control variables, we standardized them so that the IRR indicates the difference in homicide rates associated with a 1 standard deviation increase in the level of the control variable.

We conducted all analyses using STATA version 15 (StataCorp, College Station, Texas).

Table 3 Relationship Between State Firearm Laws and Medium to Large City/Smaller Locality Homicide Rates: Fixed Effects Negative Binomial Model[a]

	IRR (95% Confidence Interval)		
	Total Homicide	Firearm	Nonfirearm
Medium to large cities			
Universal background checks	**0.88[b] (0.80-0.98)**	**0.87[b] (0.77-0.97)**	0.95 (0.87-1.04)
Permit required to obtain all firearms	**0.83[b] (0.78-0.88)**	**0.79[b] (0.72-0.86)**	1.03 (0.96-1.10)
Violent misdemeanor law	0.97 (0.85-1.11)	0.94 (0.81-1.11)	1.01 (0.94-1.09)
Heightened showing may issue law	**0.87[b] (0.80-0.95)**	**0.83[b] (0.74-0.92)**	0.99 (0.90-1.09)
Stand your ground law	1.00 (0.93-1.07)	1.02 (0.92-1.12)	0.98 (0.92-1.04)
Trafficking prohibited	1.01 (0.90-1.15)	1.04 (0.87-1.23)	0.95 (0.87-1.04)
All other localities			
Universal background checks	0.98 (0.89-1.07)	1.00 (0.87-1.14)	0.94 (0.86-1.03)
Permit required to obtain all firearms	0.89 (0.78-1.00)	**0.80[b] (0.69-0.93)**	1.00 (0.89-1.13)
Violent misdemeanor law	0.83 (0.64-1.10)	**0.70[b] (0.49-0.99)**	1.08 (0.92-1.27)
Heightened showing may issue law	0.99 (0.93-1.06)	0.95 (0.88-1.03)	1.02 (0.94-1.11)
Stand your ground law	1.01 (0.95-1.07)	1.02 (0.94-1.10)	1.00 (0.94-1.06)
Trafficking prohibited	1.02 (0.95-1.10)	1.08 (0.98-1.18)	0.92 (0.84-1.01)

IRR: incidence rate ratio.

[a]All models controlled for 4 state-level factors (proportion of blacks, property crime rate, per capita alcohol consumption, and per capita number of law enforcement officers). In addition, we controlled for 8 area-specific factors (proportion of blacks, proportion of Hispanics, overall population, population density, property crime rate, proportion of the population with a college degree, poverty rate, and unemployment rate).

[b]$P < .05$ (also shown in bold type).

Falsification Tests

A falsification test (also called a placebo test) is an analysis of an intervention on an outcome that would not be expected to be affected by the intervention and is commonly used to assess the validity of an observed relationship between an intervention and the outcome of actual interest.[56] We examined the relationship of each law with nonfirearm homicide counts as a falsification test, since we would not expect firearm laws to affect nonfirearm homicides. The finding of such a relationship would lead us to question the validity of an observed relationship between a law and firearm homicide rates. Firearm and nonfirearm homicide counts were obtained from the UCR.

Results

Table 1 shows the states included in the analysis, and Table A2 (available online only) displays a list of each state and the cities that met the criteria for being classified as a large city. During the period 1991-2016, there were 442,971 reported homicides across the 48 states (Table 1). Of these, 240,290 (54.2%) occurred in large cities, while 202,681 (45.8%) occurred outside of these cities. Although more than half of the homicides occurred in large cities, these areas contained less than one-fifth (18.9%) of the total population. Nationally, the average large city homicide rate was 13.4 per 100,000, and the average smaller locality homicide rate was 3.5 per 100,000. The average ratio of large city to smaller locality homicide rates (excluding states with no large cities) ranged from a low of 0.8 in Idaho to a high of 10.1 in Michigan and Wisconsin (Figure A1, available online only).

Over the study period, the average city-specific homicide rates ranged from a low of 0.9 per 100,000 in Thousand Oaks, California, and Amherst, New York, to a high of 63.2 per 100,000 in Gary, Indiana (Table A2). The next 4 highest homicide rates occurred in New Orleans (54.0), Detroit (47.3), St. Louis (45.6), and Baltimore (43.3).

Universal background checks were associated with 13% lower firearm homicide rates in large cities (95% confidence interval [CI]: 3%-23%), but they showed no association with firearm homicide rates in smaller localities (Table 3, Table 4). Permit requirements were associated with 21% lower firearm homicide rates (95% CI: 14%-28%) in large cities and 20% lower firearm homicide rates (95% CI: 7%-31%) in smaller localities. Violent misdemeanor laws were associated with 30% lower firearm homicide rates (95% CI: 1%-51%) in smaller localities, but were not associated with firearm homicide rates in large cities. "May issue" laws that required a heightened showing of suitability for a concealed carry permit were associated with 17% lower firearm homicide rates in large cities (95% CI: 8%-26%) but were not associated with firearm homicide rates in smaller localities. Stand your ground and gun trafficking laws were not associated with firearm homicide rates in either large cities

Table 4 Relationship Between State Firearm Laws and Medium to Large City/Smaller Locality Firearm Homicide Rates: Full Model Results for Fixed Effects Negative Binomial Regression[a]

Variable	Incidence Rate Ratio (95% Confidence Interval): Medium to large cities	Incidence Rate Ratio (95% Confidence Interval): All other localities
State level		
Percent black	**2.56[b] (1.61-4.08)**	1.00 (0.62-1.61)
Property crime rate	1.05 (0.95-1.16)	1.01 (0.93-1.10)
Per capita alcohol consumption	**1.19[b] (1.08-1.30)**	**1.09[b] (1.00-1.18)**
Per capita law enforcement officers	**0.95[b] (0.90-0.99)**	0.99 (0.96-1.03)
Area level (city or aggregated nonurban area)		
Percent black	0.98 (0.78-1.23)	1.63 (0.66-4.03)
Percent Hispanic	1.00 (0.86-1.17)	1.02 (0.70-1.50)
Overall population	**0.78[b] (0.74-0.83)**	**0.87[b] (0.81-0.93)**
Population density	1.03 (0.96-1.11)	**1.21[b] (1.11-1.32)**
Property crime rate	**1.14[b] (1.07-1.22)**	1.01 (0.94-1.08)
Educational attainment	0.90 (0.80-1.01)	1.05 (0.95-1.16)
Poverty rate	1.09 (0.99-1.19)	0.93 (0.81-1.06)
Unemployment rate	0.79 (0.45-1.38)	0.82 (0.54-1.23)
State laws		
Universal background checks	**0.87[b,c] (0.77-0.97)**	1.00[c] (0.87-1.14)
Permit required to obtain all firearms	**0.79[b] (0.72-0.86)**	**0.80[b] (0.69-0.93)**
Violent misdemeanor law	0.94[c] (0.81-1.11)	**0.70[b,c] (0.49-0.99)**
Heightened showing may issue law	**0.83[b,c] (0.74-0.92)**	0.95[c] (0.88-1.03)
Stand your ground law	1.02 (0.92-1.12)	1.02 (0.94-1.10)
Gun trafficking prohibited	1.04 (0.87-1.23)	1.08 (0.98-1.18)

[a]The regression coefficients for all nonlaw variables represent the change in the outcome variable for each 1 standard deviation increase in the independent variable (except for overall population in the urban models and population density in the nonurban models, which represent the increase in the outcome variable for each 0.1 standard deviation or 0.01 standard deviation increase, respectively). All models controlled for the variables listed in the variable column.
[b]$P < .05$ (also shown in bold type).
[c]Coefficients for medium to large cities and other localities are statistically different at $P < .10$.

or smaller localities. For 3 of the laws (universal background checks, violent misdemeanor laws, and stringent may issue laws), the regression coefficients for large cities and smaller localities were significantly different (Figure A2, available online only).

In the falsification test, none of the 6 laws was associated with nonfirearm homicide rates (Table 3). Other variables that were associated with firearm homicide rates in large cities were the proportion of black residents, per capita alcohol consumption, and per capita law enforcement officers in the state, and the population size and property crime rate in the city (Table 4). Other variables associated with firearm homicide rates in smaller localities were per capita alcohol consumption in the state and the population size and population density of the nonurban area.

Discussion

To our knowledge, this is the first article to examine the impact of multiple state firearm laws on homicide rates in suburban and rural areas compared to urban areas. We found that universal background checks and stringent "may issue" laws are associated with lower firearm homicide rates in large cities, but not in smaller localities. In contrast, we found that violent misdemeanor laws are associated with lower firearm homicide rates in smaller localities, but they were not associated with homicide rates in large cities. Permit requirements were associated with lower firearm homicide rates in both large cities and smaller localities. Taken together, these findings provide evidence to suggest that there may be variation in the effectiveness of state firearm laws on firearm homicide rates based on urbanicity.

One strength of this article is that we conducted falsification testing which demonstrated that the state laws associated with lower homicide rates were only related to firearm homicide rates, not nonfirearm homicide rates. This specificity in the observed association adds validity to the findings.

An important implication of our findings is that future studies may need to examine the impact of state firearm laws at different levels of geography or else there is a risk that they could miss an effect that may be present only at a certain level. For example, if it is true that certain laws influence homicide only in large cities or only in areas outside of large cities, then studies which aggregate all homicides at the state level may miss such a specific effect, as may studies that examine only urban areas.

A second implication of our findings is that although a disproportionate percentage of homicides occur in large urban areas, a substantial proportion of homicides do occur in less urban locations and should not be overlooked. We believe this is the first study that specifically examined the impact of state firearm laws in nonurban areas. Our findings suggest some laws affect both areas, and we found 1 law (violent misdemeanor provisions) that had unique associations with firearm homicides in areas outside of large cities, which suggests the need for new policy responses attuned to lethal violence outside of these cities. One possible explanation for this finding is that intimate partner violence against women has been shown to be more frequent and more severe in rural areas than in cities.[21,57] Thus, keeping guns out of the hands of violent offenders, especially domestic violence offenders, may be particularly effective to reduce homicides in rural areas.

A unique contribution of this study is that it classified localities at the subcounty level and grouped "medium and large cities" separately from "other localities." Counties are often large and diverse and may encapsulate both urban and nonurban areas. Examining the impact of firearm policies at the city level may provide a more precise analysis that takes into account factors unique to firearm violence in urban and nonurban environments.

Limitations

There are several important limitations of this analysis. First, the Uniform Crime Reports do not contain complete reporting of homicides from all local law enforcement agencies. The CDC vital statistics data provide more complete coverage; however, we were unable to use these data because they are only available at the county level, not the city level.

Second, we limited our analysis to a dichotomous definition of urbanicity. Future research should examine rural areas as a separate category, as we may have obscured important differences by pooling data from small cities, suburban areas, and rural areas.

Third, the panel data structure presents the possibility of autocorrelation. Although we used standard errors that are unbiased in the presence of serial autocorrelation, we did not explicitly model potential autocorrelation in our analysis.

Fourth, we did not use geospatial analysis to analyze the locations of individual homicides. In addition, the UCR records the location where a homicide occurred, but it is possible that the offender resided in a different city or state and may have obtained the firearm in that locality.

Finally, when using regression analyses in social science, there are always many potential statistical problems that cannot be fully accounted for, including omitted variable bias. There are undoubtedly factors that affect homicide that were not included in the regressions, and thus the size of the relationship between the laws examined and homicide should be considered at best as crude estimates.

Conclusions

Despite these limitations, this article provides the first evidence that state firearm laws may have a differential impact in urban versus nonurban areas. Future research should expand the analysis to include finer gradations of urbanicity and rurality.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix Figure 1. Average Ratio of Large City Homicide Rate to Smaller Locality Homicide Rate, 1991–2016.
Appendix Figure 2. Percentage Difference in Homicide Rate Associated with State Firearm Laws: Urban vs. Non-Urban Areas.
Appendix Table 1. Definitions of Urbanicity and Urban/Nonurban Classifications in Prior Firearm Violence Research.

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Association between Firearm Laws and Homicide in Urban Counties

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Abstract Laws related to the sale, use, and carrying of firearms have been associated with differences in firearm homicide rates at the state level. Right-to-carry (RTC) and stand your ground (SYG) laws are associated with increases in firearm homicide; permit-to-purchase (PTP) laws and those prohibiting individuals convicted of violent misdemeanors (VM) have been associated with decreases in firearm homicide. Evidence for the effect of comprehensive background checks (CBC) not tied to PTP is inconclusive. Because firearm homicide tends to concentrate in urban areas, this study was designed to test the effects of firearm laws on homicide in large, urban U.S. counties. We conducted a longitudinal study using an interrupted time series design to evaluate the effect of firearm laws on homicide in large, urban U.S. counties from 1984 to 2015 ($N = 136$). We used mixed effects Poisson regression models with random intercepts for counties and year fixed effects to account for national trends. Models also included county and state characteristics associated with violence. Homicide was stratified by firearm versus all other methods to test for specificity of the laws' effects. PTP laws were associated with a 14% reduction in firearm homicide in large, urban counties (IRR = 0.86, 95% CI 0.82–0.90). CBC-only, SYG, RTC, and VM laws were all associated with increases in firearm homicide. None of the laws were associated with differences in non-firearm homicide rates. These findings are consistent with prior research at the state level showing PTP laws are associated with decreased firearm homicide. Testing the effects of PTP laws specifically in large, urban counties strengthens available evidence by isolating the effects in the geographic locations in which firearm homicides concentrate.

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Keywords Gun policy · Firearm · Homicide

Introduction

In 2016, there were 14,415 firearm homicides in the United States (U.S.), which accounted for nearly 75% of all homicides [1]. Firearm homicides are not distributed equally across the U.S.; 63% occurred in large, urban counties (classified as Large Central Metro and Large Fringe Metro by the U.S. Census Bureau) which contain 56% of the U.S. population [2]. States have enacted policies in response to firearm homicide, but the effect of these policies specifically in urban areas is unknown. In this study, we aim to evaluate the effect of five firearm-related policies on homicide in large, urban counties: comprehensive background checks, permit-to-purchase, right-to-carry, stand your ground, and violent misdemeanor prohibitions.

Weaknesses in federal law allow prohibited individuals to obtain firearms through unregulated private sales. Currently, only nineteen[1] states and the District of Columbia have laws requiring point of sale background checks be conducted when the seller is a private party. These laws are often referred to as comprehensive background check (CBC) laws. CBC laws require all sellers, both licensed retailers and private parties, to make firearm transfers contingent on the purchaser passing a background check. Private sales include those made at gun shows, sales arranged between strangers online, and transfers between friends and acquaintances. The most recent estimate by Miller and colleagues suggests that approximately 20% of guns are obtained without a background check [3]. In the 13 states with the least restrictive firearm laws, state prison inmates who were incarcerated for a gun crime were more likely to report obtaining that gun through an unregulated private sale than from a licensed dealer [4]. Data on recovered crime guns suggest more than 80% of criminals using firearms to commit crime were not the purchaser of record [5]. There is inconclusive evidence on the effect of background checks for private sales on firearm homicide at the state level.

Realizing that requiring background checks for private sales may, by itself, not be sufficient, ten states and the District of Columbia have an additional handgun purchaser licensing requirement; often referred to as permit-to-purchase (PTP) laws. PTP laws typically require that prospective handgun purchasers apply directly to a state or local law enforcement agency, many require applicants to submit fingerprints, for a purchase permit prior to approaching a seller. PTP laws may include a more thorough background check which law enforcement can take 30 days or more to complete. Sellers, both licensed and private, can only sell to someone with a valid purchase permit which is valid for varying lengths. States with longer duration permits may also require a point of sale background check to ensure that the purchaser has not become prohibited since the issuance of the permit. Prior research has found that PTP laws are associated with reductions in the diversion of guns to criminals [6] and gun homicide [7, 8].

It is important to note the differences between CBC and PTP laws because they are often conflated in research when in fact they are implemented differently, in ways that may influence their effectiveness. CBC laws generally depend upon the use of the National Instant Criminal Background Check System (NICS) that is also used by licensed dealers; however, issues with the NICS have been identified related to the which records are reported to the system and the quality and timeliness of records that are reported [9]. PTP laws provide a longer period for law enforcement to conduct its background check at the local level, and these checks may have access to more records increasing the likelihood that law enforcement can identify and screen out those with a prohibiting condition.

Right-to-carry (RTC) laws require law enforcement to issue concealed carry permits to any individual that meets objective criteria or allow for permitless carry (permitless carry allows for individuals who are not otherwise prohibited from gun ownership to carry without obtaining a permit). RTC laws make it easier for individuals to carry loaded, concealed firearms in public spaces, and may require little or no safety training or demonstrations of competence and proficiency. Previous research suggests that RTC laws are associated with increased rates of violence at the state level [10, 11].

Stand your ground (SYG) laws are those that give individuals expanded protections for use of deadly force in a response to a perceived threat with no duty to retreat. These laws may make otherwise non-lethal encounters deadly if individuals are carrying loaded, concealed firearms, and feel emboldened to use their firearms in self-defense rather than leaving or de-escalating a volatile situation. Research on SYG laws shows they are associated with increases in rates of state-level firearm homicide [12, 13].

Violent misdemeanor (VM) prohibitions extend criminal prohibiting conditions for the purchase of a firearm to those who have been convicted of a misdemeanor crime of violence. States with these laws recognize that prohibiting a broader pool of potentially risky firearm owners may screen out individuals at risk of committing violence but who have not yet been convicted of a felony or domestic violence misdemeanor. Previous research showed decreased risk of future gun crime among those prohibited for a VM crime [14]. A recent study by Zeoli et al. found lower rates of intimate partner homicide in states with VM prohibitions [15].

Studies evaluating the effect of CBC, PTP, RTC, SYG, and VM laws on firearm homicide have been conducted at the state level. However, firearm homicide occurs more frequently in urban areas, so evaluations at the state level may underestimate the effectiveness of these laws in the places where homicides predominate.

[1] While Nevada passed a CBC law, there are implementation issues related to how the law was written and whether it will be enforced.

This study sought to explore the effects of these firearm laws on homicide in large, urban counties where firearm homicide is more likely to occur. We also sought to separate out the effects of states with CBC-only laws and those with PTP. Based on prior research, we hypothesized that PTP and VM laws would be associated with protective effects on homicide rates, CBC-only laws would have no effect, and RTC and SYG would be associated with harmful effects.

Methods

Design

We conducted a quasi-experimental longitudinal study using an interrupted time series to evaluate the effect of firearm laws on homicide in large, urban U.S. counties from 1984 to 2015. Because these laws are related to firearms, county-year counts of homicide were stratified by firearm versus all other methods to test for specificity of the laws' effects.

Data and Measures

Based on previous research, we hypothesized that, due to the specificity of the laws regarding firearms, changes to these laws would affect only firearm homicides. The primary outcome for the study was annual, county-level counts of firearm homicide obtained from the Centers for Disease Control and Prevention's Wide-ranging ONline Data for Epidemiologic Research (WONDER) system [16]. Because firearm homicide tends to concentrate in urban areas, we restricted our analysis to counties with U.S. Census urbanization codes of "Large Central Metro" and "Large Fringe Metro" and populations greater than 200,000 across the study period resulting in a sample that contained 136 counties over 32 years for a total of 4352 county-year observations.[2]

We accessed additional county-level variables from WONDER including the percent of the population who were African American males age 15–24 and county population. County-level percent poverty was obtained from the U.S. Census and interpolated between census years [17]. Average annual measures of county-level unemployment were obtained from the Bureau of Labor Statistics Local Area Unemployment Statistics [18]. State-level variables were used for two covariates that were not readily available at the county level: incarceration rates [19] and state law enforcement expenditures [20].

We conducted legal research to identify the effective dates for each state's policies including month, day, and year. Indicators for policy variables were generated based on these effective dates. Policy indicators were coded as 1 when a law was in effect and 0 otherwise. To reduce measurement error, the policy indicators were coded as a proportion for the number of days the policy was in effect in the year in which a policy was first implemented (see Table 1).

Exploratory data analysis revealed outliers for non-firearm homicide counts for counties near New York City in 2001 due to the attack at the World Trade Center; nearly 3000 additional lives were lost due to non-firearm homicide. For counties within approximately 50 miles of New York City, we excluded the counts of non-firearm homicide for 2001 only.

Analytic Methods

We conducted an interrupted time series analysis to estimate the effects of firearm laws on county-level firearm homicide. We used non-firearm homicide as a negative control to test for the specificity of the laws' effects. We used mixed effects Poisson regression models to account for repeated measures by county and allow counties to have unique intercepts; the likelihood ratio test for mixed effects versus a Poisson model indicated the need for random intercepts ($p < 0.001$).

County-level percent poverty, unemployment, and African American males age 15–24, state-level incarceration rates, and law enforcement expenditures were included in the final model. Year fixed effects were used to account for national trends in homicide and county-level population was included as an offset to generate incident rate ratios (IRRs). Additionally, models were run with and without a county-level proxy for firearm ownership (the ratio of firearm suicide to all suicide). Analyses were conducted using Stata IC v 14.2 [21]. This study was deemed to be "not human subjects research" by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

[2] States with no counties that met the inclusion criteria: Alaska, Arkansas, Hawaii, Idaho, Iowa, Maine, Mississippi, Montana, Nebraska, New Mexico, North Dakota, South Carolina, South Dakota, Vermont, West Virginia, and Wyoming

Table 1 Firearm laws and effective dates by state

State (# of counties)	Permit to purchase	Comprehensive background check only	Right to carry	Stand your ground	Violent misdemeanor restriction
Alabama (1)			Pre-1984	6/1/06	
Arizona (1)			4/13/94	4/24/06	
California (12)		1/1/91			1/1/91
Colorado (4)		7/1/13	5/17/03		
Connecticut (1)	10/1/95				
Delaware (1)		7/1/13			
Florida (9)			10/1/87	10/1/05	
Georgia (4)			8/25/89	7/1/06	
Illinois (7)	Pre-1984		1/5/14		1/1/95
Indiana (2)		Pre-1984–11/30/98	Pre-1984	7/1/06	
Kansas (1)			1/1/07	5/26/06	
Kentucky (1)			10/1/96	7/12/06	
Louisiana (2)			4/19/96	8/1/06	
Maryland (5)	10/1/13	10/1/96–10/1/13			10/1/03
Massachusetts (6)	Pre-1984				
Michigan (4)	Pre-1984		7/1/01	10/1/06	
Minnesota (4)			5/28/03		10/1/03
Missouri (3)	Pre-1984–8/28/07		2/26/04	8/28/07	
Nevada (1)			10/1/95	10/1/11	
New Hampshire (1)			Pre-1984	11/13/11	
New Jersey (13)	Pre-1984				
New York (14)	Pre-1984				Pre-1984
North Carolina (2)	Pre-1984		12/1/95	12/1/11	
Ohio (6)			4/8/04		
Oklahoma (1)			1/1/96	11/1/06	
Oregon (3)		8/9/2015	1/1/90		
Pennsylvania (8)		10/11/95	6/17/89	8/29/11	
Rhode Island (1)		Pre-1984	Pre-1984		
Tennessee (2)		5/10/94–11/1/98	10/1/96	5/22/07	
Texas (6)			1/1/96	9/1/07	
Utah (1)			5/1/95	3/1/94	
Virginia (3)			5/5/95		
Washington (4)		12/4/14	Pre-1984		
Wisconsin (2)			11/1/11		
Total states with law during study period (total # of changes)	9 (3)	10 (9)	27 (22)	18 (18)	5 (4)

Results

Table 1 presents the laws included in the study and the associated effective dates by state for those states with counties that met our inclusion criteria.

Table 2 presents the effects of the firearm policies we examined on firearm homicide in large, urban counties after controlling for identified covariates. PTP laws were associated with a 14% reduction in firearm homicide (IRR = 0.86, 95% CI 0.82–0.90). CBC-only laws were

Table 2 Effects of firearm laws on firearm homicide in large, urban U.S. counties, 1984–2015

	IRR[a]	95% CI[b]
Permit to purchase	0.86	0.82–0.90
Comprehensive background check only	1.16	1.13–1.18
Right to carry	1.04	1.02–1.06
Stand your ground	1.07	1.05–1.10
Violent misdemeanor prohibitions	1.14	1.12–1.17
County-level % population African American male youth	1.53	1.49–1.57
County-level poverty rate	1.00	1.00–1.00
County-level unemployment rate	1.00	1.00–1.01
State-level incarceration rate	1.00	1.00–1.00
State-level law enforcement expenditures	0.99	0.99–0.99

The model also included year fixed effects

[a] Incidence rate ratio

[b] 95% confidence interval

associated with a 16% increase in firearm homicide (IRR = 1.16, 95% CI 1.13–1.18). RTC laws were associated with a 4% increase in firearm homicide (IRR = 1.04, 95% CI 1.02–1.06). SYG laws were associated with a 7% increase in firearm homicide (IRR = 1.07, 95% CI 1.05–1.10). VM laws were associated with a 14% increase in firearm homicide (IRR = 1.16, 95% CI 1.12–1.17). When we included the proxy for county-level firearm ownership, there were negligible differences in the point estimates; however, the firearm ownership proxy itself was associated with a 37% increase in firearm homicide (IRR = 1.37, 95% CI 1.26–1.49).

Because of the IRR estimates for CBC-only and VM laws were in the direction opposite to our hypotheses, we also tested the effects of 1-, 2-, and 3-year leads and lags of the laws. These estimates reveal firearm homicide rates trending upward in the years immediately prior to CBC-only (Fig. 1) and VM laws (Fig. 2) going into effect with statistically significant increased firearm homicide rates 1 year prior to the laws' introduction. The IRRs were above 1.0 each year following the introduction of CBC-only and VM laws, but leveled off for CBC-only and were essentially the same as the 1-year lead for VM laws.

Table 3 presents the effects of the same set of firearm policies on non-firearm homicide rates. None of the firearm policy variables of interest were associated with changes in non-firearm homicide, supporting the specificity of the laws' effects. When we included the proxy for county-level firearm ownership, there were negligible differences in the point estimates; however, the firearm ownership proxy itself was associated with an 18% reduction in non-firearm homicide (IRR = 0.82, 95% CI 0.73–0.92).

Discussion

This study is the first study to our knowledge that examines the impact of PTP laws in large, urban counties where firearm homicide is more likely to occur. Our study also is the first to separate the impacts of CBC laws from PTP to understand how CBC laws affect firearm homicide independent from a permitting mechanism. Our study also examined the effects of other firearm-related policies on firearm homicide.

Our results are consistent with previous research finding that PTP reduces firearm homicides without increasing homicides by other means. However, we saw no benefit of a CBC system without a PTP law. It is possible that the application process required to obtain a permit, which puts the purchaser directly in contact with law enforcement, acts to hold potential purchasers more accountable and reduces the likelihood of straw purchases made on behalf of prohibited persons. The added time to conduct the background check at the local level may also make it easier to identify and screen out prohibited individuals who may be at increased risk of using that firearm to commit a homicide. Additionally, the built-in waiting period as part of the permitting process may prevent impulsive firearms purchases.

Our study suggests an increased risk of firearm homicide in large, urban counties associated with enactment of RTC laws which is consistent with previous research conducted at the state level. Counties in states with RTC laws experienced a 4% increase in firearm homicide relative to counties in states with more restrictions on the issuance of concealed carry weapons permits. Future research should explore whether specific elements of RTC laws, or lack thereof, have differential impacts on firearm homicide. For example, some RTC states allow law enforcement to deny issuing a concealed carry permit based on "dangerousness," or require a demonstration of proficiency. These differences can inform policy discussions around which elements, if any, may mitigate the harmful effects of expanded carrying of loaded, concealed firearms by civilians.

Our findings related to the effects of SYG laws are also consistent with previous research on the effects of

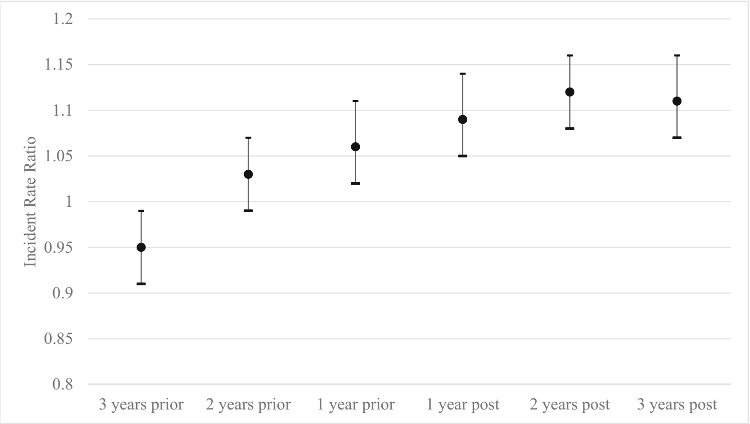

Fig. 1 Effects of CBC-only laws on firearm homicide 1-, 2-, and 3-year pre- and post-enactment

these laws on state-level firearm homicide [12, 13]. Counties in states with SYG laws experienced a 7% increase in firearm homicide. SYG laws are common in states with RTC laws and a high prevalence of gun ownership. Removing a duty to retreat in the context of populations with many armed individuals appears to increase firearm homicide.

In contrast to recent research finding protective effects of prohibitions for violent misdemeanants on intimate partner homicide [15], our study found increased risk of firearm homicide in counties of states with VM laws. However, the increased IRR for firearm homicide associated with VM laws in the year prior to the effective date suggests that the conditions influencing the passage of VM laws may increase firearm homicides. Identifying and controlling for such factors is necessary to generate unbiased estimates of the VM law effects. Future research should explore the effects of VM laws on firearm homicide in suburban and rural counties.

The increase in firearm homicide associated with CBC-only laws should be explored further. It is possible that CBC-only laws are harmful; however, we have not identified a plausible theory to explain how requiring a prospective firearm purchaser to undergo a background check would result in increased homicide rates. It is possible that states experiencing historically high rates of firearm homicide during the late 1980s and early 1990s were more likely to implement CBC-only laws to reduce violence. If these states then experienced slower declines in firearm homicide compared to states that did not pass these laws, the CBC-only laws would appear harmful in our analysis. The upward trend in the IRRs for CBC-only laws in the 3 years prior to implementation, and the statistically significant increased rate for CBC-only laws in the year prior, suggests there may be an endogenous relationship between CBC-only laws and firearm homicide such that states may have passed these laws in response to increasing rates of firearm homicide. The lack of any beneficial effect of CBC-only laws could also reflect issues related to enforcement of CBC-only laws. The enforceability challenges associated with CBC-only laws are beginning to be

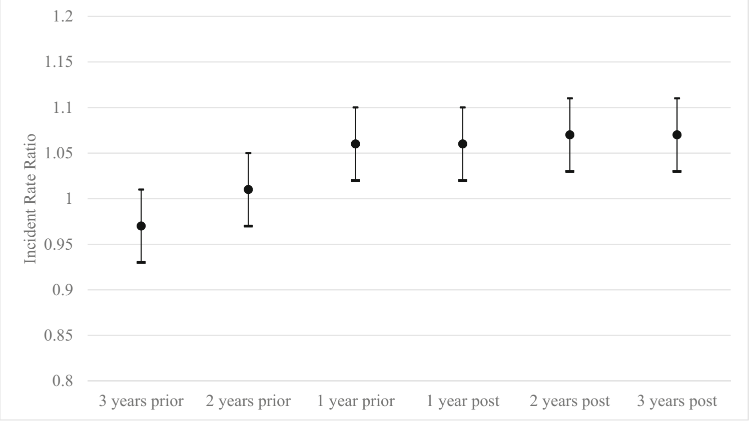

Fig. 2 Effects of VM laws on firearm homicide 1-, 2-, and 3-year pre- and post-enactment

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Table 3 Effects of firearm laws on non-firearm homicide in large, urban U.S. counties, 1984–2015

	IRR[a]	95% CI[b]
Permit to purchase	1.04	0.97–1.13
Comprehensive background check only	0.97	0.94–1.01
Right to carry law	1.03	1.00–1.06
Stand your ground	1.01	0.97–1.04
Violent misdemeanor prohibitions	0.99	0.96–1.02
County-level % population African American male youth	1.52	1.47–1.58
County-level poverty rate	1.01	1.00–1.02
County-level unemployment rate	0.99	0.99–1.00
State-level incarceration rate	1.00	1.00–1.00
State-level law enforcement expenditures	1.00	1.00–1.00

The model also included year fixed effects

[a] Incidence rate ratio

[b] 95% confidence interval

documented.[22, 23] PTP laws may be easier to comply with and enforce than CBC-only laws since sellers can only transfer a firearm to someone who has a valid permit. Future research should expand the inclusion criteria for county population size and/or urbanization. This may also allow for more states to be represented in the data and produce more robust results. Within PTP and CBC-only laws, there remain differences among states, including standards for obtaining the permit, duration of the permit, and whether a point-of-sale background check is also required in PTP states. These issues warrant additional research. Additionally, future research should explore the effects of these laws on firearm suicide at the county level.

There are some limitations to our study. As with all observational studies, there is a risk of selection bias as states choose whether to pass a policy or not. However, we attempted to minimize this bias by including county-level demographics and pre-law enactment data to estimate baseline trends. Importantly, our assessment of the effects of CBC-only and VM laws in the years prior to the laws going into effect underscores the challenges of studies of this type where omitted variables may bias estimates of the laws' impacts. This study only includes counties classified as the most urban with populations of 200,000 or greater across the entire study period. These counties may be different from those not included. Our inclusion criteria also excluded counties that may have had a population of 200,000 or more at some point during the study period but did not maintain that population level across the entire study period. However, limiting our sample to large, urban counties where firearm homicide is more likely to occur would give us more reliable estimates of policy effects. Our study relied on two covariates that were not readily available at the county level. For example, law enforcement expenditures were only available at the state level.

This study adds to the growing body of evidence that PTP laws are associated with reductions in firearm homicide. States that are considering a range of policies related to the transfer of firearms should consider a handgun purchaser licensing system through a PTP law as a mechanism to reduce firearm homicide.

Acknowledgements This research was supported by a grant from The Joyce Foundation to the Johns Hopkins Center for Gun Policy and Research http://www.joycefdn.org/grants).

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Association Between Connecticut's Permit-to-Purchase Handgun Law and Homicides

Kara E. Rudolph, PhD, MPH, MHS, Elizabeth A. Stuart, PhD, Jon S. Vernick, JD, and Daniel W. Webster, ScD, MPH

Objectives. We sought to estimate the effect of Connecticut's implementation of a handgun permit-to-purchase law in October 1995 on subsequent homicides.

Methods. Using the synthetic control method, we compared Connecticut's homicide rates after the law's implementation to rates we would have expected had the law not been implemented. To estimate the counterfactual, we used longitudinal data from a weighted combination of comparison states identified based on the ability of their prelaw homicide trends and covariates to predict prelaw homicide trends in Connecticut.

Results. We estimated that the law was associated with a 40% reduction in Connecticut's firearm homicide rates during the first 10 years that the law was in place. By contrast, there was no evidence for a reduction in nonfirearm homicides.

Conclusions. Consistent with prior research, this study demonstrated that Connecticut's handgun permit-to-purchase law was associated with a subsequent reduction in homicide rates. As would be expected if the law drove the reduction, the policy's effects were only evident for homicides committed with firearms. (*Am J Public Health.* 2015;105:e49–e54. doi:10.2105/AJPH.2015.302703)

Homicide was the second leading cause of death for individuals aged 15 to 34 years in the United States from 1999 to 2011[1] and the second leading contributor to racial disparities in premature mortality among men.[2] Firearms are used in more than two thirds of homicides in the United States,[3] and firearm availability, especially to high-risk groups (e.g., perpetrators of domestic violence and violent misdemeanors),[4,5] is positively associated with homicide risks.[6,7]

Given the importance of firearms in lethal violence, many federal and state policies have been designed to prevent individuals with a history of violence, criminal behavior, substance abuse, or serious mental illness from accessing firearms. Federal law mandates that individuals who purchase firearms from federally licensed dealers pass a background check, but sales by private, unlicensed sellers are exempt. Eighteen states and the District of Columbia require handgun purchasers from private, unlicensed sellers to pass background checks. Ten of these states and the District of Columbia strengthen the background check requirement with a permit-to-purchase (PTP) law, although 4 do not require a new background check at the time of purchase.[8] PTP laws require individuals to obtain a permit or license to purchase a handgun (from both licensed retail dealers and private sellers) that is contingent upon passing a background check and, in some cases, completing safety training. In 8 states, individuals must apply for a PTP in person at the law enforcement agency that initiates the background checks and issues permits. In the other 42 states, pre–gun-sale background checks are initiated through a licensed gun dealer, although there are significant differences among these policies. Table A (available as a supplement to this article at http://www.ajph.org) summarizes the status of these laws by state.

We conducted this study to estimate the impact of Connecticut's 1995 PTP law. This law strengthened background check requirements, especially for handguns purchased by private sellers. In addition, it raised the handgun purchasing age from 18 to 21 years and required any prospective handgun purchaser to apply for a permit in person with the local police and complete at least 8 hours of approved handgun safety training.

METHODS

To estimate the effect of Connecticut's PTP law on homicides, we compared Connecticut's homicide rates observed after the law's implementation to the rates we would have expected had the law not been implemented (the counterfactual). To estimate the counterfactual, we used longitudinal data from a weighted combination of comparison states with no PTP law change (henceforth, Connecticut's synthetic control) identified based on the ability of their prelaw homicide trends and covariates to predict prelaw homicide trends in Connecticut.

States that were considered as potential comparison states for Connecticut were those that did not have a PTP law in 1995 and therefore were "at risk" for implementing a new PTP law in 1995. Ten states (Hawaii, Illinois, Iowa, Missouri, Massachusetts, Michigan, Nebraska, New Jersey, New York, and North Carolina) and the District of Columbia were excluded from the pool of possible controls because they implemented a PTP law prior to 1995. We used outcome and annual covariate data from Connecticut and each of the 39 states in the control pool from 1984 to 2005. We concluded the postlaw period in 2005 to limit counterfactual predictions to 10 years, as has been done previously.[9]

Outcomes

We examined 2 outcomes—firearm-specific homicide rates and non–firearm-specific homicide rates (number of homicides per 100 000 state residents)—obtained from compressed mortality data from the Centers for Disease Control and Prevention's Wide-ranging Online Data for Epidemiologic Research database (http://wonder.cdc.gov/mortSQL.html). We expected the impact of the PTP law—if any—to be limited to homicides committed with firearms.

Covariates

Annually measured state-level covariates and their sources follow. Population size, population density (log-transformed), proportion aged 0 to 18 years, proportion aged 15 to 24 years, proportion Black (log-transformed), proportion Hispanic (log-transformed), proportion aged 16 years or older living at or below poverty, and income inequality as measured by the Gini coefficient were from the US Census Bureau. Average per capita individual income and number of jobs per adult were from the Bureau of Economic Analysis. Proportion living in metropolitan statistical areas, law enforcement officers per 100 000 residents, and robberies per 100 000 residents were from the Federal Bureau of Investigation's Crime in the United States publications. The Census of Governments provided data on annual expenditures for law enforcement (current operation and capital outlay).

Statistical Analysis

We used the synthetic control group approach[9] to create a weighted combination of states that exhibited homicide trends most similar to Connecticut's prior to the law's implementation (1984–1994). This weighted combination of states can be thought of as a "synthetic" Connecticut, whose homicide trends during the postlaw period predict the post-1995 trends that Connecticut would have experienced in the absence of the law change.

The algorithm for creating the weights has been described previously.[9] The vector of weights minimized the mean squared prediction error (MSPE) between the homicide rates of Connecticut during the prelaw period and the weighted vector of outcomes and covariates of the control pool states during the prelaw period.[9] No data from 1995 or thereafter were used in creating the weights and synthetic control.

After creating the weights using the Synth package in R,[10] we compared homicide rates between Connecticut and its synthetic control in the 10 years after the PTP law was implemented (from 1996 to 2005). We excluded 1995 because the law was not implemented until October of that year. We excluded 2001 from the nonfirearm homicide analysis because of the large increase in deaths attributable to the 2001 terrorist attacks, which had a disproportionate impact on Connecticut residents. The estimated number of homicides prevented by the law from 1996 to 2005 was calculated by multiplying the difference in homicide rates between Connecticut and its synthetic control by Connecticut's population size (in 100 000s) each year and summing across the years.

Statistical significance was assessed using a permutation-based test—also called a placebo or falsification test—that is similar to the Fisher exact test.[9,11] For each outcome, we repeated the analysis where we considered each of the 39 states in the control pool as the "treated" state and created a synthetic control for each of these states. We calculated the proportion of control states with an estimated rate of prevented homicides that was as extreme as or more extreme than the estimated rate prevented for Connecticut. This proportion was akin to the *P* value and indicated how unusual Connecticut's estimated effect was compared with the states in the control pool.

However, not every control state's homicide trend can be well approximated by a synthetic control. Lack of fit was determined by greater MSPE, which is the average of the squared differences between homicide rates in the "treated" state and its synthetic control during the prelaw period. In cases of large MSPE, it is not appropriate to use the synthetic control as a comparison. Consequently, we calculated the proportions of control states with results as extreme or more extreme than Connecticut for 3 separate control pools, including control states whose MSPE from their synthetic control was no more than (1) 20×, (2) 5×, and (3) 2× that of Connecticut's synthetic control MSPE. This entire analysis process was conducted twice: once for firearm homicides and once for nonfirearm homicides. We used R version 3.0.2 for all analyses.[12]

Sensitivity Analysis

In the data available as a supplement to the online version of this article, we considered an alternative approach in which we compared Connecticut's homicide rate trends to the 39 control states' average trends that were mean-shifted to the scale of Connecticut's homicide rates.

RESULTS

Using the predictive covariates as well as prelaw outcome data, we constructed a synthetic control for Connecticut for each of the 2 outcomes of interest. States with a nonzero weight contributed to the synthetic control and are listed in Table 1. Table 1 also shows how well the synthetic control approximated Connecticut's homicide rates during the prelaw period, as measured by MSPE. The last row of this table shows that the synthetic control was a better fit than a simple average of all the states in the control pool. For example, in the case of firearm homicides, the synthetic control had an MSPE of 0.157, which is an order of magnitude less than the MSPE if a simple average of all control states had been used.

TABLE 1—States With Nonzero Weights in the Synthetic Connecticut for Firearm and Nonfirearm Homicide Rates: 1996–2005

	Weight	
State	Firearm Homicides	Nonfirearm Homicides
California	0.036	0.000
Maryland	0.147	0.110
Nevada	0.087	0.121
New Hampshire	0.005	0.724
Rhode Island	0.724	0.046
MSPE synthetic control/all control states	0.157/1.633	0.090/0.740

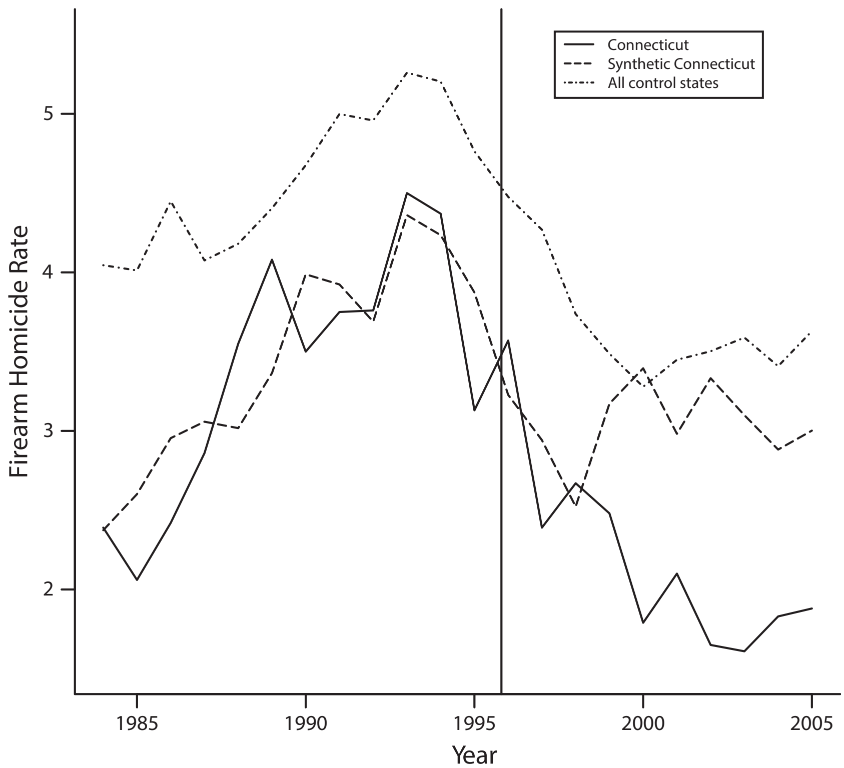
Note. MSPE = mean squared prediction error. Thirty-nine states were included in the pool of possible controls. Ten states with a similar law implemented prior to 1995 were not included: Hawaii, Illinois, Iowa, Missouri, Massachusetts, Michigan, Nebraska, New Jersey, New York, and North Carolina.

Table B (available as a supplement to this article at http://www.ajph.org) shows descriptive statistics for each of the covariates found to be predictive of homicide rates during the prelaw period. These variable summaries are provided for Connecticut, the pool of control states, and Connecticut's synthetic control optimized for (1) firearm and (2) nonfirearm homicides.

Figures 1 and 2 compare firearm and nonfirearm homicide rates over time between Connecticut and its synthetic control. The average homicide rates over the study period for all states in the control pool are included for reference. Figure 1 shows that firearm homicide rates for Connecticut and its synthetic control tracked together prior to the law's implementation in October 1995; this is also evidenced by the low MSPE shown in Table 1. However, beginning in 1999, the rates diverged markedly. Connecticut's firearm homicide rate continued to decline before leveling off in the early 2000s, whereas its synthetic control's firearm homicide rate leveled off approximately 5 years earlier. Summing the differences between Connecticut and its synthetic control from 1996 to 2005, we estimated the law to be associated with 296 fewer firearm homicides during this period, a reduction of 40% relative to the counterfactual.

The permutation tests were consistent with this graphical intuition and indicated that Connecticut's divergent firearm homicide trend during the postlaw period was statistically significant. None of the 30 potential control states with an MSPE no more than 5× that of Connecticut's had firearm homicide trends that diverged as widely from their synthetic controls as Connecticut's did (Table 2).

Figure 2 shows nonfirearm homicide rates in Connecticut compared with its synthetic control and with all states in the control pool. Connecticut's nonfirearm homicide rate trend tracked closely with that of its synthetic control's prior to the PTP law's implementation. However, the nonfirearm homicide rates for Connecticut and its synthetic control did not diverge following the law's implementation. Summing the differences between Connecticut and its synthetic control from 1996 to 2005, we estimated that the law was associated with 24 fewer nonfirearm homicides during this period than expected. The permutation tests indicated that any divergence between Connecticut's nonfirearm homicide rates and those of its synthetic control during the postlaw period was not statistically significant (Table 2).



Note. Connecticut (solid line) compared with synthetic Connecticut (dashed line) and all states in the control pool, equally weighted (dotted dashed line). The vertical line indicates when Connecticut's permit-to-purchase law was implemented.

FIGURE 1—Firearm homicide rates: Connecticut, 1996–2005.

DISCUSSION

Previous studies have suggested that PTP laws may prevent the diversion of guns to criminals,[13–15] and the sharp increase in gun homicides after Missouri's PTP law was repealed suggests that PTP laws may reduce lethal violence.[16] Consistent with these previous studies, this study demonstrated that Connecticut's PTP law was associated with a subsequent reduction in homicide rates. As would be expected if the PTP law drove the reduction, the effects were only seen for homicides committed with firearms.

Connecticut's firearm homicide rate trend departed from its synthetic control from 1999 to 2005. This lag between the law's implementation and divergence in homicide trend may call into question whether the estimated effect resulted from the PTP law or from unmeasured interventions enacted in 1999 that only selectively reduced firearm homicides. However, there are plausible explanations for a delayed policy effect. First, spikes in gun sales may occur just prior to a significant gun control law, perhaps because of media scrutiny, and the additional guns sold under less rigorous regulation could temporarily counteract the law's preventive effects.[17,18] Second, the number of transactions blocked by the PTP law may accumulate over time until gun availability in the underground market is sufficiently constrained to appreciatively affect handgun acquisition. The net effect of these 2 opposing forces—prelaw sales uptick and postlaw downturn—may result in no immediate effect but fewer high-risk gun acquisitions several years after implementation. Such a delayed effect was observed following Maryland's ban of small, poorly constructed handguns that were overrepresented in crime.[18]

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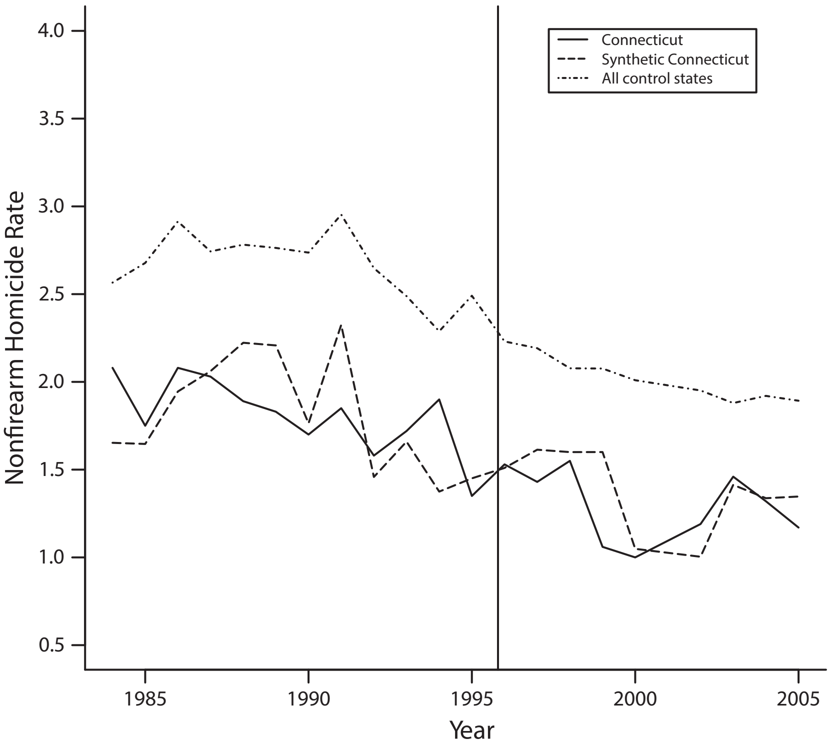

Note. Connecticut (solid line) compared with synthetic Connecticut (dashed line) and all states in the control pool, equally weighted (dotted dashed line). The vertical line indicates when Connecticut's permit-to-purchase law was implemented. Rates for 2001 are not included because of the World Trade Center attacks.

FIGURE 2—Nonfirearm homicide rates: Connecticut, 1996–2005.

It is plausible that Connecticut's PTP law could reduce firearm homicide rates as substantially as the 40% reduction estimated. The PTP law (1) strengthened background check requirements for handguns sold by private sellers and licensed firearm dealers, (2) required completion of an approved handgun safety course of at least 8 hours, and (3) increased the minimum legal age for handgun purchase from 18 to 21 years, blocking an age group with a high homicide offending rate.[19] Since 1965, Connecticut law has required private handgun sellers to mail a form to local police with information on prospective handgun purchasers to allow for—but not mandate—a background check with a 1-week waiting period. Local authorities with knowledge of a prospective purchaser's ineligibility to possess a handgun were required to notify the seller. This law was strengthened in October 1994 to require local law enforcement to "make a reasonable effort" to determine whether an applicant was ineligible to own a handgun (Connecticut Public Act No. 94-1 [July Special Session 1994], Section 1[b]); in October 1995, it was further strengthened by the PTP law, which requires prospective handgun purchasers to obtain an eligibility certificate through their local police department. The implementation of the PTP law also changed the process for purchasing handguns from licensed firearm dealers—previously, handgun purchasers could apply for a permit directly from a gun shop. After the PTP law, if the applicant passed a background check and showed proof of successful completion of an approved handgun safety course, then a permit was issued that would be valid for 5 years. Requiring application in person at the police department as well as the safety course may dissuade potential straw purchasers (those who buy guns for prohibited persons) or others considering purchasing handguns to commit a crime.

The law's protective effects against homicides may be mediated by reductions in the diversion of guns to criminals. These diversions are indirectly measured from traces of guns recovered by police such as crime guns that come across state borders and have short sale-to-crime intervals.[20] Unfortunately, reliable crime gun trace data do not extend to the prelaw period, so we could not test this hypothesis. Current crime gun trace indicators suggest that Connecticut is performing better than the national average in terms of gun diversions. The average sale-to-crime interval for guns recovered by police in Connecticut is more than 2.5 years longer than the national average.[21] Almost half of the guns recovered by police in Connecticut originated from retail sales in other states, approximately 15% higher than the national average.[21]

Estimating state law effects requires estimating the counterfactual—the outcome had the law not been implemented but all else remained equal. This is typically done by comparing outcomes over time between states with the law and states without the law. The synthetic control method used in this study was appropriate for the comparative case study design and was related to the difference-in-differences approach to estimating intervention effects.[9] This method has gained popularity recently in estimating economic and health policy effects.[9,22–25] The advantages of this approach and its assumptions have been discussed previously.[26]

The first assumption of the synthetic control approach is that there were no interruptions in the law and no effects prior to its implementation. There was no evidence that the law's implementation was interrupted. However, as

TABLE 2—Proportion of Control States With Results as Extreme as or More Extreme Than Connecticut: 1996–2005

Control States Included[a]	Firearm	Nonfirearm
≤ 20× MSPE	3/38	13/39
≤ 5× MSPE	0/30	11/32
≤ 2× MSPE	0/24	8/26

Note. MSPE = mean squared prediction error.
[a]Results from permutation tests including control states whose synthetic control's MSPE is ≤ 20×, 5×, and 2× that of the MSPE of Connecticut's synthetic control.

stated previously, it is plausible that more handguns were purchased just prior to the PTP law's implementation.

The second assumption is that the implementation of the PTP law has no effect on other states' homicide rates. If this assumption was violated in this study, there is no appealing strategy for relaxing it. One approach would be to restrict the analysis to states that are not geographically close to Connecticut. The drawback of this strategy is that states such as Rhode Island and New Hampshire, which were large contributors to Connecticut's synthetic control, would be excluded.

The third assumption is that there are no unmeasured confounders during the postlaw period. This is a concern in any study with nonrandom assignment to intervention status. However, the synthetic control provided a good fit to Connecticut's homicide rates during the prelaw period, and intrastate correlation of homicide rates from 1984 to 2005 was very high, ranging from 0.84 to 0.97. Thus, a synthetic control that fits well during the prelaw period is likely to provide a good fit during the postlaw period as well.

Connecticut passed 2 gun laws of note in the poststudy period. In 1998, Connecticut began prohibiting firearm possession for persons who committed serious offenses adjudicated in juvenile courts. However, this condition affected a very small segment of gun offenders who were not already prohibited, and there is no evidence that these policies affected homicide rates.[27] In 1999, Connecticut began requiring background checks for private transfers of long guns. However, long guns accounted for a small percentage of the firearms used in murders in Connecticut during the study period prior to 1999.[28]

Rhode Island, which contributed most to the firearm homicide synthetic control (72%), did not adopt a significant gun law during the postlaw study period. Maryland, which accounted for 14% of the firearm homicide synthetic control, implemented a law in October 1996 that required background checks for all handgun transfers. This law, in addition to a 1990 ban of "junk guns," may have reduced firearm homicides in Maryland.[18] California contributed less than 5% of the firearm homicide synthetic control and was active in adopting stricter gun control laws throughout the study period, the most significant of which were comprehensive background checks for handgun transfers and 10-year firearm prohibitions for violent misdemeanants. Both were implemented in 1991. Any protective effects of firearm laws in Maryland and California that were realized after 1995 may have biased our estimates of the impact of Connecticut's PTP law on firearm homicide rates toward the null. Successful interventions in major jurisdictions in the states included in the synthetic control could have confounded our estimates. However, we are unaware of any intervention that affected firearm homicides enough to have affected statewide rates over a 7-year period.

Fixed effects regression models are a common way of estimating the effects of state laws while also controlling for variables that may have potentially confounded this estimate. We believed this approach to be inappropriate in this case for several reasons. First, it relied on questionable assumptions that all states and time periods could have implemented a PTP law and that the association between PTP law implementation and homicide rates would be the same for all states. We had very little data with which to evaluate these assumptions, because only one other state implemented a PTP law during the study period. (Nebraska implemented a PTP law in 1991 that differed in important ways from Connecticut's.) In addition, fixed effects regression models failed to recognize the comparative case study design of both the data and research question and would have inappropriately extrapolated the effect estimated for Connecticut to the pool of control states.

The goal of this study was to estimate the effect of Connecticut's PTP law on homicides in Connecticut—not to extrapolate the effect of Connecticut's law on homicides to an average control state. The synthetic control approach allowed us to estimate such an effect and appropriately restricted the interpretation to the state of Connecticut. In addition, the method of assessing significance of the estimated results was more appropriate than a large-sample inferential technique, such as regression, given the small number of units.[9] Other advantages of this method over standard regression methods included (1) the data-driven estimation of policy effects (through the synthetic control weights) to produce the most accurate counterfactual and (2) the incorporation of both graphical and numerical checks (through the MSPE) of how well the comparison approximated the case.

Examining the extent to which stronger background check policies affect suicide rates is an area for future work. Previous research suggests that states with stricter gun permitting and licensing regulations have lower suicide rates.[29] This research should be corroborated with studies that use longitudinal data to examine changes in PTP laws and subsequent changes in firearm suicide rates.

This study has important policy implications as lawmakers consider options for reducing gun violence. Connecticut's PTP law seems to reduce firearm-specific homicides. Following the process in place in 6 states now, the most recent federal legislation considered by Congress to require background checks for many private party transactions would require prospective purchasers to go to a federally licensed gun dealer who would process the purchase application and submit the information for the background check. Future research should compare the effectiveness of this approach versus the approach used in PTP laws. Other unexamined issues include standards of evidence to hold noncompliant gun sellers accountable and the significance of penalties for failing to comply with gun sales laws. ■

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Contributors

K. E. Rudolph contributed to the study design and interpretation of results and led the analysis, drafting, and revision of the article. E. A. Stuart contributed to the study design, analysis, interpretation of results, and article revisions. J. S. Vernick contributed to obtaining the data, interpreting the results, and revising the article. D. W. Webster conceptualized the study and contributed to obtaining the data, interpreting the results, and drafting and revising the article.

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Human Participant Protection

This study was determined not to be human participant research by the institutional review board at the Johns Hopkins Bloomberg School of Public Health.

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Effects of the Repeal of Missouri's Handgun Purchaser Licensing Law on Homicides

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ABSTRACT *In the USA, homicide is a leading cause of death for young males and a major cause of racial disparities in life expectancy for men. There are intense debate and little rigorous research on the effects of firearm sales regulation on homicides. This study estimates the impact of Missouri's 2007 repeal of its permit-to-purchase (PTP) handgun law on states' homicide rates and controls for changes in poverty, unemployment, crime, incarceration, policing levels, and other policies that could potentially affect homicides. Using death certificate data available through 2010, the repeal of Missouri's PTP law was associated with an increase in annual firearm homicides rates of 1.09 per 100,000 (+23 %) but was unrelated to changes in non-firearm homicide rates. Using Uniform Crime Reporting data from police through 2012, the law's repeal was associated with increased annual murders rates of 0.93 per 100,000 (+16 %). These estimated effects translate to increases of between 55 and 63 homicides per year in Missouri.*

KEYWORDS *firearm policy, firearm violence, gun policy, gun violence*

INTRODUCTION

Homicide is the second leading cause of death for people aged 15–34 years in the USA and the leading cause of death for black males in this age group.[1] Homicide also accounts for 5 % of the Years of Potential Life Lost (YPLL) in the USA[2] and is the second leading cause of the racial disparity in life expectancy between black and white males.[3] Two-thirds of all homicides in the USA are committed with firearms,[1] and the firearm homicide rate in the USA is 19.5 times higher than the average firearm homicide rate in other high-income countries.[4]

It has been argued that weaknesses in federal and state firearms laws contribute to the unusually high homicide rate in the USA, especially the lack of background checks or record-keeping requirements for private, unlicensed sellers of firearms.[5] Many perpetrators of homicide have backgrounds that would prohibit them from possessing firearms as a result of prior convictions for felony crimes[6] or for misdemeanors involving domestic violence, being under a restraining order for domestic violence, young age, or other disqualifications.[7] Federal law requires background checks and record keeping for sales by federally licensed firearms

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dealers but exempts these regulations when the firearm seller is unlicensed. Fifteen states require individuals purchasing handguns from unlicensed sellers to pass background checks, and eleven of these states require all handgun purchasers to acquire a permit-to-purchase (PTP) license.

PTP systems require prospective handgun purchasers to obtain a license verifying that they have passed a background check. All handgun sellers, both licensed dealers and private sellers, may only sell to those with a current PTP license. Most states with PTP handgun licensing require applicants to apply for the license directly at a law enforcement agency. In all other states, individuals wishing to purchase a handgun from a licensed dealer must complete a purchase application form. The dealer or dealer's employee submits the form to the Federal Bureau of Investigation's (FBI) National Instant Check System (NICS) or, in some cases, to state police, to determine whether the applicant is prohibited from possessing firearms.

Prior research has shown that cities and states that require background checks and record keeping for handgun sales by unlicensed sellers and stricter PTP handgun licensing laws have lower levels of guns being diverted to criminals within a year of retail sale[8] and fewer guns exported to criminals across state borders.[9] A recent study found a cross-sectional association between states having PTP handgun licensing or other forms of universal background check requirements for gun sales and lower homicide rates.[10]

Missouri repealed its PTP handgun licensing law effective August 28, 2007. Missouri's law had been in place since 1921 and required all handgun purchasers to have a valid PTP license (good for 30 days) in order to lawfully purchase a handgun from any seller, licensed or unlicensed. Applicants applied in person at their local sheriff's office which facilitated the background check. Webster and colleagues[8] reported that immediately following the repeal of Missouri's PTP handgun law, there was a twofold increase in the percentage of guns that had unusually short intervals between the retail sale and the recovery by police, an indicator of firearm diversion or trafficking.[11, 12] The repeal also coincided with a sharp increase in the percentage of crime guns recovered by police in Missouri that had been originally sold by in-state retailers, from 56.4 % in 2006 to 71.8 % in 2012.[13]

This study examines the effects of the repeal of Missouri's PTP handgun licensing law on homicide rates. Because this change eliminated mandatory background checks for handguns sold by unlicensed sellers, it is of particular relevance for debates in the US Congress and in several states about proposals to extend background check requirements to all firearm sales.

METHODS

Design

The association between the repeal of Missouri's PTP handgun licensing law on homicide rates was estimated using a quasi-experimental research design with annual, state-level homicide rates. Homicide rates were age adjusted and stratified by those committed with a firearm versus all other methods to discern the specificity of the effects of the policy change on firearm versus non-firearm homicides.

Data and Measures

We hypothesized that the policy change would affect homicide rates but only those committed with firearms. Thus, the primary outcome measure was state-level annual firearm homicide rates, derived from death certificate and census data, age adjusted (reference year 2000) in Centers for Disease Control and Prevention's (CDC) Web-based Injury Statistics Query and Reporting System (WISQARS) Fatal Injury Reports.[14] Seven states (HI, ME, NH, ND, SD, VT, and WY) were dropped from the analyses because WISQARS suppressed the data for states and years for which there were very few firearm homicides to protect the anonymity of the data. Missouri's mean baseline rate of firearm homicides during the pre-repeal study years was approximately four to five times higher than was experienced in the seven dropped states, and none of the dropped states were geographically close to Missouri. Within Missouri, we also used county-level cause-of-death mortality data from CDC's Wide-ranging Online Data for Epidemiologic Research (WONDER) system[15] to assess the degree to which state-wide changes in age-adjusted homicide rates differed across counties.

These data from CDC's WISQARS and WONDER systems have the advantage of complete, mandatory reporting of death certificate data and the ability to easily isolate homicides committed with firearms versus other methods. The disadvantage of these data is that they were only available through the end of 2010 at the time of this study. We also collected and analyzed state-level data on annual rates of murder and non-negligent manslaughter (which will capture virtually all homicides) from the Federal Bureau of Investigation's (FBI) Uniform Crime Reporting (UCR) system. UCR data provided two additional years of post-PTP-law-repeal data; however, the FBI has to interpolate some data for states and years, when there is incomplete reporting from local law enforcement agencies, and rates are not age adjusted.

Although data from prior years are available, we chose 1999 as the beginning of our study period because the period 1999–2012 has been the most stable period for homicide trends in many decades. Periods of dramatic change, especially if the underlying causes for those changes cannot be easily modeled, are vulnerable to omitted variable bias in estimates of policy impact.[16]

Regression analyses are used to estimate policy change effects and controlled for changes in rates of unemployment, poverty, incarceration, burglary, law enforcement officers per capita, and the presence of four other types of state laws potentially most directly relevant to lethal violence for which there was significant change during the study period. These laws included so-called Stand Your Ground (SYG) laws, which give individuals an expanded right to use deadly force in potentially dangerous encounters with no duty to retreat, right-to-carry (RTC) laws which require law enforcement agencies to issue permits to carry concealed firearms to all legally qualified applicants, bans of unsafe handguns including so-called Saturday Night Specials, and firearm prohibitions for young adults resulting from convictions for serious crimes adjudicated in juvenile courts. SYG laws have been enacted in many states in recent years, including in Missouri in 2007. Prior research indicated that these laws may increase homicides.[17] Early research suggested that RTC laws may reduce homicides,[18] but the most rigorous studies show no evidence that RTC laws affect homicide rates.[19, 20] Maryland's adoption of a SNS ban was associated with a reduction in firearm homicide rates,[21] but this policy has not been rigorously studied in other states nor has firearm prohibitions stemming from serious juvenile offenses.

Average annual unemployment rates (per 100 population 16 years of age and older) were obtained from the Bureau of Labor Statistics.[22] Poverty rates (per 100 population) were obtained from the Census Bureau's Current Population Survey.[23] Burglary rates (per 100,000 population)—an indicator of crime rates that should not be directly affected by gun laws—and the rates of law enforcement officers (per 100,000 population) were drawn from the FBI's UCR program.[24] Incarceration rates (per 100,000 population) are from the Sourcebook of Criminal Justice Statistics.[25] The repeal of Missouri's PTP handgun licensing law was measured as the proportion of days in a year when the state had no PTP handgun law, i.e., 0 for the years the PTP law was in place (1999–2006), 0.263 in 2007, and 1 for 2008–2012.

Analytic Methods

Pre-repeal versus post-repeal differences in mean age-adjusted homicide rates were tested for statistical significance using t-tests. To estimate the independent association between the repeal of Missouri's PTP handgun licensing law and age-adjusted homicide rates, we used generalized least squares regression models. The models included state- and year-fixed effects to control for baseline differences in states' homicide rates and yearly fluctuations that occurred nationally as well as changes in the covariates described above. Standard errors for model coefficients were adjusted to account for clustering by state and for heteroskedasticty using the Eikert–Huber–White adjustment.[26] Analyses were conducted using Stata IC v 11.0.[27]

RESULTS

From 1999 to 2007, Missouri's firearm homicide rate was relatively stable, fluctuating around a mean of 4.66 per 100,000 population per year (Fig. 1). In 2008, at the first full year after the permit-to-purchase licensing law was repealed, the firearm homicide rate in Missouri increased sharply to 6.23 per 100,000, a 34 % increase from the baseline mean. For the post-repeal period of 2008–2010, the mean annual firearm homicide rate was 5.82, 24.9 % higher than the pre-repeal mean (t= 4.38, df=10, p=.001). Within Missouri, firearm homicide rates per 100,000 increased sharply between the pre- and post-repeal periods in each of the three large central metro counties/jurisdictions—by 30 % in Jackson County (11.2 to 14.7), 47 % in St. Louis County (5.0 to 7.4), 27 % in St. Louis City (21.7 to 27.5),

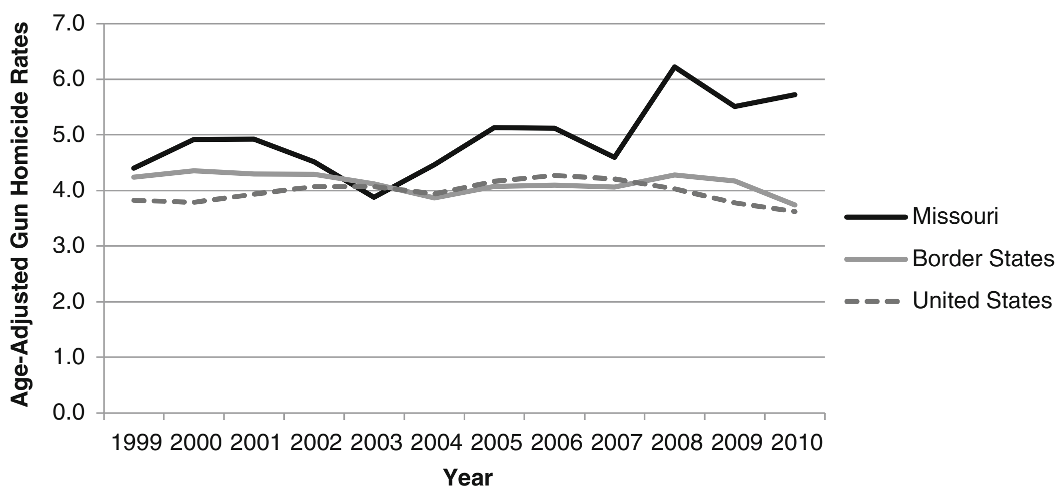

FIG. 1 Age-adjusted firearm homicide rates in Missouri, states bordering Missouri (population-weighted averages), and the USA, 1999–2010.

and 34 % overall in the nine Missouri counties designated as large metropolitan fringe counties (3.1 to 4.2).

This sharp increase in firearm homicide rates in Missouri beginning in 2008 was out of sync with changes during that period nationally and in states bordering Missouri (Table 1). The mean age-adjusted firearm homicide rate in the USA declined 5.5 % from 4.03 per 100,000 during 1999–2007 to 3.81 for 2008–2010. The population-weighted mean firearm homicide rates across the eight states bordering Missouri changed little between these two time periods (4.15 to 4.06, –2.2 %; $p = .480$, Fig. 1), and there were no statistically significant changes in any specific state that bordered Missouri.

Controlling only for baseline differences across states and year effects nationally (model 1, Table 2), the repeal of Missouri's PTP handgun licensing law was associated with an increase in firearm homicide rates of 1.32 per 100,000 ($p < .001$), a 29.4 % increase above rates projected without the repeal. After controlling for changes in rates of unemployment, poverty, burglary, incarceration, and law enforcement officers along with other state laws, the estimated increase in annual firearm homicide rates associated with the repeal of Missouri's PTP handgun law was 1.09 per 100,000 population per year ($p < .001$; 95 % confidence interval (CI) 0.81 to 1.38), a 23 % increase.

The increase in homicide rates following the repeal of Missouri's PTP handgun licensing law occurred only for homicides committed with firearms. Following similar trends nationally, Missouri's age-adjusted rate of non-firearm homicides declined from a pre-repeal (1999 to 2007) mean of 2.19 to a post-repeal (2008 to 2010) mean of 1.88 (–14 %). Regression analyses indicated that Missouri's repeal of its PTP handgun law was associated with no change in the age-adjusted non-firearm homicide rate ($\beta = -0.077$, $p = .446$) and an increase in annual homicide rates for all methods of 1.00 per 100,000 (Table 2, $p < .001$, 95 % CI 0.66 to 1.35).

TABLE 1 Mean firearm homicide rates before (1999–2007) and after Missouri repealed its permit-to-purchase handgun licensing requirement for handgun sales by licensed and unlicensed sellers (2008–2010)

	Mean before Missouri's PTP handgun law repealed 1999–2007	Mean after Missouri's PTP handgun law repealed 2008–2010	% Change	Probability 2 means are equal
Missouri	4.67	5.82	+24.9	.001
Population-weighted mean for states bordering Missouri	4.15	4.06	−2.2	.480
Arkansas	5.12	5.23	+2.1	.691
Illinois	5.10	4.77	-6.6	.335
Iowa	0.93	1.00	+7.8	.627
Kansas	3.95	3.85	−3.4	.757
Kentucky	3.26	3.29	+1.0	.898
Nebraska	1.75	2.28	+30.0	.096
Oklahoma	3.80	3.93	+3.5	.618
Tennessee	5.42	5.23	−3.5	.553

TABLE 2 Estimates of effect of the repeal of Missouri's permit-to-purchase handgun law from generalized least squares regression models on states' age-adjusted firearm, non-firearm, and all-cause homicide rates, 1999–2010, and murder and non-negligent manslaughter rates, 1999–2012

Outcome variable	β	Robust S.E.	*P* value	95 % CI for β
Firearm homicide rates, 1999–2010 R^2 within = .208, R^2 overall = .948	1.09	0.14	<.001	0.81 to 1.38
Non-firearm homicide rates, 1999–2010 R^2 within = .162, R^2 overall = .583	−0.08	0.10	.446	−0.28 to 0.12
Total homicide rates, 1999–2010 R^2 within = .177, R^2 overall = .943	1.00	0.18	<.001	0.66 to 1.35
Murder and non-negligent manslaughter rates, 1999–2012 R^2 within = .183, R^2 overall = .908	0.93	0.23	<.001	0.48 to 1.38

All models controlled for rates of unemployment, poverty, burglary, incarceration, law enforcement officers, "Stand Your Ground" laws, right-to-carry laws, bans of Saturday night special (junk) handguns, and firearm prohibitions of young adults with prior serious criminal offenses adjudicated in juvenile courts. Estimates for each of these covariates can be found in the Supplemental Tables.

Using UCR data from police reports for 1999-2012, the difference in the annual murder rate in Missouri minus that of the U.S. as a whole grew from 0.60 per 100,000 population during the pre-PTP-repeal period to 1.82 during the 5 years after the repeal of the PTP law (data not shown, t=4.12, df=12, p<.001). A model which only controlled for state- and year-fixed effects estimated a 1.34 increase in annual murder rates associated with the repeal of the PTP handgun law ($\beta = 1.34$, $p = .001$, 95 % CI 0.58 to 2.11); however, the estimated effect of the policy change was reduced to an increase of 0.93 murders per 100,000 population per year after all covariates were included in the model (Table 2, $\beta = 0.93$, $p < .001$, 95 % CI 0.48 to 1.38), a 16 % increase relative to the counterfactual.

Firearm homicide, total homicide, and murder rates were positively associated with burglary rates and negatively associated with poverty rates. New unsafe handgun bans adopted in California and Massachusetts were associated with an increase in total homicide rates ($\beta = 0.46$, $p = .008$, 95 % CI 0.12 to 0.80). No other covariate reached statistical significance at the .05 level (Supplemental Tables).

DISCUSSION

This study provides compelling evidence that the repeal of Missouri's PTP handgun licensing law, which required all handgun purchasers to pass a background check even for purchases from private sellers, contributed to a sharp increase in Missouri's homicide rate. Our estimates suggest that the law was associated with an additional 55 to 63 murders per year in Missouri between 2008 and 2012 than would have been forecasted had the PTP handgun law not been repealed.

Our analyses ruled out several alternative hypotheses to explain the relatively large and highly statistically significant increase in firearm homicides in Missouri following the repeal of its PTP handgun licensing law. We controlled for changes in unemployment, poverty, policing levels, incarceration rates, trends in crime reflected in burglary rates, national trends in homicide rates, and several kinds of other laws that could affect homicides. That Missouri's sharp increase in firearm homicides was unique within the region, specific to firearms, and was observed in metropolitan jurisdictions across Missouri suggests that unmeasured unique local circumstances (e.g., gang activity and changes in social norms) are unlikely to have biased our estimates of the impact of the policy change. Estimates of the effects of the repeal of Missouri's PTP handgun law were similar for firearm homicides and total homicides using death certificate data for 43 states through 2010, and for murders and non-negligent manslaughters using police reports for all 50 states through 2012. This suggests that the data source and time period studied are unlikely to have biased the findings.

Causal inferences from quasi-experimental studies can be strengthened with empirical evidence supporting the proposed causal chain between the intervention, mediators, and the outcomes under study. Handgun purchaser licensing and universal background checks are hypothesized to affect homicide rates by reducing gun diversions to criminals and other prohibited groups. The evidence that Missouri's increase in firearm homicides was fueled by the state's repeal of its PTP law is bolstered by data indicating that the repeal was immediately followed by a twofold increase in the percentage of crime guns that were recovered by police soon after the guns' retail sales and an unusually large increase in the percentage of Missouri's crime guns that had been purchased from Missouri gun dealers.[9] These finding are consistent with prior research showing that states that regulated handgun sales by unlicensed sellers had fewer guns diverted to criminals shortly after in-state retail sales,[8] and that states with the most comprehensive handgun sales laws including PTP licensing requiring direct interface with law enforcement have proportionately fewer guns used in crime that were originally sold by in-state retailers.[28, 29] Having a large percentage of crime guns that originate from out-of-state sales, as was the case in Missouri prior to the repeal of its PTP law, is indicative of a restricted supply of guns available to criminals from in-state sources. Restrictions from local suppliers increase prices in the underground gun market and attract suppliers from states with fewer legal impediments to gun diversion.[30, 31]

The weakening of Missouri's gun laws may have also contributed to gun trafficking to border states that regulate handgun sales by all sellers via PTP licensing. The number of guns sold in Missouri and later recovered by police in Illinois and Iowa, two border states with handgun purchaser licensing laws, increased 37 % (from 133 to 182) from 2006 (just before Missouri's PTP law was repealed) to 2012 when the overall number of crime guns recovered by police in those states actually declined by 6 %.[12]

A potential threat to the validity of our estimate of the impact of the repeal of Missouri's PTP law is confounding by the simultaneous adoption of a Stand Your Ground law in Missouri. Controlling for the effects of SYG laws across all states, our estimate of the effect of the repeal of Missouri's PTP law on homicide rates declined slightly but was still substantial and statistically significant at $p<.001$. A separate analysis of justifiable homicide data from the FBI's Uniform Crime Reports revealed that there were approximately three additional justifiable homicides per year in Missouri following the adoption of the state's Stand Your Ground law above pre-SYG-law levels—less than 1 % of the total number of gun homicides during 2008–2010.

Critics could question the use of a relatively short pre-repeal baseline period used for this study. Using more longitudinal observations can potentially produce more accurate forecasts of the counterfactual in interrupted time-series impact studies.

However, the period from 1985 to 1998 included dramatic increases and decreases in US homicide rates. Experts believe that these changes were driven by factors that could not be directly measured (e.g., dynamics of the crack cocaine market, and changes in social norms)[32] and thus controlled statistically and that these unmeasured forces appear to have been uneven across states.[19] Such conditions pose considerable challenges for deriving unbiased estimates of policy impacts. By limiting the analyses to the relatively stable period of 1999–2012, we minimized the potential for omitted variable bias that would have likely been introduced by including data from this earlier time period.

The generalizability of our findings to other states with PTP handgun laws is unknown. Data from a recent cross-sectional study indicated that PTP licensing laws and universal background check requirements were associated with lower homicide rates after controlling for other population risk factors;[9] however, the lack of longitudinal data weakens causal inference from that study. We caution, however, that passage of a PTP handgun licensing law with mandatory background checks and record keeping for all handgun sales may not result in as immediate and large a reduction in firearm homicides as occurred in reverse when Missouri's law was repealed. Although our findings indicate that Missouri benefited from the protective effects of its PTP law before the law's repeal, the beneficial effects of new laws of this type may be more gradual as enforcement practices are put in place, awareness of the law increases, and the stock of guns available in the underground market is depleted. Additional methodologically rigorous research of the impact of other laws of this type is warranted.

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The Preventive Effect of Strict Gun Control Laws On Suicide and Homicide

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ABSTRACT: States with stricter handgun control laws in 1968 were shown to have lower suicide rates by firearms both in 1960 and in 1970. These states also had higher rates of suicide by "other means." In contrast, no such effect of strict handgun control laws was found for mortality from homicide by firearms. More detailed analyses indicated that restrictions on selling and buying handguns were more important than restrictions on carrying handguns.

In considering methods by which suicide can be prevented, some thought has been given to restricting the methods available for suicide. Stengel (1964) argued that replacing coal gas by natural gas would have no effect on the suicide rate, since other methods would take the place of that which had been eliminated. He gave the example of Basel, Switzerland. Coal gas was the leading method for suicide. After detoxification, the suicide rate dropped transiently, but soon rose to its previous level with drowning now being the most popular method. Also, Fox (1975) noted that detoxification of gas in Holland in the 1960's did not decrease the suicide rate there.

The availability of barbiturates and other prescription drugs, however, has been seen as an added factor making impulsive suicide more likely (Lester, 1972). Robin and Freeman-Browne (1968) noted that the majority of attempted suicides are released into a home environment where abundant quantities of lethal methods exist. Barraclough, Nelson, Bunch and Sainsbury (1971) have made a similar point. They recommended reductions in the size and number of prescriptions for barbiturates, recalling unused tablets, setting up procedures to prevent forging of prescriptions, and not prescribing barbiturates without seeing the patient.

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Cases have been reported where patients have forged prescriptions in order to obtain lethal drugs (Freidman, 1966). The physician and pharmacist should work closely to prevent suicidal people from obtaining supplies of lethal drugs. Stoller (1969) noted that legislation to limit the prescribing of barbiturates in Australia was followed by a drop in the suicide rate.

Kreitman (1976) has argued that the drop in the English suicide rate may be attributed to the detoxification of coal gas. The percentage of carbon monoxide in coal gas declined from 13 percent in 1955 to zero percent in 1975. The suicide rate has declined in all age groups and for both sexes since 1962 for suicide by carbon monoxide poisoning. In contrast, the suicide rate by other methods has risen over the same period. Hassall and Trethowan (1972) have arrived at a similar conclusion using data from Birmingham. But Sainsbury, Baert and Jenkins (1979) have tried to demonstrate that detoxification has had no effect on the suicide rate in towns where it had taken place, as compared with towns where it had not yet taken place.

Although the influence of gun control laws on suicidal behavior has been discussed in the past (Danto, 1971, 1979; Sim, 1979), only one study has appeared attempting to demonstrate that strict gun control laws may reduce the suicide rate. Lester and Murrell (1980) showed that states with stricter handgun control laws in 1968 had a lower suicide rate in 1959-1961, a lower suicide rate in 1969-1971 and less of an increase in the suicide rate between these two time periods. It was concluded that the results supported the proposition that controlling the methods available for suicide may reduce the suicide rate.

Lester and Murrell (1980) examined the effect of strict handgun control laws in the states upon the *total* suicide rate. In the present study, the question asked was whether this preventive effect from strict handgun control laws on suicide was specific for suicide committed with a firearm. In addition, for comparison purposes, the effect of strict handgun control laws upon the homicide rate was explored for each method of committing homicide.

The measurement of the impact of gun control legislation has presented researchers with a large number of difficulties. First, a decision must be made concerning which statutes to study. Municipal, state and federal legislation has been enacted in the hope of curbing the availability of firearms. Some studies have focused on the Federal Gun Control Act of 1968 (Zimring, 1975), and others have examined state statutes (Seitz, 1972; Murray, 1975). Geisel, Roll and Wettick (1968) combined state and municipal statutes, and more recently Deutsch and Alt (1977) evaluated the impact of a state law on one city. This variation in focus limits comparisons of results. Interestingly, municipal ordinances have received little attention, yet it is likely that this information would be more useful than that on the impact of state or federal statutes due to the greater reliability of disaggregated data (Jones & Ray, 1980).

A second issue, the actual enforcement of the statutes, has not been explored in great depth. Brill (1977) has presented data on police confiscations of firearms in a sample of ten cities, but since 20 to 25 percent of the guns were either found by police while on patrol or turned in by citizens, it is difficult to draw firm conclusions about enforcement of statutes. Also, this research does not measure the practices of retail sellers of firearms. Zimring (1975) has also examined information on charges made under the Federal Gun Control Act of 1968 from 1968 to 1973. He found large increases in the number of cases prosecuted and in the number of convictions over time. Unfortunately, more comprehensive studies of enforcement have not been conducted.

A third issue that has confounded research results in the presence of firearms either in circulation prior to the enactment of gun control statutes or guns which come from other geographical areas. These alternative sources for the use or acquisition of firearms undermine the impact of any legal controls. There is evidence that guns used in criminal acts tend to be "young" (Zimring, 1975), which implies that restriction on the supply of firearms could be effective in reducing crime. At the same time, there is also evidence that some states provide a large proportion of guns to other areas of the country (Bureau of Alcohol, Tobacco & Firearms, 1976), thus undermining the effect of local gun control statutes.

A final problem in the study of gun control laws has been the measurement of the restrictiveness of the statutes. The actual content of the provisions of the statutes has not been examined in a rigorous manner, and it is this issue which is the focus of this study.

Method

Data on eight characteristics of the handgun control statutes of each state in the continental U.S. in 1968 were obtained from Bakal (1968). Characteristics included such aspects as whether a license or permit is required to carry a concealed handgun, to sell a handgun, to own a handgun, to carry a handgun openly, to buy a handgun; whether a handgun sale is reported to the police; whether there is a waiting period between purchase and delivery; and whether there is a minimum age requirement. These data were used to construct a Guttman scale of strictness, and each state was assigned a number from zero to seven representing the strictness of its handgun control statute (0 = no controls on gun sales, 7 = maximum control). Data on the suicide rates by poisons, firearms, hanging/strangulation and other means and on the homicide rates by firearms, cutting/piercing and other means were obtained for 1960 and 1970 from the *Vital Statistics of the United States*.

After the statutes for the states were coded, a multidimensional scaling procedure was used. Multidimensional scaling is used to reflect the "hidden structure" in data by the use of a spatial representation. A geometric configuration of points is used to examine the similarities or dissimilarities between subjects (Kruskal & Wish, 1978). Once the data are represented as points in a multidimensional space, the dimensions of the space are assumed to represent attributes along which the subjects (in this case, statutes) are compared (Green & Carmone, 1970).

It appeared reasonable to assume that statute characteristics could be indicative of several dimensions of restrictiveness. Preliminary analysis of the characteristics lent support to the belief that more than one dimension was present. Although multidimensional scaling has been used primarily with data that are quantitative (ordinal, interval, or ratio levels of measurement), there are some methods which have been suggested for use with nominal data (Greene & Carmone, 1970; Lingoes, 1968).

Principal component analysis was used to determine the structure of the statute characteristics. This analysis does not require any assumptions about the structure of the variables used, and extracts components which are very closely linked to the original variables (Harris, 1975, Chapter 6).

Results

In Table 1, the relationship between the strictness of the state handgun control statutes in 1968 and the death rates is shown. It can be seen that states with stricter gun control laws had lower suicide rates by firearms, both in 1960 ($r = -.46$) and in 1970 ($r = -.52$). The strictness of gun control laws was not related to the suicide rates by poisons or by hanging/strangulation. Interestingly, states with stricter gun control laws had higher rates for suicide by other means. This result suggests that, to some extent, a reduced availability of one method for suicide may induce people to switch to other methods for suicide.

The results for homicide (see Table 1) are much less supportive of a preventive effect from strict gun control laws. The homicide rate by firearms was not related to the strictness of gun control statutes. However, the stricter the gun control statutes in a state, the smaller the proportion of homicides committed by firearms.

In order to further explore the relationship between handgun control statutes and deaths due to firearms, the eight features of the handgun control statutes which had been coded for the statutes of each state were subjected to a factor-analysis using the SPSS program for a

Table 1

Correlations Between Gun Control Statute Strictness and Rates Of Suicide and Homicide Over the 48 Continental States

Rates of Suicide and Homicide	1960	1970	Increase from 1960 to 1970
Suicide rate by poisons	-.01	-.07	-.10
Suicide rate by hanging/ strangulation	.23	.15	-.20
Suicide rate by firearms (and explosives)	-.46*	-.52*	-.23
Suicide rate by other means	.34**	.43**	-.11
Proportion of suicides by firearms	-.45*	-.44**	.02
Homicide rate by firearms	-.08	-.07	.20
Homicide rate by cutting/ piercing	.04	.30***	.33***
Homicide rate by other means	.02	.22	.19
Proportion of homicides by firearms	-.37*	-.25***	-.20

*one tailed $p < .005$
**one tailed $p < .01$
***one tailed $p < .05$

varimax rotation. The resulting factor-analysis (see Table 2) indicated three principal components, related respectively to restrictions on selling, restrictions on buying, and restrictions on carrying. Factor scores for each state for each factor were computed and correlated with the death rates from personal violence (see Table 3). It can be seen that factors I and II were related to personal violence while factor III was not. Restrictions on the selling and purchasing of handguns appear to be the most important dimensions of the statutes.

Discussion

This study has lent some support to the proposition that restrictions on handguns may prevent suicide. The preventive effect of strict gun

Table 2

Principal Component Analysis of 1968 State Gun Control Statute Characteristics (Varimax Rotation)

Principal Components	Factor I	Factor II	Factor III
License or permit required to purchase handguns	.43	.67*	-.02
Waiting period required between purchase and delivery	.84*	.34	-.03
Handgun sales reported to the police	.70	.35	.02
License required to sell handguns at retail	.80*	.14	.20
Minimum age requirement for purchasing (18 years)	.71*	-.31	.27
Permit or license required to own handgun	.07	.84*	.17
Permit or license required to carry handgun openly	.01	.41	.71*
Permit or license required to carry handgun concealed	.18	-.07	.78*
Cumulative percent of variance	39.5%	55.3%	68.9%

*high loading

control laws on suicide has been shown here to pertain specifically to suicide by firearms. The results indicate that those states which make it more difficult to obtain firearms do have a higher rate of suicide by other means, suggesting that people who are suicidal may switch to an alternative method for suicide when one method becomes less available. However, in an earlier report (Lester & Murrell, 1980) we demonstrated that the *total* suicide rate is lower in states with strict gun control laws and indicated that only a few suicidal people do indeed switch to an alternative method for suicide.

Table 3

Relation Between Factor Scores and Personal Violence

Percentage and Rates of Suicide and Homicide	Factor I Restrictions on Seller	Factor II Restrictions on Buyer	Factor III Restrictions on Carrying
% Suicides by gun 1960	-.39**	-.39**	-.01
% Suicides by gun 1970	-.40**	-.35**	-.03
% Suicides by gun change	-.03	.07	-.04
% Homicides by gun 1960+	-.29*	-.30*	-.04
% Homicides by gun 1970+	-.18	-.09	.02
% Homicides by gun change	.11	.20	.06
Suicide Rates:			
by poison 1960	.09	-.09	-.04
by poison 1970	.04	-.10	-.06
by poison change	-.06	-.05	-.04
by hanging 1960	.19	.16	-.08
by hanging 1970	.20	.09	-.04
by hanging change	-.09	-.14	.07
by guns 1960	-.37**	-.40**	-.02
by guns 1970	-.42**	-.40**	-.07
by guns change	-.19	-.10	-.09
by other means 1960	.22	.40**	-.01
by other means 1970	.34**	.23	.06
by other means change	-.05	-.29*	.05
Homicide Rates:			
by guns 1960	-.07	-.18	.17
by guns 1970	.01	.02	.18
by guns change	.07	.22	.16

Table 3 (continued)

Relation Between Factor Scores and Personal Violence

Percentage and Rates of Suicide and Homicide	Factor I Restrictions on Seller	Factor II Restrictions on Buyer	Factor III Restrictions on Carrying
by cutting 1960	.10	-.06	.14
by cutting 1970	.22	.21	.18
by cutting change	.14	.38**	.03
by other means 1960	.03	-.07	.18
by other means 1970	.25*	.08	.09
by other means change	.21	.16	-.11

**one tailed p < .01
*one tailed p < .05
+Data for the state of Vermont were indeterminate since there were no homicides

Some thought must be given to the question of why the present study provided some support for the proposition that suicide can be prevented by restricting methods for suicide, whereas previous reports (reviewed above in the introduction) have not. It must be remembered, first, that this is only the second research report on this topic to appear. Most of the other writing presents the opinions of the authors, unsubstantiated by facts or "case studies" of single nations. In the other research report, Sainsbury, et al. (1979) compared the suicide rates in towns in England which had detoxified domestic gas and those which had not. In this brief report, it appears that the investigators did not examine the suicide rates separately for each method of suicide. Thus, we cannot estimate whether and to what extent switching of methods took place. Furthermore, detoxification of domestic gas does not remove a method for suicide, so much as make it less lethal. Individuals may still die from suffocation, or lack of oxygen, even though death from gas poisoning is no longer possible.

This study raises the important research issue of choice of method for suicide. Most people, when asked, can name a preferred method for suicide and can express rejection of other methods. We do not know how easy it is for people to choose alternate methods for suicide when one method becomes unavailable. It would, however, not be surprising to find that the majority of people would not change methods.

The present study on the preventive effect of gun control on suicidal behavior needs to be replicated. In the present study, the gun control laws of the states were coded for 1968. States with the stricter gun control laws in 1968 had lower suicide rates by firearms in 1970. But they also had lower suicide rates by firearms in 1960. It is necessary, therefore, that the strictness of the gun control laws in the states be coded for a longer time period, let us say from 1945 to 1975. Then, it would be possible to examine whether strict gun control laws eventually lead to a *decreasing* suicide rate by firearms, rather than merely a lower suicide rate as was found in the present study. Furthermore, a study of gun control laws over a long period would enable the effects of changing the gun control laws in a state to be examined. In the present study, it was not possible to examine the effects of the length of time for which the current gun control law had been in operation, nor was it possible to explore whether the previous gun control law in the state was weaker or stronger that the current law.

Another factor which can affect the efficacy of gun control laws in preventing suicide is their enforcement. States can easily pass strict gun control laws, and then not provide the necessary manpower to enforce the laws. There is currently no data available on the enforcement of gun control laws in the various states.

The minimal preventive effect of strict gun control laws on homicide may, in part, be accounted for by the association of homicide with crime. Criminals often obtain their guns from states other than that in which the crime was committed. For example, in a study of handguns seized by the police in New York City, only 4.0 percent were purchased in New York State (Bureau of AFT, 1976). South Carolina provided more handguns than any other state—19.6 percent. In contrast, it may be that guns used for suicide are more likely to be purchased in the state in which they are used.

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Deterrence and Gun Control: An Empirical Analysis

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I. Introduction

While many have studied the extent to which certainty and severity of punishment (including the death penalty) deter crime, the purpose of this paper is to examine the effectiveness of gun control in deterring crime. In particular, does gun control have a deterrent effect which is independent of any preventive effect of imprisonment? Is gun control effective in combating property as well as violent crime? Does it make any difference how states write handgun laws with regard to concealment or licensing? The analysis here addresses these questions in the context of a cross-state econometric model of U.S. crime.

The most frequently used weapon in the commission of murder and robbery is a firearm. The empirical results suggest that, *ceteris paribus,* licensing vis-à-vis prohibition of handguns has a deterrent effect on murder but not on robbery. The estimated coefficients indicate that the effectiveness of licensing provisions in averting other crimes—rape and burglary—is also significantly different from zero.

Part II concerns the specification of the model and presents empirical results. Part III concludes.

II. The Regression Equations

The empirical investigation deals with seven felony offenses (index crimes) punishable by imprisonment. The data on these crimes are from the U.S. Department of Justice [1977(a), Table 4]. A short description of the variables used in the model is given in Table 1. The subscripted variables are crime specific and the rest are state specific. Since gun control laws are set by state legislatures, the state was deemed to be the appropriate unit of study.

Violent crime regressions are of the form:[1]

$$C_i = \alpha + \beta_1 U + \beta_2 \text{ALCOHOL} + \beta_3 \text{DIVORCE} + \beta_4 \text{COLLEGE} + \beta_5 D + \gamma_1 \text{GUN1} + \gamma_2 \text{GUN2}.$$

Property crime regressions are of the form:

$$C_i = \alpha + \beta_1 U + \beta_2 \text{ALCOHOL} + \beta_3 \text{VALUE} + \beta_4 \text{COLLEGE} + \beta_5 D + \beta_6 S_i + \gamma_1 \text{GUN1} + \gamma_2 \text{GUN2}.$$

Table 2 presents the cross-state regressions. The sample sizes vary between 41 and 49, since average prison sentences for some felony offenses were unavailable for some states.

Effect of Socio-Economic Variables on Crime

The variable U is the teenage unemployment rate for males. The data were obtained from the U.S. Department of Labor [1977, Table 1]. The expected relationship between crime and unemployment is $\partial C_i / \partial U > 0$. The results in Table 2 show that the unemployment variable enters with a positive sign in all of the crimes and is significant in a majority of the cases in 1977. Since arrest data show that crime is predominantly a youthful male phenomenon, it is not surprising to find that the male teenage unemployment rate exerts a positive influence on most crime rates. Larceny, however, is reputed to be a high skill crime and is therefore an unlikely crime for youths [Swimmer, 1974, p.

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[1] Because the death penalty or "life" sentence is not easily quantified, S_i was excluded from the set of violent crime regressors.

TABLE 1

LIST OF VARIABLES

C_i :	crime rate per 100,000 population.
U :	teenage male unemployment rate.
ALCOHOL :	male alcoholism rate per 1,000 population.
DIVORCE :	divorce rate per 1,000 population.
COLLEGE :	percentage of the population 18 years old and over who have completed one or more years of college.
VALUE :	annual percentage change in property taxes per capita 1970–1976.
S_i :	average prison sentence in months.
D :	North-South dummy variable with 0 for North and 1 for South.
GUN1 :	gun control dummy variable with 1 for states that have only a concealment provision and 0 otherwise.
GUN2 :	gun control dummy variable with 1 for states that have a licensing provision and 0 otherwise.

625], as the larceny regression indicates.

The source of the data on male alcoholism, divorce rates, and schooling was the *Statistical Abstract of the United States* [1978, Tables 191, 119, and 232]. Crimes against persons may be motivated by a disordered psychic or behavioral state. It is assumed that alcoholism and divorce rates.[2] which are measurable proxies for emotional trauma, should each be directly related to violent crime: $\partial C_i/\partial \text{ALCOHOL} > 0$ and $\partial C_i/\partial \text{DIVORCE} > 0$. Both variables perform very well in all violent crime regressions.

The effect of schooling on crime is not, however, that clear cut. To the extent that schooling is representative of the level of affluence, the higher the percentage of the college-educated population, the greater the costs associated with criminal activity. On the other hand, the college variable is also representative of the level of know-how. And, it could be argued that know-how may be exploited in such a way as to reduce the risk of apprehension or the certainty of punishment. Thus, it is by no means obvious what the net influence of schooling on crime should be.

Higher education is found to be directly related to crime, as indicated by the positive signs on the college variable in Table 2. While it would be unwarranted to conclude that higher education is a causal factor, the results for assault corroborate the 1960 findings of Swimmer [1974] and those for larceny and burglary corroborate the 1970 findings of Mathur [1978].[3]

[2] Alcoholism and divorce rates have heretofore not been included in standard crime choice models to explain variation in violent crime rates. Forst [1976] included the "proportion of households that are not husband-wife households." Needless to say, not all single-person households are the result of marital break-ups.

[3] The purpose of the Mathur study is to investigate the deterrent hypothesis that certainty and severity of punishment deter criminal behavior. The author uses cities of 100,000 population or more as units of study. Since certainty and severity of punishment data are not available for cities, the author uses *state* data as proxies. In 1970, there were over 150 cities with 100,000 inhabitants or more. That same year, only 33 states reported certainty and severity of punishment data. Of this total, 23 states had cities with 100,000 inhabitants or more. A closer look at the data reveals that among the remaining 84 cities with 100,000 or more inhabitants, over

The correlation between rape and the college variable may be specious and obscure an underlying relationship with a common correlate. But, one could speculate that in areas with large college-educated populations victims of rape or assault receive more medical attention and legal assistance than they would, say, in the ghetto where there is little if any recourse for help. Thus, the proportion of actual violent crime reported in areas with large college-educated populations is higher. Still, the positive association between rape and the college variable should be viewed with caution.

Robbery may be more prevalent in wealthier areas. As Pressman and Carol [1971] have pointed out, "where people have more, there is more reason to steal." And, to the extent that college campuses attract reasonably affluent people, the results concerning the college variable in the robbery and auto theft regressions may enjoy some theoretical support.

It is assumed that when property values are on the upswing, crimes against property become more attractive. The annual percentage change in property taxes per capita over the period 1970–1976 was therefore employed as a proxy for the benefits associated with committing crimes against property. The source of the data was the *Statistical Abstract of the United States* [1972, Table 661 and 1978, Table 484]. The greater are the potential benefits, *ceteris paribus,* the greater will be the incidence of crime against property. Hence $\partial C_i/\partial \text{VALUE} > 0$ for burglary, larceny, and auto theft. The value variable worked as hypothesized and was statistically significant at the five percent level in the burglary and auto theft regressions.[4]

Crime-specific average sentences by state are from the U.S. Department of Justice [1977(b), Table 6.57].[5] The average prison sentence length is used to reflect the cost of illegal activity. Thus, the expected relationship between severity of punishment (as approximated by the length of the prison sentence) and crime is $\partial C_i/\partial S_i < 0$. Table 2 shows that the coefficient for average prison sentence, S_i, is negative for all but one of the crime property regressions, a result our theory leads us to expect. But so far as the 1977 cross-section data are concerned, the *t*-statistics are generally disappointing. In only the larceny regression does severity of punishment appear to be negatively related to the incidence of the crime. Since increases in sentences do not associate with significant reductions in the various property crimes, these results may suggest that punitive measures have not been harsh enough to induce the desired deterrent effect.

The North-South dummy variable, D, is intended to capture the effect of climate as well as any differences in crime that may be due to demographic and social differences between the regions. If crimes are higher in the 12 Southeastern states than elsewhere, *ceteris paribus,*

50 percent of the observations are drawn from five states and nearly 25 percent of all observations are cities in California. Mathur's empirical findings therefore may be more descriptive of the peculiarities of the state criminal justice agencies in California, Ohio, New York, Connecticut, and Massachusetts than in other states. Given the wide disparities in criminal codes and in sentencing and release policies from jurisdiction to jurisdiction and given the limitations of Mathur's data base, the meaningfulness of his results in making state-to-state comparisons (so important to the study presented here) is open to question.

[4] The value variable was included in the equations for crimes against persons (viz., the so-called violent crimes). One would expect, however, that violent crimes are motivated primarily by hate or passion, not economic opportunity. In all violent crime regressions, the results were compatible with this expectation and the value variable was excluded in reporting the final estimates. The poor showing of the value variable in the murder, rape, assault, and robbery regressions cannot, however, be attributed to a high degree of collinearity with the divorce variable (which in turn is excluded from the property crime regressions). The zero-order correlation coefficient between DIVORCE and VALUE is 0.16.

[5] Crime-specific average prison sentences were available only for larceny, auto theft, and robbery. In lieu of "average burglary sentence" which was not available, the "average sentence for all offenses" against property was used.

TABLE 2

REGRESSION OF CRIME-SPECIFIC RATES ON SOCIO-ECONOMIC VARIABLES AND GUN CONTROL DUMMIES

	Murder	Rape	Assault	Robbery	Burglary	Larceny	Auto Theft
Constant	-2.194	-30.368	-217.96	-249.86	-1073.4	-1153.9	-355.88
	(-.60)	(-3.13)^a	(-1.87)^c	(-2.21)^c	(-1.99)^c	(-1.60)	(-2.02)^c
U	.152	.780	3.734	5.788	26.361	27.428	7.453
	(1.72)^c	(3.34)^a	(1.27)	(1.98)^c	(2.21)^c	(1.42)	(1.77)^c
ALCOHOL	.034	.075	1.282	1.956	5.276	4.534	4.437
	(1.76)^c	(1.46)^d	(2.12)^c	(3.66)^a	(2.22)^c	(1.22)	(5.28)^a
DIVORCE	.700	2.547	11.989	8.131			
	(3.92)^a	(5.38)^a	(2.12)^c	(1.67)^d			
COLLEGE	.021	.859	6.654	3.819	47.471	88.976	8.549
	(.22)	(3.37)^a	(2.21)^c	(1.45)^d	(3.90)^a	(4.59)^a	(2.00)^c
VALUE					54.285	67.962	22.660
					(2.00)^c	(1.47)^d	(2.24)^c
S_i				.078	-3.209	-3.028	-1.264
				(.29)	(-.98)	(-1.39)^d	(-.72)
D	4.961	6.066	122.33	18.911	145.25	-139.78	-69.874
	(3.82)^a	(1.76)^c	(3.00)^a	(.54)	(.91)	(-.53)	(-1.26)
GUN1	.792	-.717	4.255	-23.190	3.202	163.43	-40.853
	(.89)	(-.31)	(.15)	(-.96)	(.03)	(.91)	(-1.02)
GUN2	-1.780	-4.306	-18.426	-3.138	-187.61	-149.78	-10.812
	(-2.06)^c	(-1.88)^c	(-.67)	(-.12)	(-1.73)^c	(-.81)	(-.29)
R^2	.58	.62	.35	.46	.55	.60	.72
F	8.03^a	9.46^a	3.02^b	3.80^a	5.90^a	6.98^a	11.45^a
$D.F.$	41	41	39	36	39	37	35

Figures in parentheses are t-statistics.
^{a}Significant at the .5% level.
^{b}Significant at the 1% level.
^{c}Significant at the 5% level.
^{d}Significant at the 10% level.

the dummy variable should have a positive coefficient. The regression results suggest that the southern "social climate" may be more conducive to higher murder, rape, and assault crime rates.

Effect of Gun Control on Crime

Gun control laws are not uniform across all states. In some states, the carrying of a handgun on the person is prohibited; but prohibition may depend on whether or not the firearm is concealed. In other states, a license is required to carry a handgun on or about the person; but here again registration may depend on whether or not the firearm is concealed. As of 1977, all states but Ohio either prohibited handguns or required their licensing. The gun control dummies described in Table 1 are employed to determine the effect of concealment and licensing provisions after severity of punishment and socio-economic factors have been taken into account.

Does it make any difference how states write the law with regard to concealment? Formally, the null hypothesis of no relationship between GUN1 and C_i is

$$H_o: \gamma_1 = 0 .$$

The regression results show that states have little to gain by making a distinction between concealed handguns and those that are carried openly. In other words, blanket forms of control that apply to all handguns are no more effective in deterring crime than are those that apply only to concealed handguns.

Does it make any difference how states write the law with regard to licensing? Formally, the null hypothesis of no relationship between GUN2 and C_i is

$$H_o : \gamma_2 = 0 .$$

The regression results suggest that licensing as compared with prohibition may be more effective in deterring murder, rape, and burglary. Regarding the comparative effectiveness of licensing, one could speculate that if it is known or can be ascertained that a handgun was used in the commission of any one of these three felonies (e.g., concrete evidence of spent cartridges, evidence of door locks riddled with telltale bullet holes, or rape at gunpoint), registration may make the job of tracing the weapon and ultimately apprehending the offender a little easier.

Arrest data indicate that the most frequent weapon used in the commission of robbery (as well as murder) is a firearm. Yet, the results here suggest that licensing is no more (no less) effective than prohibition in deterring robbery.

III. Concluding Remarks

Extensive public discussion about handgun control has taken place without any systematic evidence on the deterrent effects of licensing versus prohibition. Many have felt free to speculate and their speculations do not present a consistent picture.

The estimates presented in this paper are consistent with the hypothesis that licensing handguns (as opposed to prohibition) has a deterrent effect or at the very least reduces the incentive to participate in such gun-related crimes as murder and burglary. The superiority of licensing over prohibition on robbery or assault, however, is far less persuasive. Finally, in no case does it make any difference how states write the law with regard to concealment.

Because there is so little empirical evidence reported in the economic literature in either support or refutation of these findings, further work in this area therefore does not appear to be out of order.

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The Relation Between State Gun Laws and the Incidence and Severity of Mass Public Shootings in the United States, 1976–2018

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Objective: In this study, we analyzed the relationship between state firearm laws and the incidence and severity (i.e., number of victims) of mass public shootings in the United States during the period 1976–2018. ***Hypotheses:*** We hypothesized that states requiring permits to purchase firearms would have a lower incidence of mass public shootings than states not requiring permits. We also hypothesized that states banning large-capacity ammunition magazines would experience a lower number of victims in mass public shootings that did occur than states without bans. ***Method:*** We developed a panel of annual, state-specific data on firearm laws and mass public shooting events and victim counts. We used a generalized estimating equations logistic regression to examine the relationship between eight state firearm laws and the likelihood of a mass public shooting. We then used a zero-inflated negative binomial model to assess the relationship between these laws and the number of fatalities and nonfatal injuries in these incidents. ***Results:*** State laws requiring a permit to purchase a firearm were associated with 60% lower odds of a mass public shooting occurring (95% confidence interval [CI: −32%, −76%]). Large-capacity magazine bans were associated with 38% fewer fatalities (95% CI [−12%, −57%]) and 77% fewer nonfatal injuries (95% CI [−43%, −91%]) when a mass shooting occurred. ***Conclusion:*** Laws requiring permits to purchase a gun are associated with a lower incidence of mass public shootings, and bans on large capacity magazines are associated with fewer fatalities and nonfatal injuries when such events do occur.

Public Significance Statement
We cannot definitively conclude that implementing a specific law would lead to a change in the incidence or severity of mass public shootings. However, laws that limit potential shooters' access to firearms by requiring permits may reduce the incidence of mass shootings, and laws that limit the number of shots that can be fired before reloading may reduce the severity of mass public shootings when they do occur. Such laws must be balanced with citizens' right to bear arms under the Second Amendment of the U.S. Constitution.

Keywords: firearms, mass public shootings, homicide, state laws, policy

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The recent occurrence of high-profile mass shootings, such as the tragedies in Parkland (Florida), Las Vegas (Nevada), El Paso (Texas), and Dayton (Ohio), has led to growing frustration and vigorous debate regarding policies intended to prevent these events (Nagin, Koper, & Lum, 2020; Wintemute, 2018). Although mass public shootings are a rare form of violence, there is general agreement—based on combined data from both the supplementary homicide reports and searches of online newspaper databases—that both the incidence and the severity of these events have increased in recent years (Duwe, 2020). Given this increase in morbidity and mortality, and the fear these incidents instill, it has never been more important to identify laws that will help curtail the incidence and/or severity of mass public shootings in the United States. However, there is scant research into the effectiveness of gun laws in preventing mass public shootings or reducing the number of victims in such incidents.

In this study, we analyzed the relationship between state firearm laws and the incidence and severity (i.e., number of victims) of mass public shootings in the United States during the period 1976–2018. We proceed by: (a) presenting the theoretical basis for believing that certain firearm laws may reduce the incidence or severity of mass public shootings; (b) reviewing the existing literature on the effect of state firearm laws on mass shootings; (c) discussing the limitations of the existing research in terms of both the predictor variable (i.e., definition of firearm laws) and outcome variable (quantification of mass shootings); and (d) providing an overview of the present study and how it advances the literature by addressing these limitations.

Conceptual Basis for Hypothesizing a Potential Impact of Specific State Firearm Laws on Mass Shooting Incidence or Severity

We used a theoretical model that was derived from studies of the relationship between gun availability and violent crime (Cook, 1983). This model combines criminological and economic theories to posit that laws that restrict criminals' access to guns deter firearm violence by reducing the availability of guns, both through legal and illicit markets, and therefore increase the effective cost of obtaining a highly lethal weapon. Cook argued that "despite the vast arsenal of guns in private hands, guns remain a scarce commodity. This scarcity surely prevents some criminals from obtaining them or using them in violent crime . . ." (pp. 76–77). This theory suggests not only that limiting the availability of firearms will make it more difficult to purchase a gun legally but that it will also limit the supply of or increase the costs of obtaining guns through illicit markets (Cook, 1983). Detailed study of a sample of mass murderers revealed that specific precipitating events are extraordinarily common (Hempel, Meloy, & Richards, 1999). If a potential perpetrator does not already own a firearm, the cost of obtaining one might be a critical factor in his ability to commit a mass shooting.

At the population level, several studies have documented a relationship between increased access to firearms and higher rates of violent crime, both for access to legal (Miller, Azrael, & Hemenway, 2002; Siegel, Ross, & King, 2013) and illegal firearms (Stolzenberg & D'Alessio, 2000). At the individual level, a recent study demonstrated that neighborhood firearm availability was related to more than a doubling of the odds for the commission of gun violence among adolescents with a previous history of conviction for a felony or a gun-related misdemeanor (Gonzales & McNiel, 2020). A previous study had shown that the availability of guns in the home was a significant risk factor for adolescent gun violence, regardless of whether the youth had a history of gun possession or violent crime (Ruback, Shaffer, & Clark, 2011). Thus, even among offenders with a history of gun-related crime, the availability of guns may be a significant factor in whether they carry out future acts of firearm violence.

This study focused on eight state firearm laws for which there is a conceptual basis for believing that they may impact either the incidence of mass shootings or the number of casualties resulting from such an event by limiting the availability of highly lethal firearms and/or ammunition. Each of these laws, described below, may increase the effective cost of obtaining any firearm, a specific type of firearm (e.g., an assault weapon), or a specific type of ammunition (e.g., high-capacity magazines). The laws either limit access to these weapons by people who are at high risk of violence or restrict the sale of particular types of guns or ammunition.

Assault Weapon Bans

Assault weapons are military-style weapons typically defined as semiautomatic firearms that accept a detachable magazine and have one or more military features such as flash suppressors, bayonet lugs, grenade launchers, pistol grips, and barrel shrouds. A survey of experts in public health, law, and criminology revealed that they ranked bans on assault weapons as an effective strategy to prevent mass shootings (Sanger-Katz & Bui, 2017). The first conceptual basis for the hypothesis that bans on military-style assault weapons may help prevent mass shootings or limit their severity is the finding that assault weapons have been used in a large proportion of such events. Although definitive data are not available, among mass shooting incidents in which weapon information was sufficient, 36% involved the use of an assault weapon (Koper, Johnson, Nichols, Ayers, & Mullins, 2018). The second conceptual basis for an effect of assault weapon bans is the finding that attacks in which the assailant uses a military-style weapon, such as an assault rifle, result in a greater number of shots fired, victims wounded, and severe or multiple wounds (de Jager et al., 2018; Koper, 2020; Reedy & Koper, 2003). Thus, reducing the stock of assault weapons could decrease the likelihood that a shooting incident results in enough fatalities to be classified as a mass shooting (de Jager et al., 2018; Koper, 2020).

Bans on Large-Capacity Ammunition Magazines

The conceptual basis behind restricting the size of ammunition magazines as a strategy to confront mass shootings is that large-capacity magazines "increase the ability to fire large numbers of bullets without having to pause to reload. Any measure that can force a pause in an active shooting—creating opportunities for those in the line of fire to flee, take cover, or physically confront a gunman—offers a possibility of reducing the number of victims in such an attack" (Klarevas, Conner, & Hemenway, 2019, p. 1,761). Nearly 20% of mass shootings during the period 2009–2016 involved weapons with a large-capacity magazine (Koper et al., 2018), whereas two thirds of high-fatality mass shootings (i.e., six or more fatal victims) between 2006 and 2015 involved this type of magazine (Klarevas, 2016). Restrictions on the size of magazines are conceptually more likely to be effective than banning assault weapons because these weapons are not functionally different from other semiautomatic firearms but are typically equipped with high-capacity magazines (Koper, 2020). Moreover, large-capacity ammunition magazine bans pertain to a much larger number of firearms because there is a sizable class of semiautomatic weapons that are not assault weapons but that accept high-capacity magazines (Koper, 2020).

Extreme-Risk Protection Orders

Also called red flag laws or gun violence restraining orders, these statutes allow law enforcement officers, family members, or both to petition a court for an emergency order to disarm a person who is judged to be a danger to themselves or others following a due-process hearing. The conceptual basis for their potential in averting mass shootings is the finding that nearly four fifths of those who committed mass shootings had either implicitly or explicitly expressed an intent to carry out such an attack (Laqueur & Wintemute, 2020; United States Secret Service National Threat Assessment Center, 2018). Investigators in California have identified at least 21 cases in which an extreme-risk protection order was used to disarm an individual who had been planning a mass shooting (Wintemute et al., 2019).

Limiting Firearm Access for High-Risk Individuals

Nagin et al. (2020) have put forth recommendations for a general approach to curtailing mass shootings. In addition to restricting high-capacity magazines, they recommend policies that restrict firearm access for people who are at a high risk for violence. States have taken a number of approaches to accomplish this.

Permit requirements. One of the most basic approaches is to require a permit or license to purchase or possess a firearm (Webster, McCourt, Crifasi, Booty, & Stuart, 2020). Seven states (e.g., Massachusetts, New Jersey) currently have permit requirements in place.

"May-issue" laws. A related approach is one that allows law enforcement officials discretion in deciding whether or not to approve an application for a concealed carry license. This is called a may-issue law and stands in contrast from shall issue laws that give no discretion to police; unless the applicant has been convicted of a specified offense, jis or her application must be approved. Nine states (e.g., California, Connecticut) currently have may-issue laws in place.

Violent misdemeanor laws. Another approach is to prohibit firearm possession by people who are at the highest risk of violence, namely those who have a history of violence. Federal law prohibits gun possession only by those convicted of a felony or certain misdemeanors (i.e., domestic violence and gun offenses). Some states, however, have enacted violent misdemeanor laws that extend the federal prohibition to include all violent crimes. Four states (e.g., Hawaii, Maryland) currently have violent misdemeanor laws in place.

Relinquishment laws. Approximately 46% of the assailants in mass shootings during the period 2014–2017 were legally prohibited from purchasing or possessing a firearm (Zeoli & Paruk, 2020). This is the rationale behind relinquishment laws that provide for the confiscation of firearms from all individuals who become prohibited from possessing them, even if they initially acquired the gun legally. Seven states (e.g., Illinois, Pennsylvania) currently have relinquishment laws in place.

Universal background checks. Firearm ownership prohibitions may not work unless a state has a system of universal background checks, requiring that every gun purchaser be screened at the point of sale to determine whether they meet any criterion that would disqualify them from gun purchase under federal and/or state law (Webster et al., 2020). Eleven states (e.g., Colorado, Oregon) currently have universal background check laws in place.

Research on the Impact of Firearm Laws on Mass Shootings

The early research in this area focused on assessing the impact of the 1994 federal ban on assault weapons and large-capacity ammunition magazines, yielding inconsistent results (Morral et al., 2018). These studies are difficult to interpret in the absence of a comparison group and therefore limited evidence upon which to identify the counterfactual. More recently, research has focused on studying the effects of state firearm laws, which allows multiple group or panel study designs because there is indeed a wide variation in the adoption of firearm laws across states and across time (Siegel, et al., 2017).

Whereas research remains limited, there is some evidence that more permissive state gun laws are associated with higher rates of mass shootings (Reeping et al., 2019). Reeping et al. (2019) reported that for each 10-unit increase in the permissiveness of state gun laws (measured on a 100-point scale), the rate of mass shootings in a state increased by 11.5%. However, this study did not examine the impact of any specific firearm laws. In addition, it relied on a travel guide to assess state laws and did not independently verify the validity of the database. Also, in contrast, Lin, Fei, Barzman, and Hossain (2018) failed to find a statistically significant relationship between the permissiveness of state gun laws and the rate of mass shootings, although it is not clear what laws were included in their gun law index.

In 2015, Gius (2015) reported the results of the first study to examine the impact of state laws on mass shootings. He found that during the period 1982–2011, state-level assault weapons bans were associated with a significantly lower number of fatalities in mass shootings. In a more recent state-level study using a panel design, Klarevas et al. (2019) investigated the relationship between the incidence and number of deaths in high-fatality mass shootings (those with at least six fatalities, not including the perpetrator) and state-level large-capacity magazine bans. They found that these policies were associated with a significantly lower incidence of these mass shooting events and with a significantly lower death count. Unfortunately, this study considered the impact of only one type of firearm law and by virtue of the high-victim threshold was based on a particularly small number of cases.

Most recently, Webster et al. (2020) advanced the literature by examining the impact of a number of specific state laws on the incidence of fatal mass shootings from 1984 through 2017. They found that two laws—required licenses for handgun purchase and large-capacity magazine bans—were associated with fewer mass shootings. Additionally, required licenses reduced the number of fatalities in mass shootings.

Limitations of the Predictor Variable in Existing Research: Classification of State Firearm Laws

The primary limitation of the previous studies in terms of their classification of state firearm laws is that none of them provide clearly defined criteria to determine what counts as having a particular law and what does not. State firearm laws often have various exemptions, exceptions, and differences in application of restrictions. Without a clear definition of what is meant by a particular law, there is ambiguity in how that law should be coded (Siegel, et al., 2017). Thus, for any particular study, it is not precisely clear what is meant by the presence or absence of a particular law.

For example, Gius (2015) classified Hawaii as having enacted an assault weapons ban in 1992. However, Hawaii's statute restricts only the sale of assault pistols; the law does not apply to assault rifles. Without having clearly defined the meaning of an assault weapons ban, most readers would probably assume that assault rifles are banned in Hawaii, but that is not the case (Hawaii Revised Statutes, 2020). This law would not be expected to affect the incidence or severity of mass shootings, but it is included in the treatment group in the study. Similarly, Klarevas et al. (2019) classified Hawaii as having a ban on large-capacity magazines. However, this ban applies only to detachable magazines for pistols. There is no limit to the magazine capacity for rifle ammunition (Hawaii Revised Statutes, 2020).

Reeping et al. (2019) obtained their state firearm law data from the *Traveler's Guide to the Firearms Laws of the Fifty States*. The book focuses almost exclusively on laws governing where one can carry a concealed firearm. Thus, the gun permissiveness scale is relevant only to one small subset of firearm laws. Lin et al. (2018) do not even describe how they derived their gun law permissiveness index, although it appears that it may have been solely based on the state's concealed carry permitting law.

Limitations of the Outcome Variable in Existing Research: Methods Used to Quantify Mass Shootings

Most of the existing research is limited because it relies on one of two sources to quantify mass shootings: (a) the Federal Bureau of Investigation (FBI)'s Supplementary Homicide Reports; or (b) news coverage (Duwe, 2020). Each of these approaches to identify mass shootings has serious flaws.

Studies relying on the Supplementary Homicide Reports. At least three studies used the FBI's Supplementary Homicide Reports (SHR) as the main basis of their analyses, identifying those incidents in which four or more victims are fatally shot (Gius, 2015; Reeping et al., 2019; Webster et al., 2020). In addition to its limited range of variables, the SHR unfortunately presents a number of pitfalls for analytic efforts of this sort. There are situations in which separate and unrelated homicides are reported by a law enforcement agency on the same record giving the false appearance of a mass killing. In addition, occasionally a record will include an injured victim along with three fatalities also wrongly suggesting a mass killing. On the other hand, there are many mass shootings that for various reasons are omitted from the SHR. Some states are excluded from the SHR entirely for certain years because of issues with their data collection or reporting, and some jurisdictions fail to report all their homicides to the FBI (Fox, 2004).

Beyond these validity concerns, one must approach the SHR carefully with respect to particularly large-scale shootings. Because each data record is limited to 11 victims, certain mass shootings necessarily span several records, falsely suggesting multiple events. In Reeping et al.'s (2019) data, for example, Virginia is recorded as having 13 mass shootings when in fact several of these are just additional records needed to cover all the victims killed at Virginia Tech in 2007. At least one study indicated that the accuracy rate of the SHR in identifying mass shootings is only 61% (Overberg, Upton, & Hoyer, 2013).

Studies relying on media reports. Two studies relied on news reports compiled by *Mother Jones* (Gius, 2015; Lin et al., 2018). One combined data from *Mother Jones* with information from the SHR (Gius, 2015), whereas the other relied on *Mother Jones* as the sole data source (Lin et al., 2018). The *Mother Jones* list of mass shootings missed more than 40% of the incidents that occurred during the period 1982–2013, and its underreporting was particularly severe for the earlier 2 decades (Duwe, 2020). Although most mass shootings receive media attention, many are covered only in local media (Duwe, 2020). Moreover, accuracy is dependent on the extensiveness of media outlet coverage by a news media database and by the precise search terms used (Duwe, 2020). For example, a search for the term mass shooting will miss incidents described by a reporter as a quadruple shooting (Duwe, 2020). In addition, because the term mass shooting is relatively new, searches relying only on that phrase will likely undercount incidents from before the 2000s (Duwe, 2020).

Study Overview and Hypotheses

In this study, we took advantage of two new databases to further the existing research on the association between state firearm laws and mass public shootings by addressing limitations in both the predictor and outcome variables. First, we used a novel database that coded the status of 89 different state gun laws from 1976 to the present, using clearly defined criteria for identifying each law. Second, we used a comprehensive database of mass public shooting incidents from 1976 through 2018 assembled by combining all existing mass shooting databases and extensively evaluating each identified case. This triangulated data collection strategy incorporated information from the SHR, from existing databases that utilized news media reports, and from original searches of the entire database of news stories at multiple media resource websites. Institutional review board approval was not needed for this study because the data were obtained from secondary, publicly available sources.

Mass shootings have typically been defined as events in which four or more victims are fatally shot during a short period of time (Duwe, 2020). Whereas the public tends to envision mass shootings as incidents in which a shooter indiscriminately fires into a crowd of people in a public place, prior research indicates the majority of mass murders—about 70%—are actually familicides or felony-related killings, which are types of events less likely to be covered by the media (Duwe, 2020). The term, mass public shootings, is used to connote the former incidents: gun-related incidents in which strangers are killed in a public location absent other criminal activity (Duwe, 2020).

There are a few reasons that, in this paper, we focused exclusively on mass public shootings. Studies have previously examined the relationship between gun laws and shooting events with at least four fatalities, regardless of where the shooting took place. A large number of these mass shootings are domestic incidents involving the killing of family members that may have occurred in a private home rather than in a public place, as was the case with the Reeping et al. (2019) and Webster et al. (2020) studies. A second large subset of these mass shootings consists of those committed as part of an underlying criminal activity in which the killing is not the primary intended purpose but is necessary or becomes necessary to carry out the planned crime. Although hardly unimportant, these are not the types of events that typically receive widespread media coverage and may not be consistent with the public's and policymakers' conception of a mass shooting. They are also not the shootings that drive the campaign for stronger gun-control legislation (Duwe, 2020).

Our two major hypotheses were as follows: (a) States requiring permits to purchase firearms will have a lower incidence of mass public shootings than states not requiring permits and (b) states that ban large-capacity ammunition magazines will experience a lower number of victims in mass public shootings that do occur than states without bans.

Method

Data Sources

To examine the association between state-level gun laws and the incidence and severity of mass public shootings from 1976 to 2018, we relied on two primary data sets. The first includes a recently developed comprehensive list of mass public shootings using strict definitional criteria, and the second includes a comprehensive list of state laws from a publicly available dataset on all 50 states starting in 1991 that we extended back to 1976.

Mass public shootings. We assembled a database of mass public shootings using a variety of sources to capture all possible events and then researching each in detail to identify those that met our predetermined definition of a mass public shooting. Specifically, we defined a mass public shooting as an incident in which four or more victims are fatally shot in a public location within a 24-hr period in the absence of other criminal activity, such as robberies, drug deals, and gang conflict.

The process by which we collected data on mass public shootings consisted of three main phases. First, the vast majority of the cases in our sample were derived from the data set compiled by Duwe (2020), who used both the SHR and news reports as data sources. Despite its limitations, the SHR is still the most comprehensive source of U.S. homicide data that contain information on the year and month when murders occurred as well as the state and city (or county) where they took place. After relying on the SHR to identify when and where gun-related mass murders occurred in the United States, Duwe searched online newspaper databases to collect additional information not included in the SHR, such as the number of injured victims and the specific location in which the incident took place. As a result of using this triangulated data collection strategy, which was also adopted by *U.S.A. Today* (Overberg et al., 2013) and the Congressional Research Service (Krause & Richardson, 2015), Duwe was able to correct errors in the SHR data while also identifying cases that were either not reported to the SHR or were unlikely to be captured through sole reliance on news coverage.

Second, to help ensure inclusion of every mass public shooting that occurred in the United States between 1976 and 2018, we also consulted unpublished data sets (Brot, 2016; Krause and Richardson, 2015) as well as publicly available ones such as those published by Louis Klarevas (Klarevas et al., 2019); *U.S.A. Today* (2018); *Washington Post* (Berkowitz & Alcantara, 2019); Stanford University (2020); Mother Jones (2020); Everytown for Gun Safety (2020); and FBI active-shooter events (Federal Bureau of Investigation, 2020).

Finally, we conducted a consensus review to determine whether cases qualified as a mass public shooting by our operational definition. More specifically, three of the authors for this study reviewed whether the cases identified through the first two phases met the following criteria: (a) at least four of all victims were killed by gunfire; (b) at least four of the victims were killed in a public place or else at least half of all fatalities occurred in a public place; and (c) the shooting did not occur in a private residence, although those that occurred in a nonprivate residence (e.g., group home or motel) were retained. If all three authors agreed these criteria had been satisfied, the incident was included in this study as a mass public shooting. If there was any disagreement, the coders discussed the case until they reached agreement on the classification.

For each case, the coders classified the incident as yes, no, or maybe. Of the 188 possible cases identified, all three coders agreed on the classification being yes or being no for 175 of the cases (93.1%). In an additional three cases, two coders agreed on the classification and the third was not sure. There was disagreement or uncertainty for 10 cases. The interrater reliability was assessed using an extension of Cohen's kappa for more than two raters (Stata Base Reference Manual, 2017). Cohen's kappa was 0.82, which indicates very good agreement between coders (Altman, 1999).

As a result of this rigorous data-collection methodology, we assembled a comprehensive database, consisting of 156 mass public shootings from 1976 through 2018 that involved 2,839 victims, of which 1,090 were fatally shot, another 41 died by other means, and the remaining 1,708 were injured. We omitted one incident, the fatal shooting of 12 victims in Washington, DC, from the analyses, given the focus on the laws enacted by the 50 states, leaving the final counts of 155 incidents and 2,827 victims for this study. We developed a panel by calculating the number of events, killings, and nonfatal shootings by year and state. With data for 50 states across 43 years, the panel consisted of 2,150 observations in total.

State firearm laws. We relied on the State Firearm Law Database, a publicly available database of the presence or absence of 134 state firearm law provisions across 14 categories in all 50 states for the period 1991 to the present that was developed by individual examination of state statutes and historical session laws with detailed criteria defining each provision (Siegel, 2020a, 2020b; Siegel, et al., 2017). For 89 of these law provisions, we extended the database back to 1976 by examination of historical state statutes and session laws using the Hein Online and Westlaw

Edge databases. We focused on these 89 provisions because they represent the policies most commonly considered by state lawmakers to reduce intentional firearm violence (Morral et al., 2018). The provisions we excluded from the extended database were either minor policies or those designed to reduce unintentional injuries or to help identify offenders once crimes have already been committed. For example, we excluded laws such as record-keeping requirements for gun stores, ballistic fingerprinting of guns, gun storage liability laws, and personalized gun technology.

Measures

Predictor variables. From the expanded state firearm law database, we selected eight specific laws for analysis based on two criteria: (a) laws that were analyzed in previous studies of mass shootings and (b) laws for which we could identify published literature providing a conceptual basis to believe they may be effective in averting mass shootings or reducing casualties in such events. The laws were: (a) assault weapons bans; (b) large-capacity magazine bans; (c) laws requiring a permit to purchase or possess a gun; (d) extreme-risk protection order laws; (e) universal background checks; (f) may-issue concealed-carry laws; (g) relinquishment of guns required when people become disqualified from ownership; and (h) laws prohibiting gun possession by people with a history of a violent misdemeanor crime. Online Supplemental Table A displays the laws analyzed, their definitions, and the states that had these laws in effect in 2018. Laws were lagged by 1 year in the analysis; that is, we considered the potential effect of a law only in the full first year after its enactment.

Outcome variables. There were three major outcome variables that measured the incidence and severity of mass public shootings.

Incidence of mass public shootings. Because this outcome variable was dichotomous (the presence or absence of a mass public shooting in a given state during a given year), we used a logistic regression model for this analysis. To account for clustering by state, we used a generalized estimating equations (GEE) approach with an exchangeable working correlation matrix. We included both linear and quadratic trend variables. We generated standard errors that accounted for state clustering and were robust to the correlation structure assumptions (White, 1980). There were a few cases in which a state experienced more than one event in the same year (e.g., California experienced three mass public shootings in 1993). However, these were so few that modifying the outcome variable was not warranted.

Number of fatalities per shooting event. Because of the small number of events, our data set contained a great majority of zero counts (2,007 of 2,150 observations). For this reason, we used a zero-inflated negative binomial model (Yau, Wang, & Lee, 2003). In this approach, we modeled the likelihood of an event occurring separately from the number of fatalities assuming that an event did occur. We used logistic regression to model the likelihood of an event and negative binomial regression to model the number of fatalities when an event did occur. As above, we included linear and quadratic time trends and generated cluster robust standard errors.

One advantage of the zero-inflated model is that the factors associated with event occurrence and with the number of victims given that an event took place can be analyzed separately and with different predictor variables. For the logistic regression of event occurrence, we used all of the same control variables specified above. However, we did not anticipate that these demographic variables would influence the fatal victim count, assuming that an event occurs. For example, the divorce rate might impact the likelihood of a mass shooting, but there is no conceptual reason to believe that the divorce rate influences the number of fatalities resulting from a shooting. Therefore, the only predictors used for the count part of the model were the time trends (included to capture secular trends in the severity of mass public shootings), population, population density, and the state laws, which were the variables of interest.

As a sensitivity analysis, we performed negative binomial GEE regressions on the number of deaths per event using the same limited set of regressors but restricting the analysis to observations when an event occurred ($N = 143$). In this way, the model assessed the relationship between state laws and the number of fatalities in a mass shooting event, independent of any association between these laws and the likelihood of an event occurring in the first place.

Number of nonfatal injuries per shooting event. We conducted a post hoc analysis to investigate whether large-capacity magazine bans are associated with the number of nonfatal injuries when an event occurs. To do this, we performed a zero-inflated negative binomial regression but used only the time trends, population, population density, and large-capacity magazine ban laws to predict the number of injuries per event. Finally, we executed a sensitivity analysis, repeating the above model specification using a negative binomial regression restricted to observations in which an event occurred.

Control variables. We compiled an annual, state-specific panel of data on variables that might be related to both mass shooting rates and the adoption of firearm laws, therefore confounding the results. Because of the limited literature on predictors of mass shooting incidence and severity at the state level, we selected control variables based on their demonstrated association with state rates of overall firearm violence in previous studies. The variables included and the studies documenting their association with firearm violence at the state level were: (a) state population (Knopov et al., 2019; Siegel & Boine, 2019); (b) population density (Knopov et al., 2019; Siegel, Pahn, Xuan, Fleegler, & Hemenway, 2019); (c) proportion identified as Black (Campbell, Siegel, Shareef, & Rothman, 2019; Siegel et al., 2020); (d) proportion of males among young adults (ages 15–29 years) (Knopov et al., 2019; Siegel, Pahn, et al., 2019); (e) poverty rate (Powell & Tanz, 1999; Siegel, Pahn, et al., 2019); (f) unemployment rate (Campbell et al., 2019; Siegel, Pahn, et al., 2019); (g) per-capita alcohol consumption (Siegel, Pahn, et al., 2019, Siegel et al., 2020); (h) divorce rate (Díez et al., 2017); (i) incarceration rate (Campbell et al., 2019; Siegel et al., 2013); (j) household gun ownership (Campbell et al., 2019), using a commonly used proxy: the proportion of suicides committed with a firearm (Azrael, Cook, & Miller, 2004); and (k) the violent crime rate (Campbell et al., 2019; Siegel, Pahn, et al., 2019). We also included the firearm homicide rate and the suicide rate because these are direct measures of the overall magnitude of firearm violence in a state. We linearly interpolated missing years of data. Online Supplemental Table B shows the variables, definitions, data sources, and years with missing data.

Multicollinearity assessment. A unique contribution of this study is its ability to examine a wide range of firearm laws and to isolate the independent effect of laws by controlling for the presence of the others. A potential drawback of this approach is the possibility of multicollinearity. We assessed the potential for high multicollinearity and thus inflated standard error terms by computing variance inflation factors.

We estimated all models using Stata/SE version 15 (StataCorp, College Station, TX). Online Supplemental Table C provides the command syntax for the analyses. The data set, methods, and code used in this research are available online at https://osf.io/mucsh/.

Results

Descriptive Findings

During the period 1976–2018, there were a total of 155 mass public shootings resulting in 1,078 deaths and an additional 1,694 nonfatal injuries in the United States, excluding one event that occurred in nation's capital because it does not fall under the jurisdiction of any state (see Table 1, Figure 1, and Figure 2). The average mass public shooting rate ranged from a high of 0.1963 per million population in Idaho to a low of zero in nine states (see Table 1). California had the greatest number of events (25) and deaths (164), whereas Nevada had the greatest number of overall victims (915) as a result of the massive shooting in Las Vegas in 2017. The number of mass public shootings remained stable or slightly elevated between 1976 and 2002, but there was a sharp increase from 2002 through 2018 (see Figure 1). The number of mass shootings waned during the period 2013–2016 but rose sharply in 2017 and 2018. The trend in deaths followed a similar pattern (see Figure 2).

State Firearm Laws and the Likelihood of a Mass Public Shooting

In the logistic regression GEE model, one law—permit requirements—was associated with 60% lower odds of a mass public shooting (95% confidence interval [CI: −32%, −76%]) as shown in Table 2. No other laws were related to the likelihood of a mass public shooting. Other factors associated with the occurrence of a mass public shooting were population, unemployment rate, divorce rate, firearm homicide rate, and suicide rate.

In the logistic regression portion of the zero-inflated negative binomial model, one law—permit requirements—was associated with 59% lower odds of a mass public shooting (95% CI [−31%, −76%]) as displayed in Table 3. Other factors related to the likelihood of a mass public shooting were population, divorce rate, firearm homicide rate, and suicide rate. These results were consistent with that of the logistic regression.

State Firearm Laws and the Number of Fatalities in a Mass Public Shooting

In the count part of the zero-inflated negative binomial model, one law—large-capacity magazine bans—was associated with fewer deaths when a mass public shooting occurred (see Table 3). A large-capacity magazine ban was associated with 38% fewer fatalities (95% CI [−12%, −57%]). No other laws were significantly associated with a lower number of deaths in a mass public shooting.

In the sensitivity analysis in which we modeled the number of fatalities resulting from mass public shootings using a GEE negative binomial model restricted to only those observations for which an event occurred, large-capacity magazine bans were associated with 37% fewer fatalities (95% CI [−10%, −57%]), as shown in Table 4. No other laws were significantly associated with a lower number of deaths in a mass public shooting. These results

Table 1
Average Mass Public Shooting Rate and Total Number of Events and Deaths—By State, 1976–2018

State	Average rate	Events	Deaths	Nonfatal injuries	Total victims
Alaska	0.1963	4	25	2	27
Idaho	0.0405	2	8	1	9
Mississippi	0.0331	4	20	11	31
Oregon	0.0309	4	23	55	78
Nevada	0.0283	3	66	849	915
Colorado	0.0265	5	37	104	141
Washington	0.0249	7	34	33	67
Rhode Island	0.0244	1	4	0	4
Kentucky	0.0243	4	22	18	40
Connecticut	0.0199	3	39	4	43
New Hampshire	0.0196	1	4	4	8
Hawaii	0.0192	1	7	0	7
Arkansas	0.0189	2	9	13	22
Texas	0.0189	16	134	128	262
Florida	0.0182	12	123	101	224
California	0.0175	25	164	161	325
Wisconsin	0.0165	4	23	9	32
Pennsylvania	0.0132	7	37	15	52
Nebraska	0.0130	1	8	4	12
Missouri	0.0124	3	14	3	17
North Carolina	0.0118	4	20	15	35
South Carolina	0.0108	2	13	4	17
Louisiana	0.0106	2	9	5	14
Georgia	0.0102	4	21	15	36
New York	0.0099	8	46	34	80
Utah	0.0090	1	5	4	9
Minnesota	0.0089	2	15	7	22
Kansas	0.0085	1	5	2	7
Iowa	0.0083	1	5	1	6
Maryland	0.0080	2	9	2	11
Illinois	0.0076	4	19	27	46
Michigan	0.0071	3	14	10	24
Oklahoma	0.0071	1	14	6	20
Tennessee	0.0070	2	9	6	15
Arizona	0.0068	2	12	14	26
Alabama	0.0052	1	4	1	5
Ohio	0.0042	2	8	7	15
Indiana	0.0038	1	4	2	6
Massachusetts	0.0037	1	7	0	7
New Jersey	0.0032	1	6	0	6
Virginia	0.0030	1	32	17	49
Delaware	0	0	0	0	0
Maine	0	0	0	0	0
Montana	0	0	0	0	0
New Mexico	0	0	0	0	0
North Dakota	0	0	0	0	0
South Dakota	0	0	0	0	0
Vermont	0	0	0	0	0
West Virginia	0	0	0	0	0
Wyoming	0	0	0	0	0
All states	0.0129	155	1,078	1,694	2,772

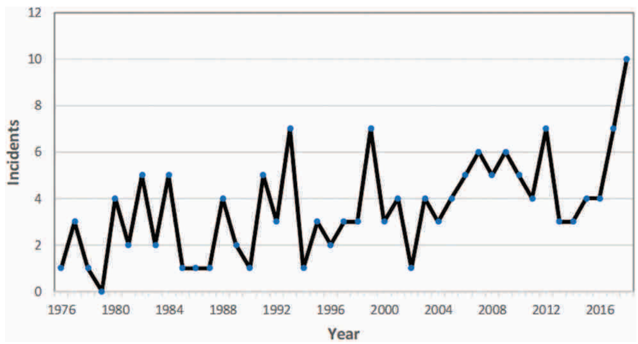

Figure 1. Number of mass public shootings by year—United States, 1976–2018. See the online article for the color version of this figure.

were almost identical to those from the zero-inflated negative binomial model.

Large-Capacity Magazine Bans and the Number of Nonfatal Injuries in a Mass Public Shooting

Large-capacity magazine bans were associated with 77% fewer nonfatal injuries (95% CI [−43%, −91%]), as shown in Table 5. In the sensitivity analysis in which we modeled the number of fatalities resulting from mass public shootings using a GEE negative binomial model restricted to only those observations for which an event occurred, large-capacity magazine bans were associated with 70% fewer nonfatal injuries (95% CI [−29%, −87%]), also shown in Table 5.

Multicollinearity Assessment

Whether we included all regressors or just those pertaining to guns, none of the gun law variables revealed a variance inflation factor above four, a conventional benchmark for concern.

Discussion

To our knowledge, this is the first paper to examine state firearm laws and their separate relationship with the likelihood of a mass public shooting and with the number of fatalities when such an event occurs. We found a robust relationship between state laws that require permits for the purchase and/or possession of guns and the incidence of mass public shootings and between large-capacity magazine bans and the number of deaths resulting from a mass public shooting if one does occur. However, we did not find any significant association between assault weapons bans or other firearm laws and either of these outcomes. Additionally, we found that large-capacity magazine bans are also associated with a lower number of nonfatal injuries when a mass public shooting occurs.

Incidence of Mass Public Shootings

Our finding that laws requiring permits to purchase or possess firearms are associated with a lower incidence of mass public shootings is consistent with those of Webster et al. (2020), who reported that laws requiring handgun permits were associated with a lower number of mass shooting incidents. This supports the theoretical framework that we adapted from Cook (1983), which posits that limiting the availability of firearms may reduce the incidence of mass public shootings by increasing the costs of obtaining a gun in both the legal and illegal markets and that this increased cost could be enough to deter a potential mass shooter. State gun permit requirements have been shown to decrease firearm homicide rates (Crifasi et al., 2018; Webster, Crifasi, & Vernick, 2014) and to reduce straw purchasing or trafficking of guns that diverts them into the illegal market (Collins et al., 2018; Crifasi, Buggs, Choksy, & Webster, 2017).

Similar to Webster et al. (2020), we did not find that universal background check laws are related to the likelihood of mass public shootings. Background checks are typically conducted through the FBI National Instant Criminal Background Check System, which consults only national databases. State mental health, drug use, and criminal databases are not searched, and several studies have documented severe limitations of state reporting to the National Instant Criminal Background Check System database (Goggins & Gallegos, 2016; Mayors Against Illegal Guns, 2011). In contrast to the federal background check system, states that require their own gun permits typically have detailed procedures that involve a check of multiple state databases and often require fingerprints rather than relying solely on self-reported information (Webster et al., 2020). Also, states that conduct their own background checks or delegate this responsibility to local authorities have lower firearm homicide rates than states that rely solely on federal background checks (Sumner, Layde, & Guse, 2008). Requiring permits to purchase or possess firearms is an effective mechanism for conducting effective criminal background checks at the local level.

Severity of Mass Shootings

Our finding that state laws prohibiting large-capacity ammunition magazines are associated with fewer fatalities and nonfatal injuries in mass public shootings is consistent with that of Klarevas et al. (2019), who reported that state-level large-capacity magazine bans were associated with a reduction in the number of deaths in high-fatality (six or more victims shot to death) mass shootings and that of Webster et al. (2020), who observed that laws banning large-capacity magazines were associated with a lower number of deaths from mass shootings. It is plausible that a ban on large-capacity magazines would not stop mass shootings per se but could

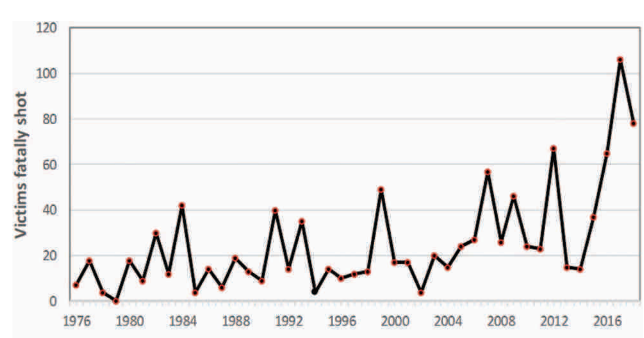

Figure 2. Number of deaths from mass public shootings by year—United States, 1976–2018. See the online article for the color version of this figure.

Table 2

Logistic Regression Model Results: Factors Affecting Occurrence of a Mass Public Shooting, 1976–2018[a]

Factor	*OR* [95% CI]	Statistical significance
Population (in millions)	**1.11[b] [.09, 1.14]**	$p < .001$
Population density (in people per .01 square miles)	0.96 [0.84, 1.08]	$p = .47$
Percent Black	0.97 [0.93, 1.02]	$p = .23$
Percent male of young adults	1.22 [0.93, 1.61]	$p = .15$
Poverty rate	0.98 [0.92, 1.05]	$p = .57$
Unemployment rate	**1.10[b] [1.00, 1.22]**	$p = .05$
Per-capita alcohol consumption	1.45 [0.93, 2.26]	$p = .10$
Divorce rate	**1.15[b] [1.00, 1.32]**	$p = .05$
Incarceration rate (per 1,000 population)	0.99 [0.83, 1.18]	$p = .93$
Household gun ownership	1.00 [0.96, 1.04]	$p = .93$
Age-adjusted firearm homicide rate	**1.20[b] [1.02, 1.41]**	$p = .03$
Age-adjusted total suicide rate	**0.85[b] [0.74, 0.98]**	$p = .02$
Violent crime rate	0.96 [0.82, 1.12]	$p = .59$
Assault weapons ban	1.36 [0.38, 4.86]	$p = .64$
Large-capacity ammunition magazine ban	0.44 [0.13, 1.44]	$p = .18$
Permit requirement	**0.40[b] [0.24, 0.68]**	$p = .001$
Extreme-risk protection order law	1.08 [0.22, 5.19]	$p = .93$
Universal background checks at point of sale	0.51 [0.18, 1.43]	$p = .20$
May-issue concealed-carry law	1.26 [0.76, 2.08]	$p = .37$
Relinquishment law	1.05 [0.52, 2.11]	$p = .90$
Violent misdemeanor law	0.64 [0.23, 1.79]	$p = .40$

Note. *OR* = odds ratio; CI = confidence interval.
[a] Outcome variable is whether or not a mass public shooting occurred in a given state in a given year. State clustering was accounted for using generalized estimating equations. All models include linear and quadratic trends. Standard errors are robust and adjusted for state-level clustering. [b] Coefficient is statistically significant from zero ($p < .05$), also shown in bold type.

at least reduce the number of fatalities and nonfatal injuries in such events because the shooter can fire fewer rounds before having to reload (Klarevas et al., 2019; Koper, 2020; Webster et al., 2020). This is consistent with a body of literature demonstrating that fatality counts in mass shootings are higher when a large-capacity magazine is used by an assailant (Koper, 2020; Koper et al., 2018).

In contrast to high-capacity magazine bans, we did not find support for the often-claimed association between assault weapon bans and mass public shootings. This conflicts with Gius' (2015) contention but is in accord with that of Webster et al. (2020). Our failure to identify an association of assault weapons bans and the incidence of, or fatalities in, mass public shootings could be explained by the fact that assault weapons are typically defined by cosmetic features rather than characteristics that directly affect the lethality of the firearm (Siegel & Boine, 2019) or by the relative infrequency of assault weapon use in mass public shootings (Duwe, 2007). Most semiautomatic firearms are not assault weapons as defined by state laws but are functionally equivalent. They are manufactured without the accessories, such as bayonet lugs, flash suppressors, and grenade launchers, that characterize assault weapons. Moreover, the firing rate of all semiautomatic weapons is the same, regardless of whether they are military-style assault weapons or just handguns, namely the speed at which the shooter can squeeze the trigger. What makes assault weapons so lethal is not any particular functional feature but simply the fact that these firearms are designed to accommodate high-capacity magazines. This may explain our finding that large-capacity magazine bans, but not assault weapon bans, were related to the number of casualties in mass public shootings.

Our finding that only two policies—permit requirements and large capacity magazine bans—were related to mass public shootings is consistent with that of Webster et al. (2020), who reported a similar result. Like Webster et al. (2020), we failed to find a relation between may-issue laws or violent misdemeanor laws and mass public shootings. Because may-issue laws affect only the ability to carry a concealed gun not the ability to purchase a firearm, one might not expect these policies to affect mass public shootings. Violent misdemeanor laws are designed to prevent adjudicated violent criminals from possessing firearms; however, in a substantial proportion of mass shootings, there is no history of a criminal conviction for a violent crime or the crime involves domestic violence (Hempel et al., 1999). Studies have documented serious loopholes in the confiscation of firearms from domestic violence offenders (Mascia, 2015). Strengthening the procedures for the surrender of firearms by persons adjudicated for domestic violence or served with restraining orders may be necessary to observe a measurable effect of these policies on rare mass public shooting events. Similarly, our failure to find a relationship between relinquishment laws and mass public shootings could have more to do with the lack of enforcement of these laws than with a conceptual problem with the idea of limiting potential shootings by making sure that people who become prohibited from possessing a firearm are disarmed.

Perhaps the most surprising negative finding was that extreme-risk protection orders were not related to the incidence of mass public shootings. However, our definition of extreme-protection order laws included those in which law enforcement personnel are authorized to initiate a proceeding, regardless of whether family

Table 3
Zero-Inflated Negative Binomial Model Results: Factors Affecting Occurrence of a Mass Public Shooting and Number of Deaths if a Mass Shooting Occurs, 1976–2018[a]

	Logistic model		Negative binomial model	
Factor	*OR* [95% CI]	Statistical significance	Incidence rate ratio [95% CI]	Statistical significance
State population (in millions)	**1.11**[b] **[1.09, 1.14]**	$p < .001$	1.01 [1.00, 1.03]	$p = .07$
Population density (per .01 square miles)	0.96 [0.85, 1.08]	$p = .49$	0.99 [0.91, 1.09]	$p = .90$
Percentage Black	0.97 [0.93, 1.02]	$p = .23$		
Percentage male (of young adults)	1.22 [0.93, 1.61]	$p = .15$		
Poverty rate	0.98 [0.92, 1.05]	$p = .57$		
Unemployment rate	1.10 [1.00, 1.22]	$p = .05$		
Per-capita alcohol consumption	1.45 [0.93, 2.26]	$p = .10$		
Divorce rate	**1.15**[b] **[1.00, 1.33]**	$p = .05$		
Incarceration rate (per 1,000 population)	0.99 [0.83, 1.19]	$p = .94$		
Household gun ownership	1.00 [0.96, 1.04]	$p = .93$		
Age-adjusted firearm homicide rate	**1.20**[b] **[1.02, 1.42]**	$p = .03$		
Age-adjusted total suicide rate	**0.85**[b] **[0.75, 0.98]**	$p = .03$		
Violent crime rate	0.96 [0.82, 1.12]	$p = .57$		
Assault weapons ban	1.36 [0.36, 5.11]	$p = .65$	1.04 [0.57, 1.90]	$p = .89$
Large-capacity ammunition magazine ban	0.45 [0.13, 1.55]	$p = .21$	**0.62**[b] **[0.43, 0.88]**	$p = .008$
Permit requirement	**0.41**[b] **[0.24, 0.69]**	$p = .001$	0.80 [0.50, 1.30]	$p = .37$
Extreme-risk protection order law	1.04 [0.21, 5.07]	$p = .96$	1.55 [0.65, 3.69]	$p = .32$
Universal background checks at point of sale	0.51 [0.17, 1.53]	$p = .23$	0.83 [0.41, 1.68]	$p = .61$
May-issue concealed-carry law	1.23 [0.74, 2.04]	$p = .42$	1.21 [0.90, 1.63]	$p = .20$
Relinquishment law	1.04 [0.51, 2.14]	$p = .91$	1.13 [0.47, 2.69]	$p = .79$
Violent misdemeanor law	0.67 [0.24, 1.88]	$p = .45$	0.80 [0.37, 1.74]	$p = .58$

Note. *OR* = odds ratio; CI = confidence interval.
[a] Models include linear and quadratic trends. Standard errors are robust and adjusted for state-level clustering. [b] Coefficient is statistically significant from zero ($p < .05$), also shown in bold type.

members can do so. We could not examine extreme-risk protection order laws that allow family members to intervene because only two states had such laws in place for more than 1 year during the study period. It may be that family members are in the best position to recognize people with access to guns who are at great risk of harming others or themselves. If this were the case, it could explain our failure to find any significant association between mass public shootings and laws that rely on law enforcement officials to identify at-risk individuals.

Policy and Research Implications

Because of the cross-sectional nature of this study, we cannot definitively conclude that implementing a specific law would lead to a change in the incidence or severity of mass public shootings. Nevertheless, our research suggests three potential policy implications that must be balanced with citizens' right to bear arms under the Second Amendment of the U.S. Constitution. First, to reduce the incidence of mass shootings, the primary objective

Table 4
Negative Binomial GEE Model Results: Factors Affecting the Number of Fatalities in a Mass Public Shooting, 1976–2018[a]

Factor	Negative binomial model incidence rate ratio [95% CI]	Statistical significance
State population (in millions)	**1.01**[b] **[1.00, 1.03]**	$p = .03$
Population density (per .01 square miles)	1.00 [0.92, 1.08]	$p = .92$
Assault weapons ban	1.08 [0.63, 1.85]	$p = .78$
Large capacity ammunition magazine ban	**0.63**[b] **[0.43, 0.90]**	$p = .01$
Permit requirement	0.83 [0.54, 1.29]	$p = .41$
Extreme-risk protection order law	1.65 [0.74, 3.70]	$p = .22$
Universal background checks at point of sale	0.79 [0.45, 1.38]	$p = .41$
May-issue concealed-carry law	1.15 [0.88, 1.52]	$p = .31$
Relinquishment law	1.07 [0.53, 2.15]	$p = .85$
Violent misdemeanor law	0.86 [0.44, 1.69]	$p = .66$

Note. CI = confidence interval; GEE = generalized estimating equations.
[a] This model is restricted to observations when a mass shooting event occurred. It includes linear and quadratic trends. Standard errors are robust and adjusted for state-level clustering. [b] Coefficient is statistically significant from zero ($p < .05$), also shown in bold type.

Table 5
Zero-Inflated Negative Binomial Model and Negative Binomial GEE Model Results: Factors Affecting the Number of Nonfatal Injuries in a Mass Public Shooting if a Mass Shooting Occurs, 1976–2018[a]

Factor	Incidence rate ratio [95% CI] [statistical significance] Zero-inflated negative binomial model	Negative binomial GEE model
State population (in millions)	**1.04**[b] **[1.01, 1.06]** [p = .001]	**1.02 [1.02, 1.06]** [p = .32]
Population density (per .01 square miles)	**0.65**[b] **[0.62, 0.85]** [p < .001]	**0.70**[b] **[0.53, 0.92]** [p = .01]
Large-capacity ammunition magazine ban	**0.23**[b] **[0.09, 0.57]** [p = .002]	**0.30**[b] **[0.13, 0.71]** [p = .006]

Note. CI = confidence interval; GEE = generalized estimating equations.
[a] The negative binomial regression is restricted to observations in which an event occurred. Both models include linear and quadratic trends. Standard errors are robust and adjusted for state-level clustering. Nevada was excluded from the models because of outlying data that prevented model convergence. [b] Coefficient is statistically significant from zero (p < .05), also shown in bold type.

should be to limit potential shooters' access to firearms generally. One interpretation of our findings is that requiring permits to purchase or possess a firearm may limit potential shooters' access to firearms. Furthermore, laws requiring permits to purchase or possess firearms may be more effective than universal background checks because they rely on state or local officials, who have the most direct access to criminal, mental health, and drug- and alcohol-related records. In contrast, universal background checks rely on FBI data, which are often incomplete.

Second, to reduce the severity of mass public shootings when they do occur, the primary goal should be to limit the number of shots that can be fired before the shooter has to reload. This can be accomplished by restricting ammunition magazines to no more than 10 rounds. The 1994 Assault Weapons Ban is an example of a policy that sought to limit the severity of mass shootings. Included in that legislation was a ban on magazines that could hold more than 10 rounds (United States Congress, 1994). Recently several prominent voices have called for a renewal of the Assault Weapons Ban (Ingraham, 2018). Because our results did not show any association between assault weapons bans and mass public shootings, it may be more effective to focus on magazine capacity rather than trying to define assault weapons in general.

Third, our failure to find a relationship between laws that prohibit people with a history of violence from possessing firearms and that require relinquishment of firearms by people who do become prohibited from possessing them may indicate weaknesses in the practical application of these laws. Few states have statutory-based procedures for confiscating firearms from people who are adjudicated for violent misdemeanors—such as domestic violence offenses—or who are served with protection orders (Zeoli et al., 2020). Future studies should examine not only the enactment of laws but also their enforcement.

The methods and findings of this paper have implications for future research in the area of state firearm laws and mass public shootings. First, we used clearly defined and explicit criteria to categorize both our predictor and outcome variables. The public availability of both our mass public shooting data set and the extended State Firearm Law Database will allow researchers to conduct their own analyses to further the work described here. Second, we have demonstrated the use of the zero-inflated negative binomial model to simultaneously but separately identify factors associated with the incidence of mass public shootings and with the number of victims when such an event occurs. Our results suggest that there are separate laws associated with the incidence and severity of mass public shootings; thus, modeling the effect of firearm laws in a simple count regression may not be sensitive enough to distinguish these relationships.

Limitations

By far, the most notable limitation of this study stems from the fact that we sought to investigate mass public shootings, a small subset of all mass shootings. The sample size for analysis was therefore unavoidably small (N = 155 events), resulting in fairly wide confidence intervals on many of our point estimates and making it difficult to conclude that laws we found to be unassociated with mass public shootings do not affect these events. The number of events in our analysis was considerably less than the 604 mass shootings examined by Webster et al. (2020) and the 344 mass shootings studied by Reeping et al. (2019) but was higher than the 69 high-fatality mass shootings examined by Klarevas et al. (2019), the 57 in Gius (2015), and the 44 in DiMaggio et al. (2019).

Compounding this problem is the fact that some of the state laws were enacted in a small number of states, further limiting the effective sample size and reducing our power to detect an effect of these laws if one exists. This is particularly true for the violent misdemeanor laws, which were in effect in only four states in 2018.

Finally, because we were unable to control fully for confounding factors that could explain the observed results, we cannot infer causality from this study. Nevertheless, we did control for a wide range of variables known to be associated with rates of firearm violence, including sociodemographic factors, household gun ownership, violent crime rate, firearm homicide rate, and suicide rate. Any unrecognized confounding variable would have to be not only associated with both the enactment of permit or magazine capacity laws and with mass public shootings but would also have to be not strongly associated with any of the above variables.

Conclusion

Despite these limitations, our estimates of the association between state permit requirements and the incidence of mass public shooting events and between large-capacity magazine bans and fatalities and injuries occurring in such events were robust to different model specifications and are consistent with the findings of previous research. In particular: (a) our GEE logistic regression estimates and zero-inflated negative binomial estimates of the association between gun permit laws and the incidence of mass shootings were nearly identical and (b) our estimates of the association between large-capacity magazine bans and the number of fatalities as well as number of nonfatal injuries were also nearly identical when modeled using a zero-inflated negative binomial model and when modeled using a negative binomial regression model restricted to observations in which a mass public shooting occurred.

This study provides evidence that state laws requiring permits to purchase a gun are related to a lower incidence of mass public shootings and that state bans on large capacity magazines are related to fewer fatal and nonfatal injuries when such events do occur. Policymakers wanting to address specifically the morbidity and mortality from mass shootings would be prudent to adopt permit-to-purchase laws and large-capacity ammunition magazine bans to reduce both the incidence of mass public shootings and the number of casualties if such events do occur. They should take these findings into account in combination with the substantial body of research on the effect of state firearm laws on other types of firearm violence (Morral et al., 2018; Siegel, Pahn, et al., 2019) and with consideration of citizens' right to bear arms under the Second Amendment of the U.S. Constitution (*McDonald v. City of Chicago,* 2010).

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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

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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

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 & Schwieit, 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 quadradic 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.

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

State	Assault Weapon Ban	Large-Capacity Magazine Ban	Private Transfer Laws: Purchaser licensing with in-person or fingerprinting	Private Transfer Laws: Point-of-sale background check only	Prohibitions Related to Domestic Violence Restraining Orders (DVROs): 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

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TABLE 1 (Continued)

State	Assault Weapon Ban	Large-Capacity Magazine Ban	Private Transfer Laws: Purchaser licensing with in-person or fingerprinting	Private Transfer Laws: Point-of-sale background check only	Prohibitions Related to Domestic Violence Restraining Orders (DVROs): Final DVRO only	DVROs: Includes ex parte orders	DVROs: Includes dating partners	DVROs: 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					12/1/95–12/1/97	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					6/4/15			
South Dakota								
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)

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TABLE 1 (Continued)

State	Assault Weapon Ban	Large-Capacity Magazine Ban	Private Transfer Laws: Purchaser licensing with in-person or fingerprinting	Private Transfer Laws: Point-of-sale background check only	Prohibitions Related to Domestic Violence Restraining Orders (DVROs): Final DVRO only	DVROs: Includes ex parte orders	DVROs: Includes dating partners	DVROs: 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								

State	Concealed Carry Permitting Laws: No issue	Concealed Carry Permitting Laws: May issue	Concealed Carry Permitting Laws: Shall issue with discretion	Concealed Carry Permitting Laws: Strict shall issue	Concealed Carry Permitting Laws: 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

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TABLE 1 (Continued)

State	Concealed Carry Permitting Laws: No issue	May issue	Shall issue with discretion	Strict shall issue	Permitless carry	Violent Misdemeanor Prohibition
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)

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TABLE 1 (Continued)

	Concealed Carry Permitting Laws					
State	**No issue**	**May issue**	**Shall issue with discretion**	**Strict shall issue**	**Permitless carry**	**Violent Misdemeanor Prohibition**
North Dakota	pre-1984–8/1/85			8/1/85–8/1/17	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	

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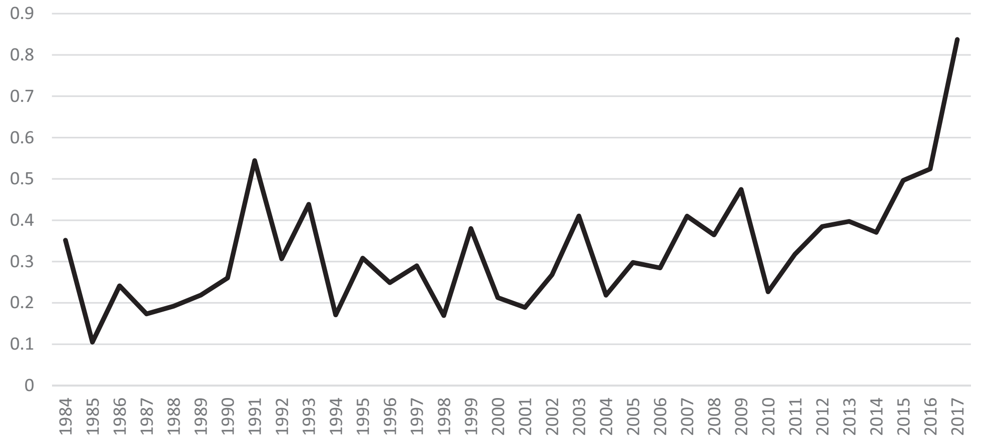

FIGURE 1 Victims in fatal mass shootings per 1 million population per year, 1984–2017

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.

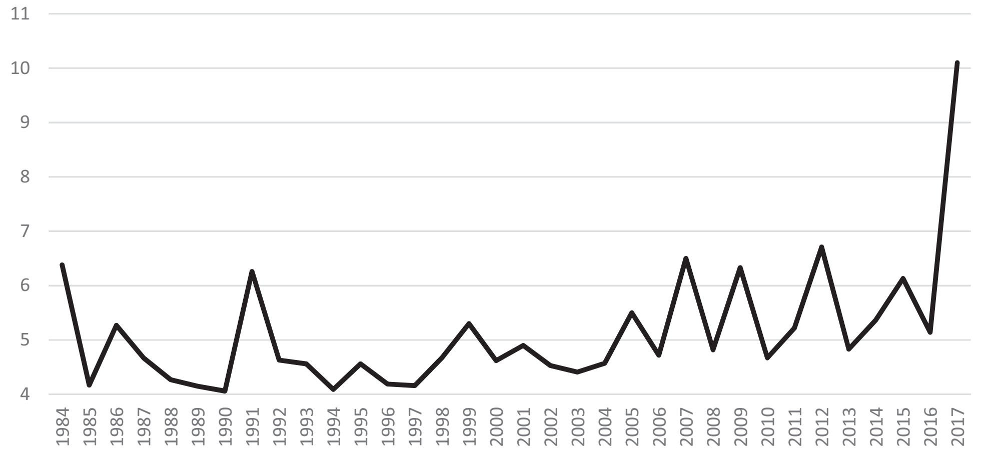

FIGURE 2 Mean number of victims murdered per incident in shootings involving 4+ victim fatalities, 1984–2017

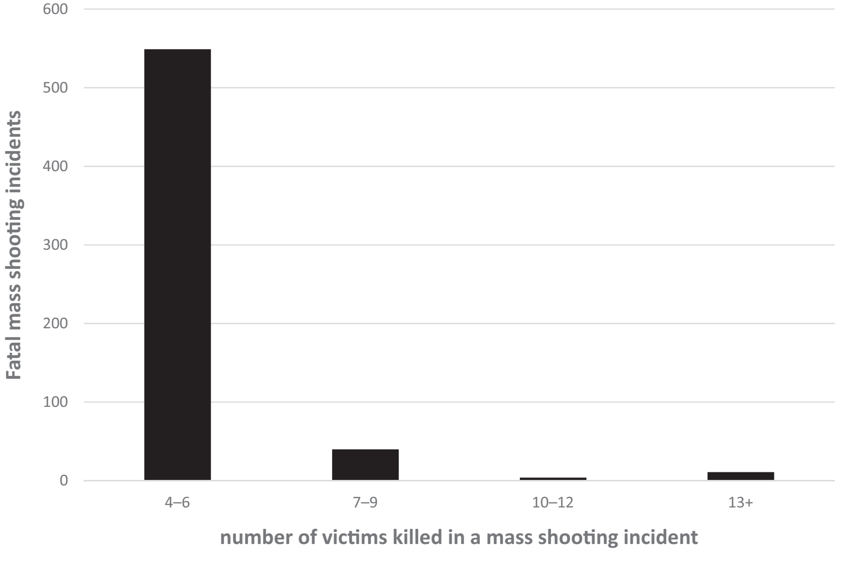

FIGURE 3 Number of incidents of fatal mass shootings by the number of victims killed, united states, 1984–2017

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	.14	0	1	.35
No issue				
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

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

Variable	Incidents ($n = 604$)		Victim Deaths ($n = 2,976$)	
	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 (n = 182) IRR	Incidents (n = 182) 95% CI	Victim Deaths (n = 842) IRR	Victim Deaths (n = 842) 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 (n = 401) IRR	95% CI	Victim Deaths (n = 2,057) 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; Tale 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.

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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.

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APPENDIX

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

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

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TABLE A1 (Continued)

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

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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
South Carolina	.18	.88	.05	.20	.14	.68
South Dakota	.08	.34	.08	.34	.00	.00
Tennessee	.07	.29	.02	.07	.05	.20
Texas	.09	.47	.02	.11	.06	.34
Utah	.07	.40	.04	.19	.04	.21
Vermont	.10	.38	.00	.00	.10	.38
Virginia	.08	.48	.03	.13	.06	.35
Washington	.08	.38	.03	.12	.05	.26
West Virginia	.14	.64	.08	.34	.06	.30
Wisconsin	.04	.24	.01	.06	.03	.15
Wyoming	.12	.47	.12	.47	.00	.00
Overall	.07	.36	.03	.12	.04	.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 (*n* = 604 shootings) IRR (IRR[a])	95% CI (95% CI[a])	Fatalities in All Fatal Mass Shootings (*n* = 2,976 fatalities) 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]

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TABLE A2 (Continued)

Variable	All Fatal Mass Shooting Incidents (*n* = 604 shootings) IRR (IRR[a])	95% CI (95% CI[a])	Fatalities in All Fatal Mass Shootings (*n* = 2,976 fatalities) 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]

[a]Parsimonious model results.
[b]Handgun purchaser licensing with in-person application and/or fingerprinting of applicant.
[*]$p = .05$.

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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 (n = 182 shootings) IRR (IRR[a])	95% CI (95% CI[a])	Fatalities in Domestic-Linked Mass Shootings (n = 842 fatalities) 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]

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TABLE A3 (Continued)

Variable	Domestic-Linked Fatal Mass Shooting incidents (n = 182 shootings) IRR (IRR[a])	95% CI (95% CI[a])	Fatalities in Domestic-Linked Mass Shootings (n = 842 fatalities) 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]

[a]Parsimonious model results.

[b]Handgun purchaser licensing with in-person application and/or fingerprinting of applicant.

*$p = .05$.

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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 (n = 401 shootings) IRR (IRR[a])	95% CI (95% CI[a])	Fatalities in Non–Domestic-Linked Mass Shootings (n = 2,057 fatalities) 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]

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TABLE A4 (Continued)

Variable	Non–Domestic-Linked Fatal Mass Shooting incidents (n = 401 shootings) IRR (IRR[a])	95% CI (95% CI[a])	Fatalities in Non–Domestic-Linked Mass Shootings (n = 2,057 fatalities) 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]

[a]Parsimonious model results.

[b]Handgun purchaser licensing with in-person application and/or fingerprinting of applicant.

*p = .05.

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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 ($n = 604$ shootings)		Fatalities in All Fatal Mass Shootings ($n = 2,976$ fatalities)	
	IRR	95% CI	IRR	95% CI
Concealed carry permit—may issue reference	.88	[.52, 1.48]	1.31	[.74, 2.32]
No issue				
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]

[a]Handgun 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 (n = 182 shootings) IRR	95% CI	Fatalities in Domestic-Linked Mass Shootings (n = 842 fatalities) 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]

[a]Handgun purchaser licensing with in-person application and/or fingerprinting of applicant.
[*]p = .05.

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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 (*n* = 182 shootings) IRR	95% CI	Fatalities in Non–Domestic-Linked Mass Shootings (*n* = 2,057 fatalities) 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]

[a]Handgun purchaser licensing with in-person application and/or fingerprinting of applicant.
*$p = .05$.
Estimates Using Poisson Fixed-Effects Regression.

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

	All Fatal Mass Shooting Incidents (n = 604 shootings)		Fatalities in All Fatal Mass Shootings (n = 2, 976 fatalities)	
Variable	**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]

[a]Handgun 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 (*n* = 182 shootings)		Fatalities in Domestic-Linked Mass Shootings (*n* = 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]

[a]Handgun 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]

[a]Handgun 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).

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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 (n = 602 shootings) IRR	95% CI	Fatalities in All Fatal Mass Shootings (n = 2, 937 fatalities) 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]

[a]Handgun purchaser licensing with in-person application and/or fingerprinting of applicant.
*p = .05.

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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 (*n* = 181 shootings) Law Variables + Covariates IRR	95% CI	Fatalities in Domestic-Linked Mass Shootings (*n* = 815 fatalities) Law Variables + Covariates 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]

[a]Handgun 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 (n = 181 shootings) IRR	95% CI	Fatalities in Non–Domestic-Linked Mass Shootings (n = 2,045 fatalities) 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]

[a]Handgun 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.

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

Variable	All Fatal Mass Shooting Incidents (n = 198 shootings) IRR	95% CI	Fatalities in All Fatal Mass Shootings (n = 1, 352 fatalities) 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]

[a]Handgun 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]

[a]Handgun purchaser licensing with in-person application and/or fingerprinting of applicant.
*$p = .05$.

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American Journal of
Preventive Medicine

RESEARCH ARTICLE

Broadening the Perspective on Gun Violence: An Examination of the Firearms Industry, 1990–2015

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Introduction: Firearm violence injures or kills 100,000 Americans each year. This paper applies the Host–Agent–Vector–Environment model to this issue. Research on firearm violence tends to focus on two elements—the host (i.e., victims of firearm violence) and the environment (i.e., gun policies)—but little attention has been paid to the agent (the gun and ammunition) or the vector (firearm manufacturers, dealers, and the industry lobby).

Methods: Using Bureau of Alcohol, Tobacco, Firearms and Explosives data, trends in firearm manufacturing were investigated from 1990 to 2015. Outcome measures included: (1) trends in domestic gun manufacturing by weapon type; (2) trends in production by firearm caliber; and (3) 2015 market share by type of firearm and company. Data were collected and analyzed in 2016.

Results: Overall domestic firearms production decreased slightly from 1996 through 2004, and then steadily increased from 1.7% in 2005 to 13.8% in 2013, when >10 million firearms were produced for the domestic market. The increase in total firearm production was driven by the increased production of pistols and rifles. Within the pistol category, increased production was attributable to an increase in higher caliber weapons. Similar trends were observed in gun purchases and recovered and traced crime guns.

Conclusions: Trends in firearm manufacturing reveal a shift toward more-lethal weapons, and this trend is also observed in gun purchases and crime gun traces. This may reflect a societal shift in cultural practices and norms related to guns and could inform strategies to reduce firearm violence.
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INTRODUCTION

Firearm violence causes more than 36,000 U.S. deaths annually.[1] Although the issue of firearm violence has traditionally been viewed from a criminal justice perspective, it is increasingly seen as a public health problem.[2] One advantage of this perspective is that it enables issues to be viewed using the Host–Agent–Vector–Environment model,[2] which is commonly applied to identify potential solutions to public health problems. In this model, the disease victim is the host; the entity that directly transmits the disease or injury is the agent; the producer or carrier of the agent is the vector; and the historical, cultural, social, economic, and political climate in which disease or injury occurs is the environment. Although this model was originally intended and used for infectious disease, it has been applied to chronic disease as well. For example, Nordsiek[3] applied this model to the obesity epidemic as early as 1964. More recently, researchers prepared papers on each aspect of the tobacco epidemic,[4] including the host

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(smokers),[5] agent (cigarettes),[6] vector (the tobacco industry),[7] and environment (tobacco policies).[8]

Recently, this model has been applied to firearm violence.[9–14] For example, Pinto et al.[9] defined the host (victims of firearm violence), agent (firearms themselves and ammunition), vector (the firearms industry, including arms manufacturers and dealers and the industry lobby), and environment (gun policies, culture, social norms, and political and economic factors) and showed how consideration of each of these factors could lead to a range of potential strategies to reduce firearm violence. There are slight variations on the application of this model to firearm violence, with other authors viewing guns as the vector and ammunition as the agent,[10–12] classifying guns as a combined agent/vector,[13] and adding perpetrators as an additional agent.[14] Regardless of how the model is applied, its value lies in the articulation of a broad range of proximal and distal contributing factors that provide potential leverage at multiple levels to achieve injury prevention goals.

Most of the discussion regarding firearm violence has focused on characteristics of the host (i.e., firearm death and injury rates and the characteristics of victims) and the environment (i.e., gun policies and social determinants of crime), but less attention has been directed toward the agent (the gun and ammunition) or to the vector (firearms manufacturers, their practices, and gun sales). In contrast to the vast literature on cigarettes and tobacco companies, similar data on firearms and firearm manufacturers have rarely been published in the public health literature. Professor Timothy Lytton at Georgia State University recently noted that, "In popular discourse or political discourse, gun violence is often talked about in the context of criminals using weapons.… the real problem in gun violence we should focus on is the firearm industry's sales, marketing and distribution practices."[15] This paper begins to address this gap in the literature by examining trends in the volume and types of firearm production and company market shares by firearm types in the U.S. over time, and by examining the correlation between trends in manufactured firearms and purchased firearms, as well as firearms recovered in actual crimes.

Several previous articles in the public health literature have examined trends in the volume and types of firearms produced by the firearm industry. In a 1993 paper in this journal, Cook[16] reported U.S. domestic firearm production by gun type during the period 1965–1990. In a 1996 paper, Wintemute[17] described changes in handgun production and in the caliber of pistols from 1985 to 1994. In a 2002 paper, Wintemute[18] provided data on trends in gun production by weapon type during the period 1976–1999 and listed the leading manufacturers of semiautomatic pistols during the 1990s. In a 2012 paper, Braga and colleagues[19] reported trends in domestic handgun production during the period 1979–1998. Most recently, a report of U.S firearms production through 2010 produced by the Small Arms Survey provided data on domestic manufacturing by firearm type from 1942 to 2010 and presented the top manufacturers during the period 1986–2010.[20]

A major limitation of the existing literature is that public health impacts of observed trends in domestic manufacturing are not clear, as these trends have not been directly correlated with trends in purchased firearms and firearms recovered in crime. Given that the existing gun stock is very large,[21] are acute trends in production having an impact on the type of firearms being purchased and used (e.g., the types of guns actually being used in crimes)?

This paper provides information on the descriptive epidemiology of gun manufacture in the U.S. during the period 1990–2015. It examines: (1) trends in overall domestic gun manufacture by weapon types (pistol, revolver, rifle, and shotgun); (2) trends in the caliber of pistols; and (3) current market share by manufacturer for each weapon type. In addition to adding information on more recent trends in the types of firearms being introduced into the domestic market, this paper compares these trends with those in purchased firearms and crime firearms recovered and traced, to confirm whether manufacturing trends would be expected to be reflected in observed public health impacts.

Ultimately, a better understanding of the products on the market may have implications for improving firearms as consumer products, such as fostering changes in design to increase safety or changes in corporate practices to better protect consumers, as has been done for tobacco products.[22] Vernick and Teret[23] have outlined six potential areas in which a better understanding of firearms and firearm manufacturer practices could contribute to the development of novel strategies: (1) implementing safety standards; (2) reducing firearm lethality; (3) implementing surveillance and recall protocols; (4) improving oversight of dealers; (5) ensuring responsible advertising; and (6) enhancing accountability. This paper cannot in itself provide definitive solutions, but it may help inform debate as well as provide a basis for further research.

METHODS

Data Sample

Annual data on domestic firearm production, imports, and exports were gathered from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) for all 50 states for the period 1990–2015.[24,25] These data were used to calculate the trend in total firearms introduced into domestic commerce by adding the number of manufactured and imported firearms and subtracting the number of exported firearms. Trends in domestic firearm production net of exports by weapon caliber were also examined. For 2015, the market share by volume for the top 20 U.S. manufacturers was determined. An estimate of firearms sold by weapon type was derived from Federal Bureau of Investigation data on the annual number of National Instant Criminal Background Check System checks.[26] Trends in crime guns by type and caliber were obtained from ATF crime gun trace reports.[27] Data were collected and analyzed in 2016.

Measures

Data on firearm production for the years 1990–2015 were obtained from the U.S. ATF through their Annual Firearms Manufacturing and Export Reports (AFMER).[24] All federally licensed firearm manufacturers are required to report manufacturing and export numbers each year, making AFMER the most comprehensive and accurate source for firearm manufacturing data. These reports stratify each year's firearm production by manufacturer and type of weapon. Weapon types include pistol, revolver, rifle, shotgun, and miscellaneous, where pistols and revolvers are further separated by caliber, or bullet diameter. For pistols, the caliber is recorded in six categories of increasing bullet diameter: (1) up to 0.22 inches; (2) up to 0.25 inches; (3) up to 0.32 inches; (4) up to 0.380 (0.357 inches); (5) 9-mm Parabellum (also 0.357 inches but more powerful than the 0.380); and (6) up to 0.50 inches. Firearm exports account for approximately 5% of overall production. AFMER data exclude production of firearms for military use, but include units manufactured for law enforcement agencies. Firearms categorized as "miscellaneous" were not included in these analyses because this category consists of starter guns, pen guns, and firearm parts that do not constitute a complete, ready-to-use firearm. The ATF provided current AFMER data, but because these data have been updated to correct a small number of errors in reporting, there are minor differences between the totals reported here and those reported in published ATF reports.

Data on firearm imports for the years 1990–2015 were obtained from the annual ATF Report on Firearms Commerce in the U.S.[25] These reports summarize the number of non-military firearms imported, but break these weapons down only by crude type: handgun, rifle, and shotgun. During the study period, the proportion of total firearms introduced into U.S. commerce that were imported varied from 16.9% to 41.4%.

An estimate for annual gun sales by weapon type was derived from the Federal Bureau of Investigation's National Instant Criminal Background Check System data.[26] Because many background checks are associated with permitting rather than purchase, these data are only a rough estimate of the number of firearms sold. However, the current analysis was restricted to background checks listed by the ATF as being associated with the transfer of a handgun or long gun.

Trends in crime guns recovered and traced were obtained from the ATF crime trace data.[27] These data are only available for the period 2006–2015 for weapon type and 2012–2015 for caliber.

Statistical Analysis

Trends in annual firearm commerce by weapon type (handgun, rifle, and shotgun) were examined by calculating domestically produced firearms net of exports plus imports. Trends by handgun type (pistol and revolver) and caliber were based on domestically produced firearms net of exports, because imports are not broken down by handgun type or caliber. To calculate the market share by company in 2015, the production net of exports for each company was determined.

Changes in firearm production over time were assessed using a rolling, 5-year, compound annual growth rate, using the formula: $CAGR = (EV/BV)^{1/5} - 1$, where EV is the ending value (value in Year 5), and BV is the beginning value (value in Year 1). This value was then converted to a percentage.

RESULTS

The number of firearms manufactured in the U.S. for domestic commerce ranged between 3 and 5 million per year between 1990 and 2005, but then grew exponentially, from 3.2 million firearms in 2005 to a peak of 10.3 million in 2013 (Table 1, Figure 1). The 5-year rolling compound annual growth rate in overall domestic firearms production was negative from 1996 through 2004, and then steadily increased from 1.7% in 2005 to 13.8% in 2013, before dropping to 7.0% in 2015. This increase in firearm manufacturing was primarily attributable to increased production of pistols and rifles. After declining from 1990 to 2005, annual pistol production increased by more than fourfold from 2005 to 2015 (from 0.8 million to 3.6 million), peaking in 2013 at 4.4 million. Whereas the number of manufactured shotguns and revolvers remained stable throughout the study period, rifle production increased nearly threefold from 1.4 million in 2005 to a peak of 4.0 million in 2013.

Within the pistol category, the dramatically increased production observed since 2005 was attributable primarily to 0.380 and higher caliber pistols (Table 2, Figure 2). Between 2004 and 2015, production of 0.380 pistols increased from 68,319 to 819,103 (a 12-fold increase), production of 9-mm pistols increased from 209,650 to 1,531,065 (a sevenfold increase), and production of pistols >9 mm increased from 304,551 to 767,471 (a 2.5-fold increase). Between 1990 and 2015, the production market share within the pistol category nearly doubled for 0.380 pistols (from 12.5% to 23.0%), increased by nearly 18 percentage points for 9-mm pistols (from 25.4% to 43.0%), and increased by seven percentage points for pistols >9-mm caliber (from 14.8% to 21.6%).

Trends in total U.S. firearm commerce (domestic production for domestic use plus imports) followed a similar pattern to domestic production itself, with a large increase in handgun and rifle production since 2005, but only a small increase in shotgun production (Appendix Table 1, Appendix Figure 1, available online).

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Table 1. Domestic Firearm Production (Net Exports), by Type, U.S., 1990–2015

Year	Pistols	Revolvers	Rifles	Shotguns	Total firearms	Pistols, 5-year CAGR, %	Rifles, 5-year CAGR, %	All firearms, 5-year CAGR, %
1990	1,371,427	470,495	1,211,664	855,970	3,909,556	—	—	—
1991	1,378,252	459,466	883,482	828,426	3,549,626	—	—	—
1992	1,669,537	469,413	1,001,833	1,018,204	4,158,987	—	—	—
1993	2,093,362	562,292	1,173,694	1,148,939	4,978,287	—	—	—
1994	2,004,298	586,450	1,316,607	1,254,924	5,162,279	7.9	1.7	5.7
1995	1,195,284	527,664	1,441,120	1,176,958	4,341,026	−2.8	10.3	4.1
1996	987,528	498,944	1,424,315	925,732	3,836,519	−10.0	7.3	−1.6
1997	1,036,077	370,428	1,251,341	915,978	3,573,824	−13.1	1.3	−6.4
1998	960,365	324,390	1,346,959	1,036,520	3,668,234	−13.7	0.5	−6.6
1999	995,446	335,798	1,569,685	1,106,995	4,007,924	−3.6	1.7	−1.6
2000	1,004,351	318,960	1,583,097	898,442	3,804,850	0.3	2.1	−0.2
2001	677,434	320,143	1,284,551	679,874	2,962,002	−8.1	0.5	−3.7
2002	743,016	347,070	1,515,535	741,384	3,347,005	−5.0	2.4	−1.8
2003	826,986	309,364	1,430,433	726,078	3,292,861	−3.6	−1.8	−3.9
2004	837,017	294,099	1,336,077	733,623	3,200,816	−3.6	−3.3	−3.4
2005	807,237	274,399	1,433,560	709,313	3,224,509	3.6	2.2	1.7
2006	1,021,544	382,067	1,500,659	714,618	3,618,888	6.6	-0.2	1.6
2007	1,222,718	391,334	1,618,257	645,600	3,877,909	8.1	2.5	3.3
2008	1,387,349	431,753	1,747,502	630,663	4,197,267	10.6	5.5	5.6
2009	1,870,063	547,526	2,256,912	752,755	5,427,256	18.3	9.5	11.0
2010	2,212,226	559,673	1,831,831	743,092	5,346,822	16.7	4.1	8.1
2011	2,598,256	572,857	2,318,207	862,401	6,351,721	16.3	7.5	10.4
2012	3,488,865	667,357	3,172,451	949,010	8,277,683	20.3	12.7	14.5
2013	4,441,726	725,282	3,979,568	1,203,072	10,349,648	18.9	12.0	13.8
2014	3,636,048	744,047	3,379,931	935,433	8,695,459	10.4	13.0	10.2
2015	3,557,199	885,259	3,691,799	777,273	8,911,530	6.5	9.8	7.0

Source: Bureau of Alcohol, Tobacco, Firearms and Explosives. Annual Firearms Manufacturers and Export Reports, 1990-2015.[24]
CAGR, compound annual growth rate.

In 2015, Sturm, Ruger & Co. (Ruger) held the largest market share in the number of firearms produced at 18.7%, followed by Smith & Wesson at 16.5% and Remington at 12.8% (Appendix Table 2, available online). The top five firearm manufacturers alone (including Sig Sauer and Maverick Arms) held 59.0% of the market, with the top

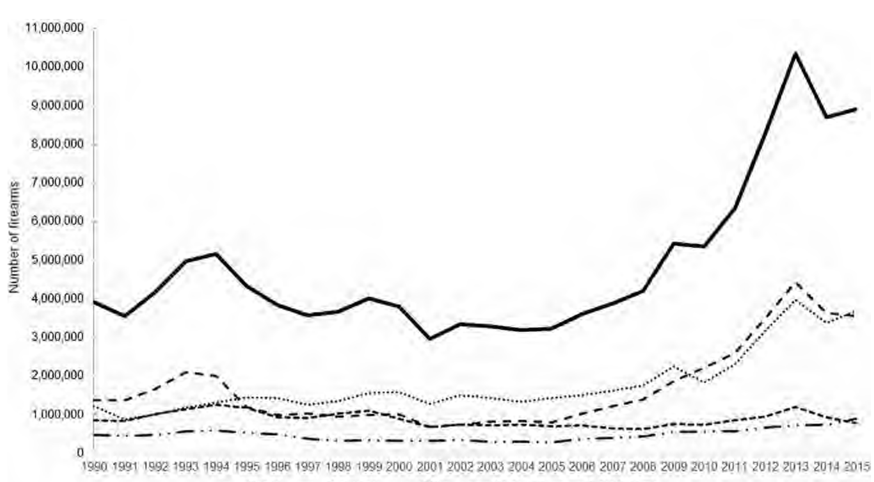

Figure 1. Domestic firearm production by type of weapon, 1990–2015.

Table 2. Domestic Pistol Production (Net Exports), by Caliber, U.S., 1990–2015

Year	Up to 0.22	Up to 0.25	Up to 0.32	Up to 0.380	Up to 9mm	Up to 0.50	Total
1990	351,456	239,345	56,297	172,051	348,679	203,599	1,371,427
1991	306,088	252,370	55,007	215,595	358,228	190,964	1,378,252
1992	352,621	253,955	50,916	371,095	468,182	172,768	1,669,537
1993	452,509	277,306	52,268	508,469	586,039	216,771	2,093,362
1994	449,495	119,769	25,972	313,915	750,693	344,454	2,004,298
1995	260,059	51,025	19,220	182,801	398,472	283,707	1,195,284
1996	206,485	41,156	20,709	166,089	319,696	233,393	987,528
1997	250,983	43,103	43,623	154,046	303,212	241,110	1,036,077
1998	184,836	50,936	62,338	98,266	284,374	279,615	960,365
1999	229,852	24,393	52,632	81,881	270,298	336,390	995,446
2000	184,577	23,198	60,527	108,523	287,329	340,197	1,004,351
2001	123,374	5,697	57,823	41,634	229,821	219,085	677,434
2002	146,221	10,009	54,000	59,476	205,197	268,113	743,016
2003	200,300	14,023	43,471	79,788	220,576	268,828	826,986
2004	211,913	10,140	32,444	68,319	209,650	304,551	837,017
2005	139,178	10,471	29,028	107,416	301,189	219,955	807,237
2006	141,653	9,627	39,205	126,939	352,646	351,474	1,021,544
2007	180,419	11,395	43,914	138,484	392,263	456,243	1,222,718
2008	195,653	14,622	40,487	278,945	421,746	435,896	1,387,349
2009	320,892	15,107	47,395	390,895	586,548	509,226	1,870,063
2010	374,505	21,722	39,792	616,310	631,028	528,869	2,212,226
2011	427,571	19,182	13,890	537,063	888,379	712,171	2,598,256
2012	675,736	9,853	11,248	582,645	1,226,756	982,627	3,488,865
2013	635,744	18,578	6,591	852,727	1,697,509	1,230,577	4,441,726
2014	427,370	19,097	10,499	873,168	1,270,425	1,035,489	3,636,048
2015	413,230	11,567	14,763	819,103	1,531,065	767,471	3,557,199

Source: Bureau of Alcohol, Tobacco, Firearms and Explosives. Annual Firearms Manufacturers and Export Reports, 1990-2015.[24]

20 manufacturers holding a combined 87.2% market share. Ruger and Smith & Wesson were the predominant pistol manufacturers in 2015 (combined 49% market share), and Remington and Ruger were the predominant rifle manufacturers (combined 39% market share).

Manufacturing trends were reflected both in National Instant Criminal Background Check System background check trends and in crime gun recovery patterns. Estimated firearm sales remained relatively steady from 1999 to 2006, but rose dramatically starting in 2007,

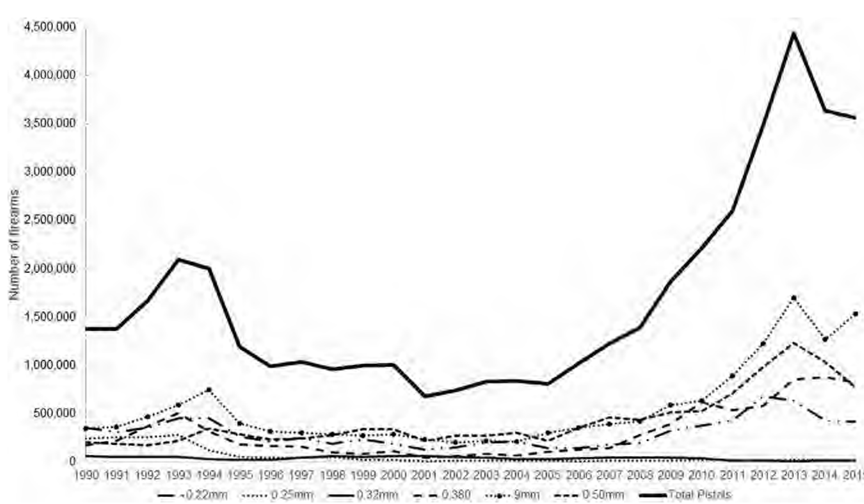

Figure 2. Domestic pistol production by caliber of weapon, 1990–2015.

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peaking in 2013 (Appendix Figure 2, available online). Crime trace data revealed an increase in recovered pistols between 2006 and 2015, with little change in rifles and a decline in revolvers and shotguns (Appendix Figure 3, available online). An analysis of recovered crime guns by caliber, which is available only for the period 2012–2015, revealed a decline in smaller caliber weapons and an increase in 0.380, 9-mm, and high caliber weapons (Appendix Table 3, available online).

DISCUSSION

To the best of the authors' knowledge, this is the first paper in the public health literature to examine trends in firearm manufacturing by weapon type, caliber, and company subsequent to 1999. There was a dramatic increase in domestic firearm production starting in 2005 and peaking in 2013, driven by the increased production of pistols and rifles. In particular, there was a marked increase in production of large caliber (0.380 and higher) pistols. The gun manufacturing market share is concentrated among a small number of companies, with the top five manufacturers holding 59% of the market in 2015.

The main implication of these findings is that there has been a large increase, especially since 2005, in the share of firearms produced that are of higher caliber and therefore greater lethality. In addition, the growing production of 0.380 pistols, which are generally compact, suggests a shift toward more-concealable weapons as well. Thus, firearm production has moved toward products designed to be more powerful and more concealable. This is evidenced by the shift from revolvers to pistols as well as the shift toward higher caliber pistols and smaller designs (the 0.380 pistol) that retain high power. Though a pistol's stopping power, or wounding potential, is also related to bullet speed, ammunition shape, and ammunition jacketing, it is generally the case that the power of these pistols increases as the categories progress because bullet diameter is strongly related to stopping power.[28–35] Koper[29] classified handgun calibers larger than 0.32 as being high stopping power handguns and noted that the 0.32 caliber dividing point is standard in the firearm literature.

Several studies have documented a connection between the lethality of weapon type and caliber and firearm injury frequency and severity.[28–35] Reedy and Koper[30] found that compared with revolvers, semiautomatic pistols result in a greater number of fired shots and a greater number of victims. Zimring[35] reported that larger caliber handguns are associated with a higher risk of fatal injury. Koper[28,29] reported an association between increased use of higher caliber weapons and increases in firearm homicide.

Although these data reflect trends in the overall entry of firearm types and calibers into the market, they are consistent with national trends in the recovery of crime guns. These trends are also consistent with an analysis of crime guns traced by the Chicago Police Department between 2001 and 2016, which revealed a decline in recovery of 0.22 caliber weapons (from 12.5% to 10% of recovered firearms), with an increase in 9-mm (from 18% to 29%) and 0.40 caliber weapons (from 2% to 13%) during the study period; both increases started in 2006.[36]

There is also empirical evidence that recent gun production trends have implications for crime because they reflect increasing numbers of guns or different types of guns making their way into the hands of high-risk possessors. Braga et al.[19] have shown that acute changes in retail sales have the potential to impact crime guns: Handguns sold at retail in a given year were over-represented by a factor of nearly five times in crime guns recovered the following year. Several studies have found a correlation between changes in the rate of retail gun sales and changes in rates of firearm homicide in subsequent years.[37–39]

The finding that firearm manufacturing is highly concentrated among a small number of companies is important because it suggests that the market may be driven by the practices of just a handful of companies. Therefore, changes in firearm design, safety, and marketing by these few companies could substantially affect the entire gun supply. For example, if just one or two companies could be convinced to begin producing "smart guns"—firearms that can only be operated by an authorized user—it is likely that such an innovation would spread through the market quickly.

By closely examining the firearm industry and its manufacturing practices, this paper builds on efforts to reframe gun violence as a societal public health problem rather than simply individual crimes, advancing a public health approach to the problem of firearm violence.

Limitations

This study has five central limitations. First, the ATF does not list imported firearms by handgun type or caliber. Thus, the estimates of total firearm commerce include only the crude categories of handguns, rifles, and shotguns. Second, the AFMER data include firearms produced for law enforcement agencies. Thus, it cannot be assumed that the observed trends are strictly related to civilian use. Third, the AFMER data do not provide any information about ammunition magazine capacities. Fourth, not all agencies provide guns to the ATF for tracing, which is voluntary, and tracing practices may change over time. Thus, changes in the composition of trace guns may reflect differences in tracing procedures over time in addition to differences in the actual composition of crime guns. Finally, this paper did not examine demand-side factors that may be contributing to increased firearm production and sales. Such an examination is beyond the scope of this analysis, but should be explored in future research.

CONCLUSIONS

Despite these limitations, the findings of this study have significant implications for finding working solutions to the problem of firearm violence. Further research is needed to determine whether industry marketing is contributing to a change in the demand for firearms and the cultural perception of guns in society.

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SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre.2017.05.002.

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TUFTS UNIVERSITY SCHOOL OF MEDICINE
CURRICULUM VITAE AND BIBLIOGRAPHY FORMAT
FOR CLINICAL FACULTY

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EDUCATION & TRAINING

Undergraduate

Year of Degree	*Degree*	*Institution, City, State or Country*	*Discipline*
1986	BA	Brown University, Providence, RI	Environmental studies

Graduate School and/or Medical School

Year of Degree	*Degree*	*Institution, City, State or Country*	*Discipline*
1990	MD	Yale University School of Medicine, New Haven, CT	Medicine
1992	MPH	University of California, Berkeley School of Public Health	Epidemiology

Postdoctoral Training

Internship and Residencies:

Years	*Institution, City, State or Country*	*Specialty*
1990-1991	Berkshire Medical Center, Pittsfield, MA	Medicine, PGY-I
1991-1993	University of California, Berkeley School of Public Health	Preventive Medicine residency

Fellowships:

Years	*Institution, City, State or Country*	*Specialty*
1993-1995	Centers for Disease Control and Prevention (CDC), Atlanta, GA	EIS program

Other Professional Training

Years *Institution, City, State or Country* *Discipline*
N/A

Licensure and Certification

Date *Location* *Certificate Number*
N/A

ACADEMIC APPOINTMENTS

Dates	*Title/Primary or Secondary*	*Department*	*Institution, City, State or Country*
August 1995 – September 1999	Assistant Professor	Department of Social and Behavioral Sciences	Boston University School of Public Health, Boston, MA

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September 1999 – February 2005	Associate Professor	Department of Social and Behavioral Sciences	Boston University School of Public Health, Boston, MA
February 2005 – August 2021	Professor	Department of Community Health Sciences	Boston University School of Public Health, Boston, MA
September 2021 - present	Professor	Department of Public Health and Community Medicine	Tufts University School of Medicine, Boston, MA

EMPLOYMENT

Dates	*Title/Position*	*Department*	*Institution, City, State or Country*
Summers, 1983-1986	Mayoral intern	Section of Environmental and Occupational Health	Danbury Health Department, Danbury, CT
June 1991 – May 1993	Part-time physician	Bureau of Alcohol and Drug Programs	Santa Clara County Health Department, San Jose, CA
July 1993 – July 1995	Epidemiology Fellow (EIS)	Office on Smoking and Health	Centers for Disease Control and Prevention (CDC), Atlanta, GA
August 1995 – September 1999	Assistant Professor	Department of Social and Behavioral Sciences	Boston University School of Public Health, Boston, MA
September 1999 – February 2005	Associate Professor	Department of Social and Behavioral Sciences	Boston University School of Public Health, Boston, MA
February 2005 – August 2021	Professor	Department of Community Health Sciences	Boston University School of Public Health, Boston, MA
September 2021 - present	Visiting Professor	Department of Public Health and Community Medicine	Tufts University School of Medicine, Boston, MA

ADMINISTRATIVE APPOINTMENTS

Dates	*Title*	*Department/Program*	*Institution, City, State or Country*
2008-2010	Concentration director	Department of Social and Behavioral Sciences	Boston University School of Public Health, Boston, MA

AWARDS AND HONORS

Dates	*Award/Honor*	*Organization, City, State or Country*
1996	Excellence in Teaching Award (SB733: Mass Communication and Public Health)	Boston University School of Public Health, Boston, MA
1998	Excellence in Teaching Award (SB815: Program Evaluation Research)	Boston University School of Public Health, Boston, MA
1999	Excellence in Teaching Award (SB815: Program Evaluation Research)	Boston University School of Public Health, Boston, MA
1999	Excellence in Teaching Award (SB733: Mass Communication and Public Health)	Boston University School of Public Health, Boston, MA
2001	Norman A. Scotch Award for Excellence in Teaching	Boston University School of Public Health, Boston, MA
2001	Co-author of Best Advertising Article award for 1996	American Marketing Association Advertising Special Interest Group
2001	Excellence in Teaching Award (SB733: Mass Communication and Public Health)	Boston University School of Public Health, Boston, MA
2002	Distinguished Professor Award	Flight Attendant Medical Research Institute, Miami, FL
2003	Excellence in Teaching Award (SB733: Mass Communication and Public Health)	Boston University School of Public Health, Boston, MA
2005	Excellence in Teaching Award (SB860: Strategies for Public Health Advocacy)	Boston University School of Public Health, Boston, MA
2005	Excellence in Teaching Award (SB822: Quantitative Methods for Program Evaluation)	Boston University School of Public Health, Boston, MA
2007	Excellence in Teaching Award (SB860: Strategies for Public Health Advocacy)	Boston University School of Public Health, Boston, MA

2007	Excellence in Teaching Award (SB733: Mass Communication and Public Health)	Boston University School of Public Health, Boston, MA
2009	Excellence in Teaching Award (SB860: Strategies for Public Health Advocacy)	Boston University School of Public Health, Boston, MA
2009	Excellence in Teaching Award (SB733: Mass Communication and Public Health)	Boston University School of Public Health, Boston, MA
2010	Educational Innovation Award	Boston University Medical Campus, Boston, MA
2010	Excellence in Teaching Award (SB721: Social and Behavioral Sciences for Public Health)	Boston University School of Public Health, Boston, MA
2011	Excellence in Teaching Award (SB721: Social and Behavioral Sciences for Public Health)	Boston University School of Public Health, Boston, MA
2011	Excellence in Teaching Award (SB860: Strategies for Public Health Advocacy)	Boston University School of Public Health, Boston, MA
2015	Excellence in Teaching Award (SB721: Social and Behavioral Sciences for Public Health)	Boston University School of Public Health, Boston, MA
2019	Lifetime Achievement Award	American Public Health Association, Alcohol, Tobacco, and Other Drugs section

INSTITUTIONAL COMMITTEE SERVICE

Dates	*Role/Committee*	*Department/Program*	*Institution, City, State or Country*
1995	Member, Information Technology Committee	School-wide	Boston University School of Public Health, Boston, MA
1996-2012	Member, Admissions Committee	School-wide	Boston University School of Public Health, Boston, MA
1996-1998	Institutional Liaison for Boston University School of Public Health and Boston University School of Medicine to the Association of Teachers of Preventive Medicine (ATPM)	Medical campus representative	Boston University Medical Center, Boston, MA
2002-2005	Member, Public Health Practice Committee	School-wide	Boston University School of Public Health, Boston, MA
2002-2005	Member, Student Life Committee	Social and Behavioral Sciences Department	Boston University School of Public Health, Boston, MA
2004-2007	Conflict of Interest Review Committee	Medical campus-wide	Boston University Medical Center, Boston, MA
2012-2018	Member, Curriculum Committee	School-wide	Boston University School of Public Health, Boston, MA
2014	Member, Community Health Sciences Department Chair Search Committee	School-wide	Boston University School of Public Health, Boston, MA
2018	Chair, Faculty Search Committee	Department of Community Health Sciences	Boston University School of Public Health, Boston, MA
2020-2021	Member, Appointments & Promotions Committee	School-wide	Boston University School of Public Health, Boston, MA
2020-2021	Member, Institutional Conflict of Interest Advisory Working Group	School-wide	Boston University School of Public Health, Boston, MA
September 2021 - present	Member, Departmental Research Committee	Department of Public Health and Community Medicine	Tufts University School of Medicine, Boston, MA

September 2021 - present	Member, Research Group on Equity in Health, Wealth, and Civic Engagement	University-wide	Tufts University

EXTERNAL COMMITTEE SERVICE

Local/Regional:

Dates	*Role*	*Organization*
1996-2000	Member	Massachusetts Coalition for a Healthy Future
1997-2000	Member	Massachusetts Coalition for a Health Future, Legislative Subcommittee
1997	Scientific consultant/advisor	BREATH (Bar and Restaurant Employees against Tobacco Hazards) and American Lung Association, Pleasant Hill, CA
1998-2000	Chair, Media Advisory Committee	Massachusetts Tobacco Oversight Council
2000-2004	Executive Board Member	Tobacco Control Research Center, Northeastern University, Boston, MA
2018-2019	Member, Smoking Subcommittee	Massachusetts Cannabis Control Commission

National:

Dates	*Role*	*Organization*
1996	Consultant/scientific advisor	American Lung Association, Washington, DC
1996-2000	Member, Board of Directors	Americans for Nonsmokers' Rights Foundation, Berkeley, CA
1996-1998	Member, Public Health Surveillance Committee	American Public Health Association
1996-1998	Member, Public Health Communication Committee	American Public Health Association
2019-2020	Member, Task Force on Developing a Firearm Violence Prevention Curriculum	Association of Schools and Programs of Public Health (ASPPH), Washington, DC
2021	Member, Messaging Working Group	Coalition to Stop Gun Violence

International:

Dates *Role* *Organization*
N/A

PROFESSIONAL SOCIETIES

Dates *Role/ Committee Assignment* *Organization/Membership*
N/A

GRANT REVIEW ACTIVITIES

Dates *Role* *Organization*
N/A

HEALTH-RELATED ADVOCACY & COMMUNITY SERVICE

Dates	*Organization, City, State or Country*	*Role*
1985 - 2010	Worked with multiple health coalitions at the state and local level to promote smoke-free bar and restaurant laws. Testified in support of smoke-free workplace laws in the following states and cities (partial list): California, Connecticut, Rhode Island, Massachusetts, Ontario (Toronto), San Diego, San Francisco, Oakland, Los Angeles, San Jose, Alameda (CA), Fremont (CA), Sausalito (CA), San Rafael (CA), Walnut Creek (CA), Berkeley (CA), Boston, Amherst (MA), Brookline (MA), Cambridge (MA)	Coalition advisor/consultant and lobbyist

1995-2000	Multiple local Boards of Health, Massachusetts	Policy advisor on tobacco control
1997 - present	Expert witness in public health litigation against tobacco, pharmaceutical, and chemical companies – Multiple law firms. Gave deposition and/or trial testimony in the following cases: • Norma R. Broin, et al v. Philip Morris Companies, Inc., et al, Case No. 91-49738 CA (22) (Circuit Court of the 11th Judicial Circuit, Dade County, Florida). Attorney: Stanley Rosenblatt • Howard A. Engle, et al v. Philip Morris Companies, Inc. et al, Case No. 94-08273 CA (22) (Circuit Court of the 11th Judicial Circuit, Dade County, Florida): Phases I, II, and III and Punitive Damages phase. Attorney: Stanley Rosenblatt • Dawn Apostolou v. The American Tobacco Company et al., Index No. 34734/00 (Supreme Court of the State of New York, County of Kings): Phases I and II. Attorney: Michael London • Antonio Badillo, et al, v. The American Tobacco Company, Inc., et al, CV-N-97-00573-ECR(RAM) (United States District Court, District of Nevada). Attorney: Perry Nicosia • Joseph Avallone, et al, v. The American Tobacco Company, Inc., et al, Docket No. L-4883-98, Case Code 241 (Superior Court of New Jersey, Middlesex County). Attorney: Perry Nicosia • Robert Murphy v. The American Tobacco Company, Inc., et al, CV-S-98-00021-HDM(RJR) (United States District Court, District of Nevada). Attorney: Perry Nicosia • People of the State of California, ex rel. Bill Lockyer, Attorney General of the State of California v. R.J. Reynolds Tobacco Company (Superior Court of California, County of San Diego). Attorney: Alan Lieberman • Julien Longden and Sheila Longden v. Philip Morris, Inc., et al., Docket No. 00-C-462 (Superior Court of New Hampshire, Hillsborough). Attorney: Chuck Douglas • Koenig vs. Wyeth, Inc., et al., Case No. 02-18165 CA 32 (Circuit Court of the 11th Judicial Circuit, Dade County, Florida). Attorney: Stanley Rosenblatt • Re: E.I. DuPont De Nemours and Company C8 Personal Injury Litigation, Case No. 2:13-MD-2433 (United States District Court, Southern District of Ohio, Columbus, Ohio). Attorney: Mike Papantonio [BARTLETT] - 2015 • Re: E.I. DuPont De Nemours and Company C8 Personal Injury Litigation, Case No. 2:13-MD-2433 (United States District Court, Southern District of Ohio, Columbus, Ohio). Attorney: Mike Papantonio [FREEMAN] - 2016 • Re: E.I. DuPont De Nemours and Company C8 Personal Injury Litigation, Case No. 2:13-MD-2433 (United States District Court, Southern District of Ohio, Columbus, Ohio). Attorney: Gary Douglas [VIGNERON] – 2016 • Re: E.I. DuPont De Nemours and Company C8 Personal Injury Litigation, Case No. 2:13-MD-2433 (United States District Court, Southern District of Ohio, Columbus, Ohio). Attorney: Gary Douglas [MOODY] – 2017 • Neal v. Monsanto. Co., No. 1722-CC10773. (Mo. Cir. Ct. St. Louis. City). Attorney: Robin Greenwald (deposition) • Winston v. Monsanto. Co., (Mo. Cir. Ct. St. Louis. City). Attorney: Robin Greenwald (deposition) • The City of Huntington and Cabell County Commission v. AmericasourceBergen Drug Corporation, et al., United States District Court, Southern District of West Virginia, Civil Action No. 3:17-01362. Attorney: Mike Papantonio (deposition) • Vapor Technology Association v. Baker, et al. Massachusetts Superior Court • Middlesex Water Company vs. 3M Company, United States District Court for the District of New Jersey. Deposition, July 19, 2021 • Aqueous Film-Forming Foams Products Liability Litigation, United States District Court for the District of South Carolina, Charleston Division. Deposition, May 20, 2022 • Multiple plaintiffs v. Monsanto. Co., (Mo. Cir. Ct. St. Louis City). Attorney: Robin Greenwald (deposition) • Multiple plaintiffs v. Syngenta. Attorney: Eric Kennedy (deposition) • Oregon Firearms Federation v. State of Oregon, United States District Court, District of Oregon. Attorney: Brian Marshall (Senior Assistant Attorney General) (deposition)	Expert witness

	• Oregon Firearms Federation v. State of Oregon, United States District Court, District of Oregon. Attorney: Brian Marshall (Senior Assistant Attorney General) (trial testimony)	
2019	Testified before Congress on Electronic Cigarette Policy: Hearing on Legislation to Reverse the Youth Tobacco Epidemic, Subcommittee on Health of the House Committee on Energy and Commerce, Washington, DC, October 16, 2019	Invited testimony

TRAINING OF STUDENTS/TRAINEES

Students/Mentees:

Dates	*Name of Student/Advisee*	*Level of Training*	*Role and Sponsor (if applicable)*	*Current Position of Advisee*
1997-1998	Jennifer Gonzalez	Master's	Dissertation advisor	Unknown
1998-1999	Linda Pucci	Master's	Research mentor/supervisor	Unknown
1998	Claudia Menashe	Master's	Research mentor/supervisor	Strategic Health Communications Expert, Brooklyn, NY
1999	Julie Lima	Master's	Research mentor/supervisor	Assistant Professor, Center for Gerontology and Healthcare Research, Brown University
2000	Jennifer Rosenberg	Master's	Research mentor/supervisor	Unknown
2002	Kaori Honjo	Master's	Research mentor/supervisor	Professor, Osaka Medical and Pharmaceutical University
2002-2003	Margie Skeer	Master's	Research mentor/supervisor	Weiner Hailey Family Professor, Department of Public Health and Community Medicine, Tufts University School of Medicine
2002-2003	Michelle Land	Master's	Fellowship preceptor	Director, Global HEOR at AmerisourceBergen/Xcenda
2003	Sarah George	Master's	Research mentor/supervisor	Director of Administration, Institute for Health System Innovation & Policy, Boston University
2003	Meg Stone	Master's	Research mentor/supervisor	Executive Director, IMPACT/Triangle, Cambridge, MA
2005	Michelle Deverell	Master's	Research mentor/supervisor	Unknown
2005	Catherine Randolph	Master's	Research mentor/supervisor	Unknown
2008	Brian Houle	Master's	Research mentor/supervisor	Assistant Professor, Department of Sociology, Australian National University
2008	Justin Nyborn	Master's	Research mentor/supervisor	Evidence Generation Lead, Lung Cancer, Takeda, Cambridge, MA
2008	Siphannay Nhean	Master's	Research mentor/supervisor	Research Analyst, College of Health Sciences and Human Services, California State University Monterey Bay
2008	Kimberly Wukitsch	Master's	Research mentor/supervisor	HealthyPeople.gov Program Manager, Office of Disease Prevention and Health Promotion, U.S. Department of Health and Human Services
2008	Laura Wulach	Master's	Research mentor/supervisor	Unknown
2008-2010	Allison McGrath Higgins	Doctoral	Dissertation advisor	Lecturer, Merrimack College
2010	Joanna DiLoreto	Master's	Research mentor/supervisor	Unknown
2010	Andrea Johnson	Master's	Research mentor/supervisor	Unknown
2010	Noreen Giga	Master's	Research mentor/supervisor	Research Manager, Abdul Lateef Jameel Poverty Action Lab, Cambridge, MA

2010	Kerry Tanwar	Master’s	Research mentor/supervisor	Program Coordinator, Maternal and Child Health Research Program, Harvard T.H. Chan School of Public Health
2010	Kathleen Wood	Master’s	Research mentor/supervisor	Unknown
2010	Tiana Wilkinson	Master’s	Research mentor/supervisor	Social Determinants of Health and Equity Program Manager at PacificSource Health Plans, Portland, OR
2010	Elizabeth Gentry	Master’s	Research mentor/supervisor	Unknown
2011	Danielle Hinchey	Master’s	Research mentor/supervisor	Director of Performance Improvement at Delaware Psychiatric Center
2011	Heather Valerio	Master’s	Research mentor/supervisor	Doctoral student, Viral hepatitis clinical research program, The Kirby Institute, University of New South Wales, Sydney
2011	Katie Poirier	Master’s	Research mentor/supervisor	Unknown
2011	Kathryn Kinzel	Master’s	Research mentor/supervisor	Epidemiologist, Massachusetts Department of Public Health
2011	Kelsey Chen	Master’s	Research mentor/supervisor	Physician
2011	Jessica Kenney	Master’s	Research mentor/supervisor	Global health professional
2011	Jessica Ruhlman-Shoaff	Master’s	Research mentor/supervisor	Division of Chronic Disease Research Across the Lifecourse, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute
2012	Theodora Swenson	Undergraduate	Research mentor/supervisor	Program Manager, Active Design at New York City Department of Health and Mental Hygiene
2012	Amanda Barbeau	Master’s	Research mentor/supervisor	Program Officer, Patient-Centered Outcomes Research Institute, Washington, DC
2012	Jen Burda	Master’s	Research mentor/supervisor	Daughters of Nazareth
2012	Kathryn Power	Master’s	Research mentor/supervisor	Community Relations and Policy Manager at Partnership HealthPlan of California, San Francisco, CA
2012	Mark Lohsen	Doctoral	Research mentor/supervisor	Research Associate, 1Globe Health Institute, Norwood, MA
2012	Jody Grundman	Master’s	Research mentor/supervisor	Pediatric endocrinology fellow, Children’s National Hospital, Washington, DC
2011-2012	Jane Binakonsky	Doctoral	Research mentor/supervisor	Unknown
2013	Kalé Kponee	Master’s	Research mentor/supervisor	Associate at Analysis Group Inc., and Adjunct Lecturer in Epidemiology at Harvard University
2013	Yamrot Negussie	Master’s	Research mentor/supervisor	Research Associate, The National Academy of Sciences, Engineering, and Medicine, Washington, DC
2013	Jane Pleskunas	Master’s	Research mentor/supervisor	Epidemiology researcher, Boston Medical Center
2013	Sarah Vanture	Master’s	Research mentor/supervisor	Unknown
2013-2015	Sarah Roberts	Master’s	Research mentor/supervisor	Currently applying to medical school
2013	Amanda Ayers	Master’s	Research mentor/supervisor	Associate Director, Center for Wellness and Health Promotion, Harvard University Health Services
2013	Korene Stamatakos	Master’s	Research mentor/supervisor	Solution Implementation Manager at Learning Solutions from Syneos Health, Cary, NC
2013	Ashley Fryer	Master’s	Research mentor/supervisor	Clinical Social Worker

2014	Catherine O'Doherty	Master's	Research mentor/supervisor	Unknown
2014	Marisa Castrini	Master's	Research mentor/supervisor	Senior Value-Based Care Analyst, SOHO Health
2014	Catherine Morse	Master's	Research mentor/supervisor	Unknown
2014	Alex de Groot	Master's	Research mentor/supervisor	Biostatistician, Intuitive Surgical, Sunnyvale, CA
2014	Cynthia Retamozo	Master's	Research mentor/supervisor	Health Care Data Analyst, Commonwealth Medicine, University of Massachusetts Medical School, Worcester, MA
2015	Lucero Leon-Chi	Master's	Research mentor/supervisor	Epidemiologist, Massachusetts Department of Public Health
2015	Ashley Galloway	Master's	Research mentor/supervisor	Research assistant, VA Boston Healthcare System
2016	Dan Aaron	Doctoral	Research mentor/supervisor	Attorney, Office of the General Counsel, United States Food and Drug Administration (FDA)
2016	Tori Smith	Undergraduate	Research mentor/supervisor	Researcher, RTI
2016	Carolina Diez	Undergraduate	Research mentor/supervisor	Member Experience Coordinator, Neighborhood PACE, Boston, MA
2017	Aldina Mesic	Master's	Research mentor/supervisor	PhD student at University of Washington and Global Health Scholar at Fogarty International Center, NIH
2017	Lydia Franklin	Undergraduate	Research mentor/supervisor	Research Coordinator, CommunicateHealth, Northampton, MA
2017	Alev Cansever	Undergraduate	Research mentor/supervisor	Community Residence Counselor, McLean Hospital
2017	Fiona Potter	Undergraduate	Research mentor/supervisor	Currently applying to medical school
2017-2018	Anita Knopov	Doctoral	Research mentor/supervisor	Emergency medicine resident, Brown University
2017	Anika Sharma	High school	Research mentor/supervisor	Undergraduate student, Boston University College of Engineering
2017	Tessa Collins	Undergraduate	Research mentor/supervisor	Master of Health Science in Community and Global Health student at Clark University
2017	Gopal Amin	Doctoral	Research mentor/supervisor	Unknown
2014-2017	Brittany Chen	Doctoral	Dissertation advisor	Managing Director, Health Equity, Health Resources in Action
2018	Benjamin Solomon	Master's	Research mentor/supervisor	Member Experience Coordinator, Ro, New York, NY
2018	Julia Campbell	Master's	Research mentor/supervisor	Doctoral student at UNC Gillings Global School of Public Health
2018	Faizah Shareef	Doctoral	Research mentor/supervisor	Medical student, Boston University School of Medicine
2019	Brooke Wong	Undergraduate	Research mentor/supervisor	Student at American University; research assistant at the Behavioral Health and Well-Being Lab
2019	Serena Bernstein	High school	Research mentor/supervisor	Undergraduate student
2019	Max Goder-Reiser	Doctoral	Research mentor/supervisor	Medical student at Boston University School of Medicine
2020	Devon Dunn	Master's	Research mentor/supervisor	Epidemiologist, Massachusetts Department of Public Health
2020-2021	Isabella Critchfield-Jain	Undergraduate	Research mentor/supervisor	Undergraduate student at Boston University
2020-2021	Matthew Boykin	Master's	Research mentor/supervisor	Biostatistician, University of North Carolina at Chapel Hill
2020-2021	Alicia Owens	High school	Research mentor/supervisor	Currently applying to undergraduate institutions

2020-2021	Rebecca Muratore	Master's	Research mentor/supervisor	MPH student at Boston University School of Public Health
2020-2021	Taiylor Nunn	Master's	Research mentor/supervisor	MPH student at Boston University School of Public Health
2020-2021	Joanne Oh	High school	Research mentor/supervisor	High school student at Concord Academy
2020-2021	Amanda Katchmar	Master's	Research mentor/supervisor	Student at Boston University School of Public Health
2020-2021	Miriam Neufeld	Post-doctoral	Research fellowship supervisor	Department of Surgery research fellow, Boston University School of Medicine
2021	Grace Ye	Post-doctoral	Research fellowship supervisor	Pediatric emergency medicine fellow, Boston University School of Medicine
2021	Emily Belt	Undergraduate	Thesis advisor	Student, Brown University
2021	Kaisaier Yimuran	Master's	Directed study preceptor	Student, Tufts MPH program
2022	Amani Dharani	Master's	Directed study preceptor	Student, Tufts MPH program
2022	Emma Wiklund	Master's	Applied learning experience preceptor	Student, Tufts MPH program
2022	Carly Amon	Doctoral	Research intern advisor	Student, Tufts University School of Medicine
2022	Kathleen Grene	Doctoral	Research year preceptor	Student, Tufts University School of Medicine MD/MPH program
2022	Hannah Rieders	Undergraduate	Research internship supervisor	Student, Mt. Holyoke College
2022	Madeline Rieders	Undergraduate	Research internship supervisor	Student, Mt. Holyoke College
2022	Joanne Oh	High school	Research internship supervisor	Student, Concord Academy
2022	Jinan Moumneh	Master's	Research internship supervisor	Student, Tufts MPH program
2022	Julia Asfour	Master's	Directed study preceptor	Student, Tufts MPH program
2022	Bliss Rose	Master's	Applied learning experience preceptor	Student, Tufts MPH program
2023	Hannah Rieders	Doctoral	Research internship supervisor	Student, University of Michigan
2023	Madeline Rieders	Doctoral	Research internship supervisor	Student, University of Michigan
2023	Leighla Dergham	Master's	Research internship supervisor	Student, Tufts MPH program
2023	Ronan Iyer	Master's	Research internship supervisor	Student, Tufts MPH program

Postdoctoral Trainees:

Past/Current Trainee	*Trainee Name (Where Training Occurred)*	*Postdoc Research Training Period*	*Prior Academic Degree(s)*	*Prior Academic Degree Year(s)*	*Prior Academic Degree Institution(s)*	*Title of Research Project*	*Current Position of Past Trainees / Source of Support of Current Trainees*
Sebastian Ramos	Tufts University School of Medicine	2023-2024	MD			Structural Racism and Racial Disparities in Reproductive Health Outcomes	CTSI KL-2

EDUCATIONAL ACTIVITIES

Dates	*Role/Course or Program Title (if applicable)*	*Department*	*Institution City, State or Country*
Spring 1995	Instructor / Strategies to reduce tobacco use	Social and Behavioral Sciences	Boston University School of Public Health
Summer 1995	Instructor / Tobacco Control Summer Institute (Clean indoor air laws)	School of Public Health	University of North Carolina, Chapel Hill, NC
Spring 1996	Instructor / Strategies to reduce tobacco use	Social and Behavioral Sciences	Boston University School of Public Health
Summer 1996	Instructor / Strategies to reduce tobacco use	Social and Behavioral Sciences	Boston University School of Public Health
Summer 1996	Instructor / Tobacco Control Summer Institute (Clean indoor air laws)	School of Public Health	St. Louis University, St. Louis, MO
Spring 1996	Instructor / Program evaluation research	Social and Behavioral Sciences	Boston University School of Public Health
Fall 1996	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Fall 1997	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Fall 1997	Instructor / Program evaluation research	Social and Behavioral Sciences	Boston University School of Public Health
Spring 1998	Instructor / Program evaluation research	Social and Behavioral Sciences	Boston University School of Public Health
Summer 1998	Instructor / Tobacco Control Summer Institute (Clean indoor air laws)	School of Public Health	University of New Mexico, Albuquerque, NM
Summer 1998	Instructor / Program evaluation research	Social and Behavioral Sciences	Boston University School of Public Health
Fall 1998	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Fall 1998	Instructor / Program evaluation research	Social and Behavioral Sciences	Boston University School of Public Health
Spring 1999	Instructor / Public health advertising and video production	Social and Behavioral Sciences	Boston University School of Public Health
Fall 1999	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2000	Instructor / Program evaluation research	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2000	Instructor / Public health advertising and video production	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2000	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2001	Instructor / Public health advertising and video production	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2001	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2002	Instructor / Public health advertising and video production	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2002	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2003	Instructor / Public health advertising and video production	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2003	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2004	Instructor / Public health advertising and video production	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2004	Instructor / Strategies for public health advocacy	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2005	Instructor / Strategies for public health advocacy	Social and Behavioral Sciences	Boston University School of Public Health

Summer 2005	Instructor / Quantitative methods for program evaluation	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2005	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2006	Instructor / Strategies for public health advocacy	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2006	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2007	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2007	Instructor / Strategies for public health advocacy	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2007	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2007	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2008	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2008	Instructor / Strategies for public health advocacy	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2008	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2008	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2009	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2009	Instructor / Strategies for public health advocacy	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2009	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2009	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2010	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2010	Instructor / Strategies for public health advocacy	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2010	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2010	Instructor / Mass communication and public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2011	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2011	Instructor / Strategies for public health advocacy	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2011	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2012	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2012	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2013	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2013	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Spring 2014	Instructor / Social and behavioral sciences for public health	Social and Behavioral Sciences	Boston University School of Public Health
Fall 2014	Instructor / Social and behavioral sciences for public health	Community Health Sciences	Boston University School of Public Health
Spring 2015	Instructor / Social and behavioral sciences for public health	Community Health Sciences	Boston University School of Public Health
Fall 2015	Instructor / Social and behavioral sciences for public health	Community Health Sciences	Boston University School of Public Health

Spring 2016	Instructor / Social and behavioral sciences for public health	Community Health Sciences	Boston University School of Public Health
Fall 2016	Instructor / Social and behavioral sciences for public health	Community Health Sciences	Boston University School of Public Health
Spring 2017	Instructor / Social and behavioral sciences for public health	Community Health Sciences	Boston University School of Public Health
Fall 2017	Instructor / Strategies for public health advocacy	Community Health Sciences	Boston University School of Public Health
Spring 2018	Instructor / Strategies for public health advocacy	Community Health Sciences	Boston University School of Public Health
Fall 2018	Instructor / Strategies for public health advocacy	Community Health Sciences	Boston University School of Public Health
Spring 2019	Instructor / Strategies for public health advocacy	Community Health Sciences	Boston University School of Public Health
Fall 2019	Instructor / Strategies for public health advocacy	Community Health Sciences	Boston University School of Public Health
Spring 2020	Instructor / Strategies for public health advocacy	Community Health Sciences	Boston University School of Public Health
Fall 2020	Instructor / Individual, community, and population health	Community Health Sciences	Boston University School of Public Health
Fall 2020	Instructor / Strategies for public health advocacy	Community Health Sciences	Boston University School of Public Health
Spring 2021	Instructor / Strategies for public health advocacy	Community Health Sciences	Boston University School of Public Health
Fall 2021	Instructor / Communication theory: from principles to practice	Public Health and Community Medicine	Tufts University School of Medicine
Spring 2022	Instructor / Public health action: programs, policy, and advocacy	Public Health and Community Medicine	Tufts University School of Medicine
Summer 2022	Co-instructor / Public health field experience (MD/MPH)	Public Health and Community Medicine	Tufts University School of Medicine
Summer 2022	Instructor / Public health action: programs, policy, and advocacy	Public Health and Community Medicine	Tufts University School of Medicine
Fall 2022	Instructor / Behavioral sciences for public health	Public Health and Community Medicine	Tufts University School of Medicine
Spring 2023	Instructor / Public health assessment	Public Health and Community Medicine	Tufts University School of Medicine
Spring 2023	Instructor / Social marketing	Public Health and Community Medicine	Tufts University School of Medicine

PRACTICE ACTIVITIES & INNOVATIONS

Dates *Activity* *Sponsor/Institution*
N/A

VISITING PROFESSORSHIPS & INVITED ACADEMIC PRESENTATIONS

Visiting Professorships

Dates *Department* *Institution* *City, State or Country*
N/A

Invited Academic Presentations

Local/Regional:

Dates	*Presentation Title*	*Presentation Type*	*Institution*	*City, State or Country*
1995	The effect of tobacco advertising on youth smoking	Oral	Massachusetts Department of Public Health (Protecting Youth from Tobacco Conference)	Andover, MA

1995	Tobacco and the Latino community	Oral	Latino Health Institute	Boston, MA
1996	The power of mass communication to promote health	Oral	Boston University School of Public Health, Public Health Forum	Boston, MA
1996	Keynote - Massachusetts Tobacco Control Conference	Keynote speaker	Massachusetts Department of Public Health	Marlboro, MA
1996	The state of tobacco control	Oral	Boston University School of Medicine Cancer Prevention and Control Grand Rounds	Boston, MA
1997	The Tobacco Settlement: The thrill of victory or the agony of defeat?	Oral	Boston University School of Public Health, Public Health Forum	Boston, MA
1997	Global tobacco settlement: Public health victory or resounding defeat?	Oral	Preventive Medicine Grand Rounds, Carney Hospital	Dorchester, MA
1998	The societal costs of welfare "reform"	Oral	Boston University School of Public Health, Public Health Forum	Boston, MA
1999	Marketing public health: Strategies to promote social change	Oral	Massachusetts Prevention Centers, annual conference	Marlboro, MA
1999	The effects of the Massachusetts anti-tobacco media campaign on youth tobacco use	Oral	Cancer Prevention and Control Grand Rounds, Boston University School of Medicine	Boston, MA
1999	Marketing public health: Strategies to promote social change	Plenary session address	Annual conference of the New York State Public Health Association / New York State Association of County Health Officials	Cooperstown, NY
2000	Smoking and fast cars: The use of motor sports sponsorship as a promotional tool	Oral	Cancer Prevention and Control Grand Rounds, Boston University School of Medicine	Boston, MA
2001	Circumventing the cigarette television advertising ban: A review of tobacco industry sponsorship of motor sports events	Oral	Harvard University, Tobacco Control Working Group	Cambridge, MA
2002	Banning smoking in bars and restaurants: Protecting the public's health or infringing on civil liberties?	Oral	Boston University, Food for Thought Lecture Series	Boston, MA
2003	Smoking in bars: The last frontier?	Oral	Cancer Prevention and Control Grand Rounds, Boston University School of Medicine	Boston, MA
2003	Boston's smoking ban: Chaos or compliance?	Oral	Harvard University, Tobacco Control Working Group	Cambridge, MA
2005	News for a change (media advocacy training)	Oral	American Cancer Society	Framingham, MA
2006	Media advocacy training	Oral	Massachusetts Department of Public Health	Boylston, MA
2006	Media advocacy training	Oral	Massachusetts Department of Public Health	Boston, MA
2007	Tobacco advertising and health disparities	Oral	STOMP (Stomp Tobacco Out Mass People) Symposium, Massachusetts Department of Health	Boston, MA
2010	Top 10 myths about health care reform	Oral	Lifetime Learning – The Dr. George Altman World Affairs and Politics Lecture Series	Newton, MA
2011	Underage drinking and the media	Oral	Norfolk District Attorney Underage Drinking Prevention Conference	Wrentham, MA

2013	Alcohol, tobacco, and firearms: From science to policy	Oral	Boston University School of Medicine, Department of Pediatrics, Grand Rounds	Boston, MA
2013	Interrogation research by Yale medical school faculty members: Ethical and human subjects protection concerns	Oral	Yale University, Knowledge and Power: A conversation about the Military and National Security in Academia	New Haven, CT
2013	Rebel with a cause: Harnessing the core values of adolescence to prevent substance abuse	Oral	Massachusetts Department of Public Health, School Health Conference	Boston, MA
2014	What's in a brand? How an understanding of what brands youth are drinking can help identify effective interventions	Oral	9th Annual New England School Safety Conference	Norwood, MA
2015	Should medical providers recommend e-cigarettes to their patients as a smoking cessation tool?	Oral	Pearls for Practice: The Fourth Annual MASAM (Massachusetts chapter of the American Society of Addiction Medicine) Addiction Medicine Risk Management Course for All Providers	Waltham, MA
2017	Breaking the gridlock in the firearm debate: Is there common ground?	Oral	Boston University, Rhett Talks program	Boston, MA
2018	Reducing firearm violence: How research can play a role	Oral	Boston University, Management Town Meeting	Boston, MA
2021	Effects of flavored electronic cigarette bans: What does the evidence show?	Oral	Vermont Center on Behavior and Health, Annual Conference (online)	Burlington, VT (via Zoom)
2022	Why New Jersey? Explaining differences between states in the racial disparity in infant mortality	Oral	Department of Ob/Gyn (grand rounds), Tufts University School of Medicine	Boston, MA (via Zoom)
2022	Why New Jersey? Explaining differences between states in the racial disparity in infant mortality	Oral	Health Equity Research Cluster Symposium, Tufts University	Boston, MA (via Zoom)
2023	Finding Common Ground with Gun Owners on Gun Safety Policy	Oral	DC Interfaith Gun Violence Prevention Group	Chevy Chase, MD (via Zoom)

National:

Dates	*Presentation Title*	*Presentation Type*	*Institution*	*City, State or Country*
1993	The role and effectiveness of tobacco control policies	Oral - Panel	National Cancer Institute (ASSIST training course)	Washington, DC
1994	The role of government in tobacco control and the effects of preemption on protection of the public from environmental tobacco smoke exposure	Oral - Panel	The Wellness Foundation (California Preemption Education Conference)	San Diego, CA
1994	The evaluation of public health programs	Oral - Panel	Centers for Disease Control and Prevention, National Center for Health Promotion and Disease Prevention (Chronic Disease Conference)	Washington, DC

1995	Tobacco prevention: Connecting for the future	Oral	National Cancer Institute (ASSIST Information Exchange Training)	Washington, DC
1996	Preemption in tobacco control	Oral	The 1st Annual Conference on Local Control	Chicago, IL
2007	Science, communication, and scientific integrity: The example of secondhand smoke; and Balancing health and autonomy in public health policy: The example of car smoking bans	Oral	Freedom, Tolerance, and Civil Society Conference (sponsored by Institute for Humane Studies, George Mason University)	Boston, MA
2008	Science, communication, and scientific integrity: The example of secondhand smoke; and Balancing health and autonomy in public health policy: The example of car smoking bans	Oral	Freedom, Tolerance, and Civil Society Conference (sponsored by Institute for Humane Studies, George Mason University)	Boston, MA
2010	Evidence-based science and regulation of tobacco products	Oral	Tobacco Merchants Association Annual Meeting and Conference	Williamsburg, VA
2011	Can modified risk tobacco products serve the public's health? Two barriers stand in the way	Oral	Food and Drug Law Institute, Tobacco Regulation and Litigation Conference	Washington, DC
2012	Top ten myths regarding harmful and potentially harmful tobacco constituents; and Top two myths regarding the modified risk tobacco products provisions of the Tobacco Act	Oral	Tobacco Merchants Association National Meeting and Conference	Williamsburg, VA
2013	The nexus of science and law in tobacco control policy	Keynote address	The American Journal of Law & Medicine 2013 Symposium, Boston University School of Law	Boston, MA
2013	Success rates for nicotine replacement therapy; and Medicinal and lifestyle nicotine products: What works?	Oral	Tobacco Merchants Association Annual Meeting and Conference	Williamsburg, VA
2013	Electronic cigarettes: Youth use	Oral	Tobacco Merchants Association Meeting: FDA Regulation of Electronic Cigarettes	Leesburg, VA
2014	The safety of electronic cigarettes: What do we know in 2014?	Oral	Tobacco Merchants Association Annual Meeting and Conference	Williamsburg, VA
2014	Should physicians recommend electronic cigarettes for their smoking patients?	Plenary debate	Association for Medical Education and Research in Substance Abuse (AMERSA), Annual Conference	San Francisco, CA
2014	Behavioral study of cigarette and tobacco substitution	Oral	Tobacco Merchants Association, E-Vapor Research Collaborative Funding Conference	Leesburg, VA
2015	Electronic cigarettes and harm reduction	Panel	Drug Policy Alliance, Annual Drug Policy Reform Conference	Washington, DC
2016	Electronic cigarettes: Why we can't handle the truth	Oral	Responsible Retailing Forum, Annual Meeting	Boston, MA
2016	Electronic cigarettes: Why we can't handle the truth	Oral	National Tobacco Harm Reduction Conference	New York, NY (via Skype)

2016	Forced to lie: The marketing implications of the FDA's deeming regulations for electronic cigarettes	Oral	Tobacco Merchants Association, Regulations for E-Cigarettes, National Conference	Alexandria, VA
2017	Impact of state concealed carry permitting legislation on homicide rates	Oral	American State Legislators for Gun Violence Prevention (ASLGVP), Fourth Annual Policy Summit	Boston, MA
2018	Precision dissemination: 10 critical steps in 10 minutes	Oral	Robert Wood Johnson Foundation, Sharing Knowledge Conference	Chandler, AZ
2019	What does it mean to say that firearm violence is a public health issue?	Oral	Robert Wood Johnson Foundation, Sharing Knowledge Conference	Houston, TX
2021	Strategies for leading politically sensitive research: Real world examples and approaches	Oral	Robert Wood Johnson Foundation, RELEVANT Conference (online)	Via Zoom
2022	Gun violence is a public health problem: What does that actually mean?	Oral	State Legislative Leaders Foundation, 2022 Fall Leadership Summit	Boston, MA
2022	Another Gun Policy Platform? So What?	Oral	97Percent Foundation Annual Conference	Via Zoom
2023	Bridging the Divide Between Gun Owners and Non-Gun Owners: Results from the National Lawful Use of Guns Survey (NLUGS)	Oral	Health and Medical Care Archive (ICPSR) Webinar	Via Zoom

International:

Dates	*Presentation Title*	*Presentation Type*	*Institution*	*City, State or Country*
N/A				

MAJOR RESEARCH INTERESTS

My research has focused on three major areas: tobacco, alcohol, and firearms. Tying these fields of research together is the broad goal of trying to confront the influence of powerful corporations on the public's health. Within the tobacco control field, my research has included study of the health effects of active smoking, the health effects of secondhand smoke, evaluation of policies to reduce youth smoking and enhance smoking cessation, the effect of cigarette advertising on youth smoking behavior, and the potential role of electronic cigarettes as a harm reduction strategy in tobacco control. My major research accomplishments include being the first to definitively link smoking and acute myeloid leukemia, initiating research into the health effects of secondhand smoke on bar and restaurant workers, and pioneering the field of brand-specific research in tobacco control. In the alcohol field, my work has focused on studying the effect of alcohol advertising and marketing practices on drinking behavior among underage youth. I helped to initiate the field of brand-specific alcohol research and my research team was the first to identify the specific brands of alcohol being consumed by underage youth and link these brand choices to brand-specific alcohol advertising exposure. In the area of firearm violence prevention, my work has focused on evaluating the impact of state firearm laws on rates of firearm violence, studying gun culture, trying to find common ground between gun owners and non-gun owners to bridge the seemingly intractable divide in public discourse, and identifying ways to engage gun owners in gun violence prevention. Most recently, I have developed a research program in racial health inequities, focusing on studying the impact of structural racism on racial disparities in a number of health outcomes, including police shootings, overall firearm homicide, COVID-19 mortality, and COVID-19 vaccination. My research team developed one of the few existing measures of state-level structural racism and demonstrated that the Black state structural racism index and the Hispanic state structural racism index that we created are both strongly associated with differences between states in the magnitude of the Black-White and Hispanic-White disparity in rates of COVID-19 vaccination. I now hope to extend these structural racism indices to the county and city levels and to create a longitudinal database that can be used to evaluate the impact of interventions designed to reduce racial health inequities.

RESEARCH SUPPORT

Dates	*Grant Title*	*PI Name*	*Funding Source*	*Grant Number*	*Amount*	*Role*
1997-1998	Cigarette Advertising in Magazines and Youth Smoking Behavior	Michael Siegel	Massachusetts Department of Public Health (DPH)	N/A	$64,000	Principal Investigator
1997-1999	Influence of Tobacco Marketing and Counter-advertising on Smoking Initiation among Youth	Michael Siegel	Robert Wood Johnson Foundation (RWJF)	031587	$200,000	Principal Investigator
1998-2001	The Tobacco Industry Sponsorship Research Project	Michael Siegel	American Cancer Society (ACS)	RPG-98-264-01-PBP	$251,000	Principal Investigator
2000-2004	Denormalizing Smoking via Policy and Media Interventions	Lois Biener and Michael Siegel	NIH/National Cancer Institute (NCI)	5 R01 CA86257-01	$4,139,027	Co-Principal Investigator
2002-2005	Protecting Workers and the Public from Secondhand Smoke: The Impact of Clean Indoor Air Policies on Secondhand Smoke Exposure and Smoking Behavior	Michael Siegel	Flight Attendant Medical Research Institute (FAMRI)	N/A	$651,000	Principal Investigator
2004-2007	Tobacco Use Trajectories Amid Fluctuating State Program Budgets	Lois Biener and Michael Siegel	NIH/National Cancer Institute (NCI)	R01 CA86257-05	$1,771,053	Co-Principal Investigator
2011-2015	Alcohol Brand Research among Underage Drinkers	David Jernigan and Michael Siegel	NIH/National Institute on Alcoholism and Alcohol Abuse (NIAAA)	R01 AA020309-01	$1,570,267	Multiple Principal Investigator
2016-2017	Building a Culture of Health around Firearms: The Relationship between Social Gun Culture, Gun Ownership, Firearm Policy, and Firearm Violence	Michael Siegel	Robert Wood Johnson Foundation (RWJF)	73337	$486,426	Principal Investigator
2017-2019	The Impact of State-Level Firearms Laws on Homicide Rates by Race/Ethnicity	Michael Siegel	National Institute of Justice (NIJ)	2016-MU-MU-0047	$610,000	Principal Investigator
2018-2021	Identifying Shared Values to Support an Inclusive Culture of Health around Firearms: What Communication Messages Work?	Michael Siegel	Robert Wood Johnson Foundation (RWJF)	76132	$599,413	Principal Investigator
2022	Finding the So-Called Common Ground in Gun Safety	Michael Siegel	The 97 Percent Foundation	1	$149,614	Principal Investigator

EDITORIAL BOARDS

Dates	*Role*	*Board/Publication Name*
1996-2000	Consulting editor for methods/statistics	Tobacco Control (journal)

AD HOC JOURNAL REVIEWER

Publication Name (partial list)

American Journal of Public Health, JAMA, New England Journal of Medicine, Pediatrics, Archives of Internal Medicine, American Journal of Epidemiology, Journal of Public Health Policy, Tobacco Control, American Journal of Preventive Medicine, Preventive Medicine, Journal of Health Communication, Journal of Studies on Alcohol and Drugs, Injury Epidemiology, Injury Prevention, Addiction, JAMA Pediatrics, American Journal of Drug and Alcohol Abuse, Substance Abuse, Substance Use and Misuse, Alcohol and Alcoholism, Nicotine and Tobacco Research, Journal of Racial and Ethnic Health Disparities

PATENTS

Year Awarded *Patent Number* *Description*
N/A

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a) *Refereed Publications:*

1) **Siegel M**, Rieders M, Rieders H, Moumneh J, Asfour J, Oh J, Oh S. Structural racism and racial health disparities at the state level: A latent variable approach. *Journal of the National Medical Association* 2023 (in press).
2) Grene K, Dharani A, **Siegel M**. Gun violence prevention policy: Perceived and actual levels of gun owner support. *Preventive Medicine Reports* 2023 (in press).
3) **Siegel M**, Rieders M, Rieders H, Moumneh J, Asfour J, Oh J, Oh S. Using a latent variable method to develop a composite, multidimensional measure of structural racism at the city level. *Journal of Racial and Ethnic Health Disparities* 2023 (in press).
4) Grene K, Dharani A, **Siegel M**. Gun owners' assessment of gun safety policy: Their underlying principles and detailed opinions. *Injury Epidemiology* 2023 (in press).
5) **Siegel M,** Wiklund E. The relationship between state-level structural racism and disparities between the non-Hispanic Black and non-Hispanic White populations in multiple health outcomes. *Journal of the National Medical Association* 2023;115(2):207-222.
6) **Siegel M**, Rieders M, Rieders H, Moumneh J, Asfour J, Oh J, Oh S. Measuring structural racism and its association with racial disparities in firearm homicide. *Journal of Racial and Ethnic Health Disparities*. Published December 12, 2022. https://doi.org/10.1007/s40615-022-01485-2.
7) Liu Y, **Siegel M**, Sen B. Association of state-level firearm-related deaths with firearm laws in neighboring states. *JAMA Network Open* 2022;5(11):e2240750. https://dx.doi.org/10.1001/jamanetworkopen.2022.40750.
8) Katchmar A, Shafer P, **Siegel M**. Analysis of state portrayals of the risks of e-cigarette use and the cause of the EVALI outbreak. *Harm Reduction Journal* 2022 (in press).
9) Boine C, **Siegel M**. The effectiveness of value-based messages to engage gun owners on firearm policies: A three-stage nested study. *Injury Epidemiology* 2022 (in press).
10) Ross CS, Gradus J, Siegel M, Alcorn T, Garverich S, Lincoln AK. Distinct groups of firearm owners with differential risk for suicide in the United States: A latent class analysis. *Preventive Medicine* 2022 (in press).
11) **Siegel M**, Katchmar A. Effect of flavored e-cigarette bans in the United States: What does the evidence show? *Preventive Medicine* 2022;165:107063. https://doi.org/10.1016/j.ypmed.2022.107063.
12) Sun S, Cao W, Ge Y, **Siegel M**, Wellenius GA. Analysis of firearm violence during the COVID-19 pandemic in the United States. *JAMA Network Open* 2022; 5(4):e229393. https://dx.doi.org/10.1001/jamanetworkopen.2022.9393.
13) Ye G, Thatipamala P, **Siegel M**. Assessment of reasons for ownership and attitudes about policies among firearm owners with and without children. *JAMA Network Open* 2022; 5(1):e4122995. https://dx.doi.org/10.1001/jamanetworkopen.202142995.
14) **Siegel M**, Critchfield-Jain I, Boykin M, Owens A, Muratore R, Nunn T, Oh J. Racial/ethnic disparities in state-level COVID-19 vaccination rates and their association with structural racism. *Journal of Racial and Ethnic Health Disparities* 2021. Published online ahead of print on October 29, 2021. https://link.springer.com/article/10.1007/s40615-021-01173-7. PMID: 34713336.
15) Neufeld M, Poulson M, Sanchez S, **Siegel M**. State firearm laws and firearm injury-related inpatient hospitalization rates: A nationwide panel study. *Journal of Trauma and Acute Care Surgery* 2021. Published online before print on October 27, 2021. https://journals.lww.com/jtrauma/Abstract/9000/State_Firearm_Laws_and_Nonfatal_Firearm.97260.aspx PMID: 34711793.

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17) **Siegel M**, Critchfield-Jain I, Boykin M, Owens A, Nunn T, Muratore R. Actual racial/ethnic disparities in COVID-19 mortality for the non-Hispanic Black compared to non-Hispanic White population in 353 US counties and their association with structural racism. *Journal of Racial and Ethnic Health Disparities* 2021. Published online ahead of print on September 3, 2021. https://link.springer.com/article/10.1007/s40615-021-01109-1. PMID: 34462902.
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TABLE A: Studies Examining the Effectiveness of State-Level Large Capacity Ammunition Magazine Bans on the Incidence and Severity of Mass Public Shootings

Study, Date (years covered) No. of events	**Firearm Laws Examined**	**Key Findings**
Gius, 2015[1] (1982-2011) 57 events	State assault weapon bans (most of which were accompanied by large-capacity magazine bans)	The presence of a state assault weapons ban was associated with a statistically significant[2] 45% reduction in the number of mass shooting fatalities.
Blau et al., 2016[3] (1982-2015) 184 events	State assault weapon bans (similar to Gius, most of these laws were accompanied by large-capacity magazine bans).	The presence of a state assault weapons was associated with a statistically significant decrease in the incidence of mass shootings. The magnitude of the effect was not provided in the paper and cannot be calculated because a probit model was used.
Klarevas et al., 2019[4] (1990-2017) 69 events	State large-capacity magazine bans	The presence of a large-capacity magazine ban was associated with a non-statistically significant 72% reduction in the incidence of high-fatality mass shootings (more than five victim deaths) (p-value not reported) and a non-statistically significant 95.4% decrease in the number of fatalities in a high-fatality mass shooting (p-value not reported.
Webster et al., 2020[5] (1984-2017) 604 events	State large-capacity magazine bans	The presence of a state large-capacity magazine ban was associated with a statistically significant 48% reduction in the incidence of mass shootings and a non-statistically significant 70% reduction in the number of mass shooting fatalities (p-value not reported). For domestic-related mass shootings,[6] these laws were associated with a statistically significant 61% reduction in incidence and a statistically significant 75% reduction in the number of fatalities.
Siegel et al., 2020[7] (1976-2018) 155 events	State large capacity ammunition magazine bans	The presence of a state ban on large capacity ammunition magazines was associated with a non-statistically significant 56% reduction in the incidence of a mass public shooting (p=0.18) and a statistically significant 38% reduction in the number of fatalities in a mass public shooting).

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The impact of state and federal assault weapons bans on public mass shootings

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The purpose of the present study is to determine the effects of federal and state assault weapons bans on public mass shootings. Using a Poisson effect model and data for the period 1982 to 2011, it was found that both state and federal assault weapons bans have statistically significant and negative effects on mass shooting fatalities but that only the federal assault weapons ban had a negative effect on mass shooting injuries. This study is one of the first studies that looks solely at the effects of assault weapons bans on public mass shootings.

Keywords: assault weapons ban; mass shootings

JEL Classification: K14; I12

I. Introduction

According to a recent report prepared by the Congressional Research Service (Bjelopera *et al.*, 2013), a public mass shooting has four distinct attributes:

(1) Occurred in a relatively public place.
(2) Involved four or more deaths – not including the shooter.
(3) Victims were selected randomly.
(4) Shooting was not a means to a criminal end, such as robbery or terrorism.

Examples of high-profile public mass shootings that fit this definition are Sandy Hook, Aurora, Fort Hood, Virginia Tech and Columbine. Many of the perpetrators in these mass shootings used multiple types of firearms. Contrary to popular belief, however, assault rifles were not the predominant type of weapon used in these types of crimes. In fact, according to a recent study, handguns were the most commonly used type of firearm in mass shootings (32.99% of mass shootings); rifles were used in only 8.25% of mass shootings (Huff-Corzine *et al.*, 2014). All data used in Huff-Corzine *et al*. (2014) is for the period 2001–2010.

Even though rifles are used in less than 10% of public mass shootings, one of the first pieces of legislation that comes up for consideration whenever there is a mass shooting is an assault weapons ban. For example, after the Sandy Hook shooting, there was a call for a revival of the 1994 federal assault weapons ban. This firearms ban was part of the Violent Crime Control and Law Enforcement Act of 1994 and outlawed semi-automatic weapons that had certain distinguishing features, such as pistol grips, flash hiders and folding stocks (Koper, 2004). The ban was very narrow; only 118 gun models were banned under this law. In addition to banning certain types of guns, the 1994 law also prohibited large-capacity magazines, which held more than 10 rounds of ammunition. This prohibition affected many more types of guns than the assault weapons ban primarily because many semi-automatic weapons, including handguns, are capable of using large-capacity magazines.

The 1994 law had several loopholes and exemptions. All assault weapons and large-capacity magazines manufactured prior to the effective date of the ban were legal to own and transfer. In addition, only exact copies of the banned assault weapon models were banned; models without certain characteristics were still legal even though the rate of fire was the same. Finally, there was no prohibition against new, legal assault weapons being able to accept older, grandfathered large-capacity magazines. Hence, most new, legal models of assault rifles could use pre-ban large-capacity magazines. Given the above, the federal law was limited in its ability to affect firearm availability or crime.

Regarding state-level assault weapons bans, California was the first state to enact such a law in 1989. Several other states followed California's lead and enacted their own bans shortly thereafter (Connecticut, Hawaii and New Jersey), and then, in 1994, the federal ban was enacted. After the federal ban expired in 2004, all of the states that had bans prior to 1994 opted to continue with them.

Even though there have been numerous calls for assault weapons bans, both at the state and at the federal level, very little research has been conducted on the effects of these laws on mass shootings. Gius (2014), looking at data for the period 1980 to 2009, found that state-level assault weapons bans had no significant effects on gun-related murder rates, but that the federal assault weapons ban was associated with a 19% increase in gun-related murders. Chapman *et al.* (2006) examined the effects of Australia's 1996 gun law reforms on firearm-related homicides, including mass shootings, and found that, after enactment of the laws, there were declines in firearm-related homicides and suicides but no significant decrease in unintentional firearm deaths. It was also noted that there were 13 mass shooting incidents in Australia in the 18 years prior to the enactment of the stricter gun control measures but no mass shootings after passage of the laws. Koper (2004) looked at trends and correlations and concluded that the federal assault weapons ban's effect on gun-related violence was minimal at best. Duwe *et al.* (2002) examined the effects of right-to-carry laws on mass shootings. Using data for the period 1977 to 1999, the authors employed both Poisson and negative binomial models and found that right-to-carry laws had no statistically-significant effects on mass shootings. Finally, Lott and Landes (2000) looked at mass shooting incidents also for the period 1977 to 1997 and found that states that enacted right-to-carry laws had fewer mass shootings than states that did not enact such laws.

The purpose of the present study is to determine the effects of the federal and state assault weapons bans on public mass shootings. Using a Poisson, fixed-effect model and data for the period 1982 to 2011, it was found that both state and federal assault weapons bans had statistically significant and negative effects on mass shooting fatalities but that only the federal assault weapons ban had a negative effect on mass shooting injuries. This study is one of the first studies that looks solely at the effects of assault weapons bans on public mass shootings. Most prior studies examined the effects of other types of gun control measures on mass shootings (Lott and Landes, 2000; Duwe *et al.*, 2002; Chapman *et al.*, 2006) or the effects of assault weapons bans on much broader categories of crime (Koper, 2004; Gius, 2014).

II. Empirical Technique and Data

In order to determine whether assault weapons bans have any effects on public mass shootings, the following equation is estimated in the present study:

$$\begin{aligned} Y = \alpha_0 &+ \alpha_1 \text{ state assault weapons ban} \\ &+ \alpha_2 \text{ federal assault weapons ban} \\ &+ \alpha_3 \text{ control variables} \\ &+ \alpha_4 \text{ state fixed effects} \\ &+ \alpha_5 \text{ year fixed effects} \end{aligned} \qquad (1)$$

where Y is the number of deaths or injuries due to mass shootings. Control variables include the following: percentage of population that is black; population density; percentage of population that has a 4-year college degree; per capita median income; annual unemployment rate; percentage of population that is aged 18–24;

percentage of population that is aged 25–34 and per capita prison population. The state assault weapons ban variable is expressed as a dummy variable that equals one if the state has an assault weapons ban and zero otherwise. The federal assault weapons ban dummy variable equals one for the years 1995–2004.

All data are state level and were collected for the years 1982–2011. Socio-economic data were obtained from the *Statistical Abstract of the United States* and other relevant Census Bureau documents. Information on state-level assault weapons bans were obtained from Ludwig and Cook (2003), the Legal Community against Violence, the National Rifle Association and the US Bureau of Alcohol, Tobacco, Firearms and Explosives.

Data on mass shootings were obtained from the Mother Jones website and the *Supplementary Homicide Reports*, US Department of Justice. According to this data, there were 57 public mass shooting incidents from 1982 to 2011. For the assault weapons ban period (which includes the federal ban years and the years when states that had their own assault weapons bans), there were 24 public mass shootings; for the nonban period, there were 33 incidents. The average number of fatalities per mass shooting during the assault ban period was 7.5; during the nonban period, the average number of fatalities was 8.6.

III. Results and Concluding Remarks

A Poisson, two-way fixed-effect model, controlling for both state-specific and year-specific effects, was used to estimate the effects of state and federal assault weapons bans on public mass shootings. All observations were weighted by state population. Results are presented on Table 1.

These results indicate that fatalities due to mass shootings were lower during both the federal and state assault weapons ban periods. Although some prior research has shown either that assault weapons bans did not reduce crime or that they actually increased gun-related murder rates (Gius, 2014), the present study's focus on mass shootings shows the effectiveness of these gun control measures in reducing murders due to mass shootings. Regarding the injury regression, state-level assault weapons bans had no statistically-significant effects, but the federal ban had a significant and negative effect on mass shooting injuries.

It is important to note that these results are not unexpected. In 2012, for example, there were 72 fatalities due to mass public shootings. Of those 72, at least 30 were committed using a rifle. In the same year, there were 12 765 murders, of which only 322 were committed using a rifle. Rifles (assault weapons) are used much more frequently in mass shootings than they are in murders in general. Hence, any law that restricts access to rifles is likely to be much more effective in reducing mass shootings than it is in reducing murders in general.

Finally, it is important to note that mass shooting fatalities are a very small percentage of overall murders. Hence, even if a certain type of gun control measure was found to completely eliminate mass shootings (which assault weapons bans do not), the overall murder rate would decline by a very small

Table 1. Poisson fixed-effects regression results

Variable	Mass shooting deaths	Mass shooting injuries
State assault weapons ban	−0.59202 (−2.28)**	0.298 (1.16)
Federal assault weapons ban	−1.079 (−7.04)***	−1.733 (−10.10)***
Proportion of population that is black	65.66 (5.33)***	87.05 (6.20)***
Population density	−0.0177 (−2.73)***	−0.0542 (−7.18)***
Real per capita median income	0.000029 (0.48)	0.00021 (3.53)***
Proportion of population with college degree	1.66 (0.70)	−4.72 (−2.21)**
Unemployment rate	−0.0698 (−0.02)	−3.51 (−1.06)
Proportion of population >18 and <25	−55.21 (−5.94)***	−84.27 (−7.81)***
Proportion of population >24 and <35	−39.20 (−5.09)***	−20.59 (−2.65)***
Per capita prison population	−0.00362 (−4.62)***	−0.00067 (−0.85)
Log-likelihood	−1846.48	−2860.63

Notes: ** 1% < p-value < 5%; *** p-value < 1%.
Test statistics are in parentheses.
State and year fixed effects are not reported.

amount. Therefore, although the results of the present study indicate that assault weapons bans are effective in reducing mass shooting fatalities, their effects on the overall murder rate are probably minimal at best.

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Guns, laws and public shootings in the United States

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ABSTRACT

Since the late 1990s, there have been increasing numbers of public shootings carried out with firearms in the United States. These tragedies continually renew the regulatory debate concerning public safety while considering civil liberties. Using a unique data set, we investigate whether laws correspond to whether an event occurs and the effects of event-specific characteristics on public shooting outcomes. In particular, we analyse how state-specific gun laws, the types of firearms, the shooting venues and the mental health of the gunman impact the outcomes of public shootings. Results show that most gun laws are unrelated to whether an event occurs. In addition, common state and federal gun laws that outlaw assault weapons are unrelated to the likelihood of an assault weapon being used during a public shooting event. Moreover, results show that the use of assault weapons is not related to more victims or fatalities than other types of guns. However, the use of hand guns, shot guns and high-capacity magazines is directly related to the number of victims and fatalities in a public shooting event. Finally, the gunman's reported mental illness is often associated with an increase in the number of victims and fatalities.

KEYWORDS
Guns; public shootings; gun control; gun laws

JEL CLASSIFICATION
K10; K40

I. Introduction

Public shootings prompt renewed debates about gun control with calls for legislation and regulations to limit the types and availability of firearms. After the shootings at Sandy Hook Elementary, President Obama vowed to 'use whatever power [his] office holds' to prevent future tragedies.[1] While most people would agree that preventing future tragedies is a worthy goal, policymakers disagree on the best course of action to take in order to achieve this goal. This comes as no surprise since there is little research on what policies or factors affect the outcomes of public shootings. However, given that shooting events are increasing over time (see Figure 1), this type of research is pertinent.

Although changes in gun legislation have been slow to evolve, in 2013 President Obama signed into law the Investigative Assistance for Violent Crimes Act of 2012. The act provided the attorney general the authority to assist in investigations of public shooting events occurring in a place of public use and active shooter events at the request of state law enforcement officials. On 5 January 2016, President Obama proposed an updated strategy to reduce gun violence in America. The strategy focuses on new background check requirements to increase the effectiveness of the National Instant Criminal Background Check System and to enhance the education and enforcement of existing state gun laws.[2] Some policymakers favour expanded gun legislation, such as an assault weapons ban, a limit on high-capacity magazines or expanded background checks. However, little is known about the effect of existing regulations on public shooting outcomes. Others point to mental illness as an explanation for these tragic events. Yet there is little research on how the presence of mental illness influences the outcomes of public shootings. This article addresses these unanswered questions. Indeed, the results from our study have important implications as policymakers move forward to prevent future tragedies.

While gun violence arises out of sociocultural, educational, behavioural and product safety issues which transcend simply gun ownership, gun

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[1]http://www.nytimes.com/2012/12/17/us/politics/bloomberg-urges-obama-to-take-action-on-gun-control.html
[2]http://www.ncsl.org/research/civil-and-criminal-justice/summary-president-obama-gun-proposals.aspx

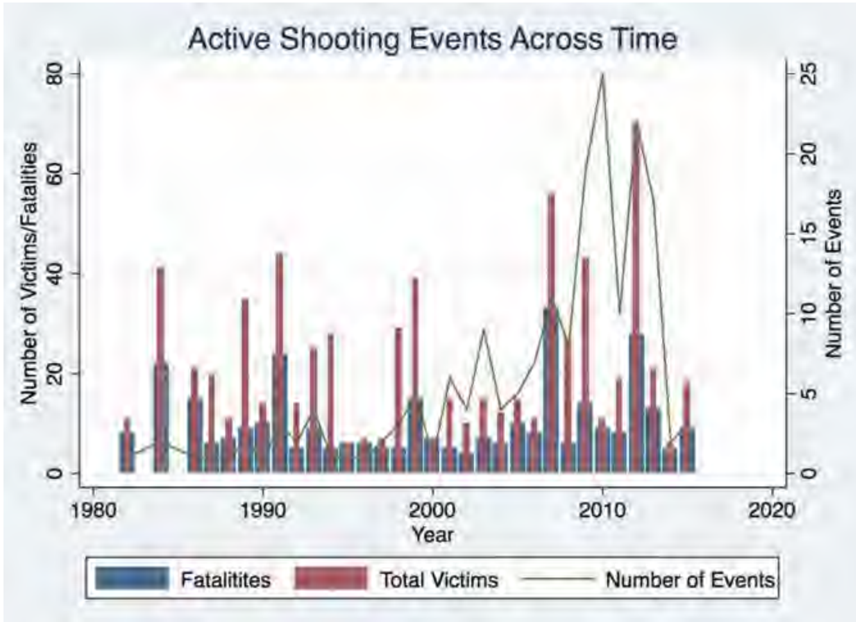

Figure 1. Distribution of events.

violence and, specific to the current analysis, many public shootings are arguably random events. Given the random and uncertain nature of tragic events like Sandy Hook, Aurora, Columbine and most recently at Umpqua Community College in October of 2015, the question arises as to whether or not public policy can have the same impact on a random act of mass violence as public policy has had on other areas of concern (Mozaffarian, Hemenway, and Ludwig 2013).

Policymakers across the political spectrum have variations of opinions on public policy and the impact the regulations or laws would have on the occurrence of these uncertain events. Some policymakers emphasize that a breadth of tougher gun laws would have prevented these random acts of violence or at the very least reduced the severity of the event. Counter to this argument, pro-gun or anti-control policymakers disbelieve gun controls have any preventive efficacy. Other pundits indicate the public shootings could have been prevented or the severity of the event would have been dramatically reduced through site-specific security. Given the breadth of the political debate and public opinion, the question still remains whether gun ownership regulation, gun and ammunition control, background checks and owner education have any effect on the damages caused by public shootings.

In this article, we analyse the outcomes of public shooting events using a unique panel data series of U.S. states from 1982 to 2014. The data include 184 public shootings over the last 31 years. Using these data, we create a state panel over time to test whether gun laws are associated with occurrences of public shootings. We find that most laws have little correlation with whether an event occurs. The one consistent finding is that state assault weapons laws show a negative correlation with active shooter events.

We then look at a cross section of public shootings to test whether gun laws, particularly laws that restrict or regulate weapons that are collectively classified in the National Firearms Act of 1968 (NFA) as assault-type weapons, impact whether assault weapons are used in public shootings. We find that state laws such as the NFA restrictions, as well as the federal assault weapons ban, have no effect on whether an assault weapon is used in a public shooting. In addition, using data on the weapons used in each public shooting, we analyse whether the types of guns as well as the number of guns used during a public shooting is associated with the resulting number of victims and fatalities. Our results indicate that assault weapons use is not associated with more victims or fatalities. Additional assault guns are also not associated with more victims than other types of guns and have no significant relationship with fatalities. The use of high-capacity magazines, hand guns and shotguns, however, are consistently associated with more victims and more fatalities during a given public shooting.

Finally, we analyse whether the mental health status of the gunman affects the number of victims and fatalities. Our data contain information on whether the gunman had been diagnosed with mental illnesses, whether he had taken medication and whether he was currently off the medication at the time of the shooting. Overall, the mental health of the gunman is positively correlated with the number of victims and use of depression medication is positively correlated with both the number of victims and the number of fatalities.

This article provides an important contribution to our understanding about laws associated with public shootings and their outcomes. Many papers have researched the determinants of gun crime more broadly. For example, Duggan (2001) uses gun magazine subscriptions as a proxy for gun ownership to show that more guns are associated with increased crime. Other papers show that economic factors such as unemployment rates and incomes are associated with crime rates (Becker 1968; Corman and Mocan 2005; Gould, Weinberg, and Mustard 2002; Raphael and Winter-Ebmer 2001). Another strand of literature evaluates the effects of gun legislation on crime. Kwon et al. (1997), for example, find that states with restrictions such as licence requirements and waiting periods have fewer gun deaths, but the result is not significant in statistical terms. Lott and Mustard (1997) and Moody (2001) show that right to carry laws lead to less violent crime, but others find conflicting evidence (Ayres and Donohue 2003; Duggan 2001; Olson and Maltz 2001). In another study, Kwon and Baack (2005) form a comprehensive measure of gun control legislation and find that this measure is associated with fewer gun-related deaths. The objectives in these papers are focused solely on gun crime. We extend this literature by specifically examining the determinants and factors that affect whether a public shooting occurs and public shooting outcomes.

Other studies have examined public shootings. For instance, Chapman et al. (2006) look at the effects of broad gun reforms that removed semi-automatic guns, pump-action shotguns and rifles from civilian possession in Australia on gun violence, including public shootings. They find that the reforms were associated with a sharp decline in public shootings. Additionally, Duwe, Kovandzic, and Moody (2002) and Lott and Landes (2000) look at whether right to carry laws influence public shootings in the United States. Our analysis extends the literature by analysing a large panel to test the relation between many gun laws and public shootings. Our article also looks at whether state and federal assault weapon bans influence whether or not these types of weapons were used in the cross section of public shootings. Finally, our analysis extends previous work by looking at the cross-sectional data to estimate how event-specific characteristics influence the outcomes of public shootings.

This article proceeds as follows: Section II describes the data used in the analysis, Section III details the results, and Section IV concludes.

II. Data description

The shooting event data were obtained and cross-referenced from multiple publically available data sources.[3] We identify 184 shooting events between 1982 and October 2015 as mass shootings, spree shootings or active shooter events. We follow the FBI's definition in defining each type of shooting event. 'Mass' shootings are defined based on the following: (1) shootings were carried out by a single gunman, (2) shootings happened during a single incident and (3) shootings occurred in a public place with a minimum of four fatalities.[4,5,6] 'Spree' shootings are defined as (1) shootings were carried out by a single gunman, (2) shootings happened across multiple locations with no break in time between the shootings and (3) shootings occurred in a public place with a minimum of two fatalities.[4,5,6] An 'Active shooter' incident is defined as (1) an individual actively engaged in killing or attempting to kill people, (2)

[3]The Stanford Mass Shootings of America (MSA) data project, the Global Terrorism Database, a compiled data set by Follman, Aronson, and Pan (2012), and the Department of Justice's study on active shooter incidence in the United States.
[4]Serial Murder: A Multi-Disciplinary Perspective for Investigators. The Federal Bureau of Investigations. https://www.fbi.gov/stats-services/publications/serial-murder/serial-murder-july-2008-pdf.
[5]The exception of a 'single' gunman is the case of the Columbine massacre and the Westside Middle School killings, both of which involved two shooters.
[6]The gunman is excluded in the victim count.

shooting occurs in a confined/unconfined and populated area and (3) the subject's criminal actions involve the use of firearms.[7]

Data specific to the mass shooting include location (city and state), date of the mass shooting, the number of fatalities, the number of non-fatal victims and the venue of the mass shooting. Data specific to the gunman in the mass shooting include race, gender, age, prior signs of mental illness, known prescribed mental illness medication, prescribed medicine adherence at the time of the mass murder, suicide by the gunman, whether police killed the gunman and whether the gunman was arrested. Data specific to the weapons used in the mass murder include whether the weapon was obtained legally, the type of weapon used, the number of each type of weapon and the capacity of the ammunition magazine(s).

We obtain state-specific gun law data from each state's Department of Public Safety (or related department as the name varies by state), the United States Bureau of Alcohol, Tobacco, and Fire Arms and the United States Code of Federal Regulations (CFR) Title 27, Part 1 sub-chapter C. Nine different state-specific gun laws are included in our analysis as well as the federal ban on assault weapons. These are described in detail as follows.

Assault weapons ban

Federal regulation which bans the possess, import or purchase assault weapons or cosmetic features that would classify a firearm as an assault weapon, except for those already in lawful possession at the time of the law's enactment. The Federal Assault Weapons Ban of 1994 defined certain firearms as assault weapons based on the features they possessed (Public Safety and Recreational Firearms Use Protection Act, H.R.3355, 103rd Congress (1993–1994)).

Assault weapons law

The federal assault weapons ban expired in 2004; however, several states either fully adopted or have modified the definitions of the 2004 law. Seven states and the District of Columbia have enacted assault weapon bans or restrictions with various definitions and criteria.

Purchase permit

A certificate, identification card or other permit (terminology varies state by state) is required to acquire/purchase any lawful firearm.

Gun registration

Requires gun owners to record the ownership of their firearms with a designated law enforcement agency.

Licence requirement

Requires a state licence to possess a lawful firearm.

Concealed carry permit (CCW)

Permits the carry of a lawful firearm in public in a concealed manner on one's person or in close proximity. Requirements for CCW vary widely by state with a typical permit requiring residency, minimum age, submitting fingerprints, passing a computerized instant background check (or a more comprehensive manual background check), attending a certified handgun/firearm safety class, passing a practical qualification demonstrating handgun proficiency and paying a required fee.

Open carry

Permitting the carry of a lawful firearm in public in an open manner where a casual observer can observe an individual carrying a firearm. Similar to a CCW, requirements for open carry vary widely by state with a typical permit requiring the same standards listed above for CCW.

NFA restrictions

The National Firearms Act of 1968 defines a number of categories of regulated firearms which are collectively known as NFA firearms. These range from the

[7]A Study of Active Shooter Incidents in the United States between 2000 and 2013. The United States Department of Justice and the Federal Bureau of Investigation. https://www.fbi.gov/news/stories/2014/september/fbi-releases-study-on-active-shooter-incidents/pdfs/a-study-of-active-shooter-incidents-in-the-u.s.-between-2000-and-2013.

firing capacity (semi and full automatic) of a firearm, the length of the firearm barrel, suppression devices and ancillary devices considered destructive devices (i.e. grenades, bombs, explosive missiles, poison gas weapons and other comparable devices).

Peaceable journey law

Regulates the transport a firearm for any lawful purpose from any place where he may lawfully possess and carry such firearm to any other place where he may lawfully possess and carry the firearm if, during transportation, the firearm is unloaded, and neither the firearm nor any ammunition being transported is readily accessible or is directly accessible from the passenger compartment of such transporting vehicle.

Stand your ground

Legal concept that a person may justifiably use force in self-defence when there is reasonable belief of an unlawful threat at any location, without an obligation to retreat first. This is analogous to the Castle doctrine, stating that a person has no duty to retreat when their home is attacked.

Figure 1 shows the distribution of events in our data. The wide bars illustrate average fatalities over time, the narrow bars illustrate the average number of victims over time and the line illustrates the number of events over time. It is clear that the number of events has increased in recent history, although the severity of events as measured by the number of fatalities and victims does not show a clear trend.

Table 1 reports statistics that describe the sample of state-year data. We include all 50 states as well as Washington D.C.[8] With 51 states and 33 years of observable data, we have 1683 state-year observations. In addition to whether an event occurs, we also report *Population*, which is the state population according to the U.S. Census, and *Income*, which is the aggregate level of personal income gathered from the U.S. Bureau of Economics Analysis. We then create indicator variables that capture whether or not a state had one of each of the gun laws during a particular year.

Table 1. Summary statistics: panel data (obs. = 1683).

	Mean	Standard deviation	Min	Max
Active shooter event	0.09	0.29	0	1
Population (million)	5.39	6.01	0.45	38.8
Income (billion USD)	157	0.22	0.01	1.94
Year	1998	9.52	1982	2014
Purchase permit	0.27	0.45	0	1
Gun register	0.12	0.32	0	1
Assault law	0.13	0.33	0	1
Licence requirement	0.10	0.30	0	1
CCW permits	0.88	0.32	0	1
Open carry	0.71	0.46	0	1
NFA restrictions	0.39	0.49	0	1
Peaceable journey law	0.43	0.50	0	1
Stand your ground	0.78	0.42	0	1
AR-Ban	0.30	0.46	0	1

Table 1 shows that a shooting event occurred in approximately 9% of the state-year observations. The mean state population during that time was 5.39 million and aggregate personal state income totalled $157 million. The gun law indicators show for what fraction of state-year observations various gun laws held. For example, only 10% of the state-year observations had licence requirements while 88% of the observations required CCW permits.

For the 184 shooting events that occurred in the United States between 1982 and 2014, we also gather information particular to each event. This information is summarized in Table 2. Outcome variables include the number of individuals that were injured or killed (*Victims*) and the number of fatalities (*Fatalities*). Explanatory variables include the age of the gunman (*Age*), an indicator variable capturing whether the gunman was a minority (*Minority*) and an indicator variable for whether there were reported signs that the gunman suffered from possible mental illness (*Mental Illness*). We also gather data on the venue of the mass shooting. *School* and *Workplace* are indicator variables for whether the mass shooting occurred at a school or workplace. To examine cultural influences on violence, we include a variable *Culture of Honour* defined by states in the Southern United States which are considered honour states. A culture of honour is a culture where people avoid intentionally offending others and maintain a reputation for not accepting improper conduct by others. Brown et al. (2009) show that culture of honour states are more likely to have students carry weapons to school and are more likely to experience school shootings.

[8]We note that results reported in this study are qualitatively similar when we exclude Washington D.C. and just use the 50 states.

Table 2. Summary statistics: cross-sectional data (obs. = 184).

	Mean	Standard deviation	Min	Max
Victims	8.82	9.73	0	70
Fatalities	4.23	4.72	0	33
Age	36.64	15.14	12	89
Minority	0.36	0.48	0	1
Mental Illness	0.46	0.50	0	1
Use Depression Med	0.14	0.35	0	1
Off Depression Med	0.09	0.29	0	1
School	0.22	0.42	0	1
Workplace	0.54	0.50	0	1
Culture of Honour State	0.67	0.47	0	1
Year	2006.14	7.16	1982	2015
Arrested	0.37	0.48	0	1
Police	0.20	0.40	0	1
Legal Gun	0.87	0.34	0	1
#Guns	1.80	1.19	1	9
#Handguns	1.05	0.79	0	4
#Revolvers	0.14	0.49	0	5
#Shotguns	0.28	0.52	0	2
#Assault Guns	0.34	0.53	0	2
D_Handguns	0.78	0.41	0	1
D_Revolvers	0.11	0.31	0	1
D_Shotguns	0.24	0.43	0	1
D_Assaultguns	0.31	0.46	0	1
High Capacity Magazine	0.37	0.48	0	1
Purchase Permit	0.38	0.49	0	1
Gun registration	0.22	0.42	0	1
Assault weapon law	0.26	0.44	0	1
Licence requirement	0.08	0.27	0	1
CCW permits	0.84	0.37	0	1
Open carry	0.83	0.38	0	1
NFA restrictions	0.48	0.50	0	1
Peaceable journey laws	0.34	0.47	0	1
Stand your ground	0.83	0.38	0	1

From various reports, we also obtain data on the guns used during the mass shooting. *Legal Gun* is an indicator variable for whether the gun (or guns) used by the gunman at the mass shooting was obtained legally. Specifically, *Legal Gun* includes (according to state law) if the firearm(s) was/were registered, if a permit was required for ownership and/or if a licence was required for ownership. As part of the legal purchase of a firearm, FBI instant background checks are required of all purchasers. The expectation to the background check regulation is the Private Sale Exemption, otherwise known as the widely debated 'Gun Show Loophole'. Under federal law, private-party sellers are not required to perform background checks on buyers, record the sale or ask for identification. However, according to a National Institute of Justice, the research arm of the U.S. Department of Justice, study, only 2% of criminal guns come from gun shows.[9] As of September 2015, 18 states and Washington D.C. have background check requirements beyond federal law. Eight states require universal background checks at the point of sale for all transfers, including purchases from unlicensed sellers.

More detailed weapon information reported in Table 2 includes the total number of guns at the scene (*#Guns*), the number of handguns (*#Handguns*), the number of revolvers (*#Revolvers*), the number of shot guns (*#Shotguns*) and the number of assault weapons (*#Assault Guns*).[10,11] We also create indicator variables for the various gun types used in the sample of mass shootings. *D_Handgun, D_Revolvers, D_*Shotguns and *D_Assaultguns* indicate that a hand gun, revolver, shot gun or assault weapon was used during the mass shooting, respectively. In addition to the gun types, we create an indicator variable for whether a high-capacity magazine (*High Capacity Magazine*) was used. We define a high-capacity magazine according to the commonly accepted definition used under the United States' Federal Assault Weapons Ban, which expired in 2004, as a magazine capable of holding more than 10 rounds of ammunition. In addition to the information about the gun types, Table 2 also includes indicator variables that capture the nine common gun laws in each state where a mass shooting occurred.

Table 2 shows that the mean number of victims is 8.82 while the mean number of fatalities is 4.23. We note that the minimum number of fatalities is 0.00 as we have included not only mass and spree shootings but active shooter incidences which by definition do not require a fatality. The average age of a gunman is slightly over 36. Approximately 36% of gunmen were minorities and more than 46% of gunmen had possible signs of mental illness. This latter summary statistic suggests that policymakers and regulators might attempt to address mental health issues in an attempt to deter the number of active shooting incidences. We further explore this possibility below.

[9]Homicide in eight US cities: Trends, Context, and Policy Implications. National Institute of Justice, U.S. Department of Justice. https://www.ncjrs.gov/pdffiles1/ondcp/homicide_trends.pdf.

[10]Handgun (27 CFR 478.11). (a) Any firearm which has a short stock and is designed to be held and fired by the use of a single hand; and (b) Any combination of parts from which a firearm described in paragraph (a) can be assembled.

[11]Revolver (27 CFR 478.11). A weapon originally designed, made, and intended to fire a projectile (bullet) from one or more barrels when held in one hand, and having (a) a chamber(s) as an integral part(s) of, or permanently aligned with, the bore(s); and (b) a short stock designed to be gripped by one hand and at an angle to and extending below the line of the bore(s).

Table 2 also shows that 22% of active shooter events occurred at schools and 54% occurred at places of work. The remaining 24% of events did not occur at one of these two venues. We found that 67% of active shooter incidences occurred in states which are considered to have a culture of honour. In Table 2, we also find that 87% of guns used in the cross section of mass shootings were obtained legally. The average total number of guns used by a gunman is 1.80, the average number of handguns used is 1.05, the average number of revolvers used is 0.14, the average number of shotguns used is 0.28 and the average number of assault weapons used is 0.34. These simple statistics suggest that hand guns are used the most and nearly three times as much as assault weapons, which is the second most commonly used gun type in the sample. When examining the gun-type indicator variables, at least one hand gun was used 78% of the time, while revolvers were used 11% of the time, shotguns were used 24% of the time and assault weapons were used approximately 31% of the time. High-capacity magazines were used in 37% of active shooter events.

Table 2 also reports the summary statistics for the nine common state gun laws that were in existence during the year the mass shooting occurred. We find that nearly 38% of events took place in states that required purchase permits, 22% in states that required the registration of fire arms, 26% in states that had an assault weapons law, 8% in states that had licence requirements, 84% in states that had conceal and carry permit laws, 83% in states that had open carry laws, 48% in states that had restrictions on NFA-classified weapons, 34% in states that had peaceable journal laws and 83% in states that had stand your ground laws and the time of the mass shooting.

III. Empirical results

In this section, we present our empirical results. First, we examine how state-specific characteristics such as population, income and gun laws affect the likelihood of an active shooter event in a particular state during a particular year. Second, we determine whether certain gun laws targeting the prohibition of assault weapon use affect the likelihood that assault weapons were used in an active shooter event. Third, we examine cross-sectional factors that explain the number of victims and the number of fatalities during an event by focusing on the types of guns used by the gunman as well as the mental health of the gunman.

Predictors of mass shootings

We begin by examining characteristics that influence the likelihood of an active shooter event in a particular state during a particular year. Utilizing the panel data set described above, we estimate the following equation with a probit regression.

$$\begin{aligned} Event_{i,t} = \gamma_0 + \theta_{j,i,t} \sum_{j=1}^{10} GunLaws_{i,t} \\ + \gamma_1 PersIncome_{i,t} \\ + \gamma_2 Population_{i,t} + \gamma_3 Year_t + \varepsilon_i \\ + \eta_{i,t} \end{aligned} \tag{1}$$

Event is equal to one if an active shooter event occurred in state *i* during year *t*, zero otherwise. The independent variables include nine indicator variables that capture whether a particular gun law existed in state *i* during year *t* as well as a dummy variable capturing the time period when the federal ban on assault rifles existed from September 1994 to September 2004 (*AR-Ban*). We also include state aggregated personal income in \$ billions (*Income*) and state population in millions (*Population*). In order to control for any time trend in active shooter events, we include a count variable *Year*, which equals the year of a particular observation. Finally, we include state fixed effects to account for omitted time invariant variables (ε_i).

Table 3 reports the marginal effects from estimating variations of Equation (1) with robust standard errors clustered by state. Column 1 reports the probit regression results when we only include the gun law indicator variables. The first important result is that 7 of the 10 indicator variables produce estimates that are not statistically different from zero. We note that the indicator variable *Assault Law* produces a negative and significant coefficient while *AR-Ban and Stand Your Ground* produce positive and significant estimates. These results indicate that state assault weapon bans are associated with a lower likelihood of an active shooter event while the federal assault weapons ban and stand your ground laws are associated with an increase in the probability of an event. When we

Table 3. Determining active shooter events: effect of gun laws.

	1	2	3
AR-Ban	0.078**	0.004	−0.068**
	(0.034)	(0.020)	(0.032)
Assault Law	−0.042***	−0.022*	−0.045**
	(0.016)	(0.012)	(0.018)
Purchase Permit	−0.006	−0.024	0.372
	(0.036)	(0.016)	(0.358)
Gun register	0.059	−0.007	0.115
	(0.061)	(0.018)	(0.139)
Licence requirement	−0.047	−0.003	−0.271
	(0.033)	(0.017)	(0.207)
CCW permits	−0.034	−0.020	0.276
	(0.048)	(0.022)	(0.258)
Open carry	−0.021	0.010	0.312
	(0.030)	(0.011)	(0.289)
NFA restrictions	−0.004	0.017	0.346
	(0.033)	(0.018)	(0.288)
Peaceable journey law	−0.017	−0.010	−0.404
	(0.024)	(0.012)	(0.350)
Stand your ground	0.050**	−0.004	−0.181***
	(0.022)	(0.019)	(0.044)
Income (billion USD)		−0.023	0.688***
		(0.066)	(0.238)
Population (million)		0.008***	−0.020
		(0.002)	(0.022)
Year		0.006***	0.004***
		(0.001)	(0.001)
State fixed effects	No	No	Yes
Observations	1683	1683	1683

The dependent variable is an indicator for an active shooter event. Coefficients in columns 1 and 2 represent marginal effects from probit regressions. Column 3 provides the coefficients from a linear probability model. Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

include controls for population and personal income in column 2, the estimates on the *AR-Ban* and *Stand Your Ground* indicator variables are no longer significant. Further, the coefficient on *Assault Law* is only marginally significant. Again, none of the other seven indicator variables produces a significant coefficient. We note, however, that the estimates for *Population* and *Year* are positive and significant in column 2, reflecting the fact that incidents occur in states with higher populations and have increased over time.

Column 3 presents the results from a linear probability model where we include state fixed effects.[12] A few results are noteworthy. First, we find that the coefficient on *Stand Your Ground* becomes negative and significant at the 0.01 level while the coefficients on *AR-Ban* and *Assault Law* are negative significant at the 0.05 level. We also find that, when controlling for state fixed effects, *Income* and *Year* produce positive and significant coefficients while *Population* does not. Combined, the results in Table 3 show that any effect that gun laws have on the likelihood of an active shooter outcome depends on the econometric specification. Further, many of the gun laws analysed in the table have no effect on the probability of an event. The only estimate that is consistently negative is the coefficient on state assault weapons laws. These results might contribute to policy debate about the effectiveness of gun laws on active shooter events.

Gun laws and weapon choice

Next, we examine whether gun laws, including the Federal Assault Weapons Ban, affected the use of assault weapons during an active shooter event. Using the cross-sectional data, we estimate the following equation:

$$\begin{aligned} AR\_used_i = {} & \gamma_0 + \gamma_1 AR - Ban_t + \gamma_2 Assault\ Law_t \\ & + \gamma_3 Age_i + \gamma_4 Minority_i + \gamma_5 School_i \\ & + \gamma_6 Workplace_i + \gamma_6 Cutlure\ of\ Honour \\ & State_i + \gamma_7 Mental\ Illness_i + \gamma_8 LegalGun_i \\ & + \gamma_9 Year_t + \theta_{j,i,t} \sum_{j=1}^{8} GunLaw_{i,t} + \eta_i \end{aligned} \tag{2}$$

Here, the dependent variable is equal to unity if an assault weapon was used during an event and zero otherwise. The independent variables of interest are an indicator variable capturing the period when the Federal Assault Weapons Ban existed (September 1994 to September 2004) as well as an indicator variable capturing whether the state in which the event occurred had an assault weapons law. Other control variables include characteristics of the gunman and the venue, such as *Age, Year*, and indicator variables for *Minority, School, Workplace, Culture of Honour State, Mental Illness* and *Legal Gun*. We also include eight indicator variables that capture the remaining state gun laws.

Table 4 reports the results from estimating Equation (2) using probit regressions. We report the marginal effects from the probit estimates as well as robust standard errors. In column 1, we only include the indicator variables *AR-Ban* and *Assault Law*. The estimates are statistically insignificant, indicating that neither the federal assault weapon ban nor state assault weapon bans affect the probability that assault weapons are used in an active shooter event. In column 2, we include control

[12]We use a linear probability model instead of a probit given the biases and inconsistency found in fixed effects estimators for non-linear models (see Greene 2004).

Table 4. Determinants of the use of assault weapons.

	1	2	3	4
AR-Ban	−0.161	−0.157	−0.226	−0.233
	(0.162)	(0.169)	(0.181)	(0.182)
Assault Law	0.192	0.201	0.167	0.218
	(0.199)	(0.210)	(0.232)	(0.246)
Age		−0.001		−0.002
		(0.003)		(0.003)
Minority		−0.082		−0.090
		(0.073)		(0.074)
School		0.079		0.082
		(0.114)		(0.119)
Workplace		0.018		0.010
		(0.088)		(0.088)
Culture of Honour State		0.024		0.061
		(0.074)		(0.090)
Mental Illness		0.072		0.045
		(0.069)		(0.071)
Legal Gun		0.008		−0.005
		(0.103)		(0.101)
Year		−0.006		−0.004
		(0.005)		(0.005)
Purchase Permit			0.214*	0.202
			(0.124)	(0.138)
Gun register			0.003	−0.034
			(0.124)	(0.135)
Licence requirement			−0.046	0.069
			(0.158)	(0.194)
CCW permits			0.021	0.014
			(0.111)	(0.116)
Open carry			−0.090	−0.041
			(0.117)	(0.123)
NFA restrictions			−0.083	−0.099
			(0.121)	(0.123)
Peaceable journey law			0.051	0.019
			(0.098)	(0.097)
Stand your ground			0.162*	0.191**
			(0.083)	(0.082)
Wald	0.98	6.19	9.91	14.95
p-Value	0.613	0.721	0.449	0.599
Observations	184	184	184	184

Coefficients represent marginal effects from probit regressions. Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

variables for characteristics of the gunman and venue as well as the variable *Year*. Again, we do not find that either federal laws or state laws affect the use of assault weapons. We also note that none of the control variables are significantly different from zero. Column 3 includes additional indicator variables capturing the other eight common state gun laws. Again, we do not find that *AR-Ban* and *Assault Law* produce significant estimates. We do, however, find that *Purchase Permit* and *Stand Your Ground* produce positive and significant coefficients. Column 4 reports the results of the full model. When including the control variables that capture the characteristics of the gunman and venue, the estimate for *Purchase Permit* is no longer significant. However, the coefficient on *Stand Your Ground* remains positive and significant, suggesting that states with stand your ground laws were more likely to have an active shooter event where the shooter used an assault weapon. Perhaps more importantly, neither *AR-Ban* nor *Assault Law* produce significant coefficients. Overall, the results in Table 4 support the idea that gun laws targeting the restriction of assault weapons do not impact whether these weapons are used during an active shooter event.

Explaining the number of victims and fatalities: gun characteristics

In this section, we attempt to identify factors that influence the number of victims and the number of fatalities in an active shooter event. In particular, we examine the effect of the number and types of guns used on the number of victims and fatalities. We also include a variety of control variables that might provide some important inferences. We estimate the following equation using our cross-sectional sample of active shooter events:

$$\begin{aligned} Victims/Fatalities_i = {} & \beta_0 + \beta_1 Legal\ Gun_i \\ & + \beta_2 D\_Hand\ guns_i \\ & + \beta_3 D\_Revolvers_i \\ & + \beta_4 D\_Shotguns_i + \beta_5 D\_Assault_i \\ & + \beta_6 High\ Capacity\ Magazine_i \\ & + \beta_7 Age_i + \beta_8 Minority_i \\ & + \beta_9 School_i + \beta_{10} Workplace_i \\ & + \beta_{11} Culture\ of\ Honour\ State_i \\ & + \beta_{12} Mental\ Illness_i \\ & + \beta_{13} Arrested_i + \beta_{14} Shot\ by \\ & Police_i + \beta_{15} Year_i + \varepsilon_i \end{aligned} \tag{3}$$

The dependent variable is either the number of victims (*Victims*) or the number of fatalities (*Fatalities*) during an event. Independent variables of interest include *Legal Gun, D_Handguns, D_Revolver, D_Shotguns, D_Assault* and *High Capacity Magazine*. Additional control variables include *Age* and the indicator variables for *Minority, School, Workplace, Culture of Honour State* and *Mental Illness*. In addition to the demographic information about the gunman and the venue, we also control for the outcome of the event. *Arrested* is an indicator variable for whether the gunman was arrested. *Shot by Police* is an indicator variable for whether the gunman was shot by police officers. The omitted dummy category consists of cases when the gunman committed suicide. As before, we also control for *Year*.

Since the dependent variables are discrete count variables, we use negative binomial regressions. While the Poisson regression also allows for consistent estimates using count data, the Poisson model makes more restrictive distributional assumptions than the negative binomial model by requiring means and variances to be equal. The summary statistics of both *Victims* and *Fatalities* in Table 2 show that the variances of both *Victims* and *Fatalities* are much larger than the means, suggesting that the dependent variables are over-dispersed. Therefore, we report the results from the negative binomial regressions along with robust standard errors in Table 5, although we note that qualitatively similar results are found when we use Poisson regressions to estimate Equation (3).

Column 1 shows the results from a simple regression where the dependent variable is *Victims* and the only independent variable is the indicator variable *Legal Gun*. We do not find that *Legal Gun* produces an estimate that is significantly different from zero. In column 2, we include indicator variables for each of the gun types. We find that the estimates for each of the indicator variables produce positive estimates that are statistically different from zero. However, we cannot reject the null that the coefficients are equal to each other. This suggests that there is not one type of gun that causes more victims than another. In column 3, we estimate a simple regression where we only include the indicator variable *High Capacity Magazine* and find that the estimate is positive and statistically significant. In column 4, we find that *D_Handguns* and *D_Shotguns* retain their positive and significant estimates, but the coefficients on *D_Revolvers* and *D_Assault* do not. Moreover, the coefficient on *D_Assault* is statistically lower than the coefficients on *D_Handguns* and *D_Shotguns* and the coefficient on *D_Revolvers* is statistically lower than the coefficient on *D_Shotguns*. We also note that *High Capacity Magazine* produces a positive and significant estimate, which is similar to the simple regression in column 3. A few other results are noteworthy. We find significantly negative

Table 5. Determining the number of victims and fatalities: effect of gun types.

	Dependent variable: victims				Dependent variable: fatalities			
	1	2	3	4	5	6	7	8
Legal Gun	−0.122			0.118	−0.242			0.011
	(0.222)			(0.143)	(0.250)			(0.181)
D_Handguns		0.430**		0.386***		0.431**		0.437***
		(0.173)		(0.141)		(0.189)		(0.168)
D_Revolvers		0.288**		0.143		0.541***		0.330***
		(0.138)		(0.125)		(0.129)		(0.119)
D_Shotguns		0.443***		0.620***		0.391**		0.605***
		(0.170)		(0.132)		(0.181)		(0.161)
D_Assault		0.373**		−0.083		0.097		−0.234
		(0.160)		(0.152)		(0.172)		(0.185)
High Capacity Magazine			0.591***	0.478***			0.403**	0.388**
			(0.154)	(0.147)			(0.166)	(0.164)
Age				−0.009***				−0.004
				(0.003)				(0.004)
Minority				−0.074				0.068
				(0.114)				(0.142)
School				−0.393**				−0.570***
				(0.191)				(0.219)
Workplace				−0.517***				−0.719***
				(0.134)				(0.136)
Culture of Honour State				0.072				−0.046
				(0.105)				(0.137)
Mental Illness				0.339***				0.261**
				(0.113)				(0.131)
Arrested				−0.186				−0.598***
				(0.119)				(0.137)
Shot by Police				−0.246*				−0.441***
				(0.136)				(0.171)
Year				−0.034***				−0.031***
				(0.007)				(0.008)
Observations	184	184	184	184	184	184	184	184

Coefficients from negative binomial regressions. Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

coefficients for *Age, School, Workplace, Shot by Police* and *Year* and a positive and significant coefficient on the indicator variable *Mental Illness*. This latter finding suggests that mentally ill gunman generally inflict injury upon a greater number of individuals. The negative coefficient on *Year* suggests that while the likelihood of events has increased over time the severity as measured by victims and fatalities has decreased.

To determine the economic magnitude of any of the estimated coefficients, we transform the negative binomial estimate into percentage differences using the expression $100 \times \{\exp(\beta_j) - 1\}$, where β_j is one of the j estimated coefficients from Equation (3). Focusing on column 4, the use of this expression for the estimated coefficient for, say, *D_Handguns*, we find that when a handgun is used by a gunman, the number of victims increases approximately 47%. When shotguns or high-capacity magazines are used, the number of victims increases by 86% or 61%, respectively. Further, mentally ill gunmen generally have a 40% higher number of victims than non-mentally ill gunman.

The results in column 4 provide some important insights into the outcomes of active shooter events. First, we find that mental illness and high-capacity magazines are positively correlated with the number of victims during these types of incidents. Second, while handguns and shotguns also correlated with the number of victims, assault weapons are not. Third, younger shooters, at places other than schools or workplaces, generally have a higher number of victims. Lastly, we find that, in cases where the gunman is shot by police, the number of victims decreases by nearly 28%.

Columns 5–8 report the results when the number of fatalities is used as the dependent variable. Results in columns 5–7 are generally similar to those in the full model (column 8), so, for brevity, we only discuss the findings in column 8. We also find that the conclusions that we draw in column 4 are somewhat similar to those in column 8. For instance, *D_Handguns, D_Shotguns, High Capacity Magazines* and *Mental Illness* produce positive estimates while *School, Workplace, Shot by Police* and *Year* produce negative coefficients. However, we also find a significantly positive estimate on *D_Revolvers* and a significantly negative estimate on *Arrested*. Focusing on the magnitude of the coefficients in column 8 to the corresponding coefficients in column 4, the economic significance seems to be similar between columns.[13,14]

Next, we extend our analysis by examining the number of guns and gun types instead of looking only at the whether a particular type of gun was used in the mass shooting. To do so, we estimate a variant of Equation (3) as follows:

$$\begin{aligned} Victims/Fatalities_i = \beta_0 &+ \beta_1 \# Gun_i \\ &+ \beta_2 \# Hand\ guns_i \\ &+ \beta_3 \# Revolvers_i \\ &+ \beta_4 \# Shotguns_i + \beta_5 \# Assault_i \\ &+ \beta_6 Age_i + \beta_7 Minority_i \\ &+ \beta_8 School_i + \beta_9 Workplace_i \\ &+ \beta_{10} Culture\ of\ Honour\ State_i \\ &+ \beta_{11} Mental\ Illness_i \\ &+ \beta_{12} Arrested_i + \beta_{13} Shot\ by \\ &Police_i + \beta_{14} Year_i + \varepsilon_i \end{aligned} \tag{4}$$

In Equation (4), the dependent and independent variables are the same as in Equation (3) with one exception. Instead of including indicator variables for gun types, in Equation (4) we include the total number of guns (*#Guns*), the number of handguns (*#Handguns*), the number of revolvers (*#Revolvers*), the number of shotguns (*#Shotguns*) and the number of assault weapons (*#Assault Guns*). The results are reported in Table 6. For brevity, we will discuss the results from the full models in columns 3 and 4 and columns 7 and 8. In column 3, we find that, after controlling for a variety of independent variables, the estimate for *#Guns* is significantly positive. In economic terms, a unit increase in the number of guns is associated with a 21.7% increase in the number of

[13]As a measure of robustness, we estimate Equation (3) using a different definition for assault weapons. Instead of the definition used for Assault Weapons according to FBI reports, we redefine Assault Weapons using a broader definition that has been used in a bill that was introduced 24 January 2013 that would impose various bans on assault weapons. Results from these tests again show that whether a gun that was used under this alternative definition is unrelated to the number of injured victims or the number of fatalities.

[14]As another measure of robustness, instead of including an indicator variable for the use of high-capacity magazines, we include the number of guns that were used with high-capacity magazines. These unreported tests also show a direct relation between the number of guns with high-capacity magazines and the number of injured victims as well as the number of fatalities. The results from these tests are available upon request from the authors.

Table 6. Determining the number of victims and fatalities: effect of the number of guns.

	Dependent variable: victims				Dependent variable: fatalities			
	1	2	3	4	5	6	7	8
#Guns	0.268***		0.196***		0.228***		0.178***	
	(0.072)		(0.058)		(0.068)		(0.057)	
#Handguns		0.300***		0.258***		0.288***		0.247**
		(0.095)		(0.078)		(0.109)		(0.097)
#Revolvers		0.051		−0.047		0.238		0.104
		(0.095)		(0.066)		(0.169)		(0.067)
#Shotguns		0.331**		0.362***		0.285*		0.369***
		(0.135)		(0.114)		(0.152)		(0.135)
#Assault Guns		0.323**		0.189*		0.081		−0.006
		(0.133)		(0.100)		(0.132)		(0.127)
Age			−0.010***	−0.010***			−0.005	−0.005
			(0.003)	(0.003)			(0.005)	(0.004)
Minority			−0.053	−0.000			0.128	0.161
			(0.128)	(0.125)			(0.153)	(0.148)
School			−0.484**	−0.514***			−0.645***	−0.668***
			(0.201)	(0.194)			(0.217)	(0.207)
Workplace			−0.648***	−0.669***			−0.811***	−0.833***
			(0.152)	(0.148)			(0.141)	(0.138)
Culture of Honour State			0.032	0.051			−0.076	−0.073
			(0.110)	(0.107)			(0.145)	(0.139)
Mental Illness			0.326***	0.338***			0.251*	0.273**
			(0.120)	(0.118)			(0.141)	(0.136)
Arrested			−0.165	−0.153			−0.581***	−0.585***
			(0.131)	(0.124)			(0.145)	(0.140)
Shot by Police			−0.200	−0.216*			−0.376**	−0.389**
			(0.139)	(0.130)			(0.178)	(0.168)
Year			−0.026***	−0.029***			−0.025***	−0.026***
			(0.007)	(0.007)			(0.007)	(0.007)
Observations	184	184	184	184	184	184	184	184

Coefficients from negative binomial regressions. Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

victims. The other control variables produce coefficients that are similar in sign and magnitude to the corresponding coefficients in the previous table. In column 4, we find that the estimates for *#Handguns*, *#Shotguns* and *#Assault Guns* produce estimates that are positive and significant at the 0.10 level or lower. In economic terms, a unit increase in the number of handguns, shotguns and assault weapons is associated with a 29%, 44% and 21% increase, respectively, in the number of victims. In this case, we cannot say that assault guns have a statistically different impact on victims than the other types of guns.

Columns 5–8 report the results when the dependent variable is the number of fatalities. We report that while *#Handguns* and *#Shotguns* produce positive and significant estimates, *#Assault Guns* does not. In addition, the coefficient on *#Assault Guns* is statistically lower than the coefficients on *#Handguns* and *#Shotguns*. We still observe negative coefficients on the indicator variables for *School, Workplace, Arrested, Shot by Police* and *Year*. Further, the estimate for *Mental Illness* is positive and significant. Results in this subsection have interesting and important implications. First, the use of assault weapons is not necessarily associated with more injuries or more deaths in our cross section of active shooter events. Instead, the use of handguns and shotguns is more highly correlated with the number of victims/fatalities. Second, mentally ill gunmen have a higher number of victims and fatalities than non-mentally ill gunmen. Third, law enforcement (in terms of arresting the gunmen or shooting the gunmen) is associated with a decrease in the number of victims/fatalities. The inferences from these tests are likely to contribute to the ongoing gun policy debate.[15]

Explaining the number of victims and fatalities: mental health characteristics

In Table 2, we found that 46% of the individuals responsible for active shooter events in the United States showed possible signs of mental illness according to various reports. Further, our findings in Tables 5 and 6 seem to indicate that mental illness is associated

[15]As mentioned in footnote 6, we use an alternative definition for assault weapons according to a bill voted on by the U.S. senate on 24 January 2013. Using this alternative definition for assault weapons, we are able to draw similar conclusions to those drawn in Table 6.

with a higher number of victims/fatalities. Given these statistics, we provide a more thorough examination of the role that mental illness plays in explaining the total number of victims and the number of fatalities. We not only examine reports of possible signs of mental illness, but we also gather information about the types of medication the gunman was prescribed and whether or not the gunman was on or off the prescribed medication at the time of the mass shooting.

We estimate the following equation using our cross-sectional sample of active shooter events:

$$\begin{aligned} \mathit{Victims/Fatalities}_i = \beta_0 &+ \beta_1 \mathit{MentalIll}_i \\ &+ \beta_2 \mathit{Use\,DepMed}_i \\ &+ \beta_3 \mathit{OffDepMed}_i \\ &+ \beta_4 \mathit{Age}_i + \beta_5 \mathit{Minority}_i \\ &+ \beta_6 \mathit{School}_i + \beta_7 \mathit{Workplace}_i \\ &+ \beta_8 \mathit{Culture\ of\ Honour\ State}_i \\ &+ \beta_8 \mathit{Arrested}_i + \beta_9 \mathit{PoliceShot}_i \\ &+ \beta_{10} \mathit{Year}_i + \varepsilon_i \end{aligned} \tag{5}$$

As before, the dependent variables are either the number of victims or the number of fatalities. The independent variables are similar to those used in the previous section. We control for *Age, Year* and include the indicator variables for *Minority, School, Workplace, Culture of Honour State, Arrested* and *Shot by Police*. The independent variables of interest in Equation (5) are the indicator variable, *Mental Illness*, for whether there were reported signs of mental illness in the gunman, the indicator variable *Use Depression Med*, for whether the gunman had reportedly been prescribed depression medication, and the indicator variable *Off Depression Med*, for whether the gunman had previously been prescribed depression medication, but was reported off the depression medication at the time of the incident.

Results from estimating Equation (5) using negative binomial regressions are reported in Table 7 along with robust standard errors. As before, in unreported tests we estimate Equation (5) using Poisson regressions and find results to be qualitatively similar to our negative binomial results. Columns 1–3 and 6–8 present the results from simple regressions where we include each independent variable of interest. Columns 5 and 10 report the results from estimating the full model for each dependent variable. Because we are able to draw inferences from the full models that are similar to those from the various simple regressions, we only discuss our findings in columns 5 and 10.

Column 5 shows that after controlling for a variety of other variables both *Mental Illness* and *Use Depression Med* produce estimates that are positive

Table 7. Determining the number of victims and fatalities: effect of mental status.

	Dependent variable: victims					Dependent variable: fatalities				
	1	2	3	4	5	6	7	8	9	10
Mental Illness	0.456***			0.396**	0.312**	0.325**			0.236	0.192
	(0.154)			(0.165)	(0.138)	(0.163)			(0.171)	(0.151)
Use Depression Med		0.518***		0.381**	0.335**		0.645***		0.513***	0.531***
		(0.156)		(0.165)	(0.162)		(0.136)		(0.152)	(0.163)
Off Depression Med			−0.279	−0.230	0.101			−0.933***	−0.833***	−0.448**
			(0.242)	(0.225)	(0.189)			(0.168)	(0.178)	(0.180)
Age					−0.010***					−0.004
					(0.004)					(0.005)
Minority					−0.137					0.032
					(0.138)					(0.162)
School					−0.433*					−0.514**
					(0.231)					(0.239)
Workplace					−0.622***					−0.693***
					(0.165)					(0.141)
Culture of Honour State					0.041					−0.074
					(0.121)					(0.156)
Arrested					−0.190					−0.603***
					(0.136)					(0.151)
Shot by Police					−0.232*					−0.386**
					(0.138)					(0.169)
Year					−0.031***					−0.031***
					(0.008)					(0.007)
Observations	184	184	184	184	184	184	184	184	184	184

Coefficients from negative binomial regressions. Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

and significantly differ from zero. These results suggest that differences in the mental health of the gunmen are directly associated with the number of victims in an active shooter event. This finding also states that despite the use of depression medication mental illness still has a direct effect on the number of victims.

Column 10 presents the coefficients when using the number of fatalities as the dependent variable. Here, we do not find that mental health of the gunman is correlated with the number of fatalities. However, we again find that the use of depression medication is associated with a higher number of fatalities. Interestingly, being off of depression medication is associated with a significantly lower number of fatalities. The coefficients for *School, Workplace, Arrested* and *Shot by Police* are again negative and significant at the 0.05 level, which is consistent with our findings in the previous tables. The results in this subsection have some important implications that might also add to the gun policy debate. While Table 2 shows that about 46% of gunmen had signs of mental illness, Tables 5 and 6 present some evidence that mental illness is indeed an important determinant of the number of victims/fatalities. In this last table, we observe that the use of depression medication is also associated with a high number of victims/fatalities. This could mean one of two things. First, the use of depression medication may simply signal that a particular gunman had severe mental health issues, which could explain the higher number of victims/fatalities. Second, our findings might suggest that depression medication is not an important deterrent in the severity of crimes committed by the mentally ill.[16]

IV. Conclusion

After recent active shooter events, policymakers have renewed the debate about how to prevent more of these incidents from occurring. A call for greater regulation has been made by the public as well as by politicians. However, little is known about the factors that impact whether an event occurs and the outcomes of such events. To inform policy, this study takes a comprehensive look at these types of incidents in the United States during the last 31 years. Our analyses find that most gun laws are not correlated with whether an event occurs, with the exception of state assault weapons laws which show a consistent negative correlation. However, neither state nor federal assault weapons laws are significantly related to whether these types of weapons are used in active shooter events.

When taking a closer look at the incidents themselves, our multivariate results show that the use of assault weapons is not generally associated with an increase in the number of victims or the number of fatalities. On the other hand, the uses of high-capacity magazines, handguns and shotguns are all consistently associated with increases in both the number of victims and fatalities. Combined with earlier findings, these results suggest that policymakers might want to focus future policy on other areas besides the regulation of assault weapons.

Our tests also show that signs of mental illness in the gunman are positively correlated with the number of victims and fatalities. In particular, current use of depression medication is significantly correlated with an increase in the number of victims and fatalities. These results indicate that improvements in mental health may reduce the severity of active shooter events.

Disclosure statement

No potential conflict of interest was reported by the authors.

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[16]We also ran regressions where we interacted mental illness with our other variables such as age, minority status and venue. We did not find any significant interaction effects.

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The Effect of Large-Capacity Magazine Bans on High-Fatality Mass Shootings, 1990–2017

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Objectives. To evaluate the effect of large-capacity magazine (LCM) bans on the frequency and lethality of high-fatality mass shootings in the United States.

Methods. We analyzed state panel data of high-fatality mass shootings from 1990 to 2017. We first assessed the relationship between LCM bans overall, and then federal and state bans separately, on (1) the occurrence of high-fatality mass shootings (logit regression) and (2) the deaths resulting from such incidents (negative binomial analysis). We controlled for 10 independent variables, used state fixed effects with a continuous variable for year, and accounted for clustering.

Results. Between 1990 and 2017, there were 69 high-fatality mass shootings. Attacks involving LCMs resulted in a 62% higher mean average death toll. The incidence of high-fatality mass shootings in non–LCM ban states was more than double the rate in LCM ban states; the annual number of deaths was more than 3 times higher. In multivariate analyses, states without an LCM ban experienced significantly more high-fatality mass shootings and a higher death rate from such incidents.

Conclusions. LCM bans appear to reduce both the incidence of, and number of people killed in, high-fatality mass shootings. (*Am J Public Health*. 2019;109:1754–1761. doi: 10.2105/AJPH.2019.305311)

The recent spate of gun massacres in the United States has re-energized the debate over how to prevent such tragedies.[1] A common response to high-profile acts of gun violence is the promotion of tighter gun legislation, and there is some evidence that laws imposing tighter restrictions on access to firearms have been associated with lower levels of mass shootings.[2] One proposal that has received renewed interest involves restricting the possession of large-capacity magazines (LCMs).[3–5] This raises an important question: what has been the impact of LCM bans on high-fatality mass shootings?

In an attempt to arrest an uptick in mass shooting violence in the early 1990s, Congress in 1994 enacted the federal assault weapons ban, which, among other things, restricted ownership of certain ammunition-feeding devices.[6,7] The law, which contained a sunset provision, was allowed to expire a decade later. Pursuant to that ban (18 USC §921(a) [1994]; repealed), it was illegal to possess LCMs—defined as any ammunition-feeding device holding more than 10 bullets—unless the magazines were manufactured before the enactment of the ban. LCM restrictions are arguably the most important component of assault weapons bans because they also apply to semiautomatic firearms without military-style features.[8,9]

Beginning with New Jersey in 1990, some states implemented their own regulations on LCMs. Today, 9 states and the District of Columbia restrict the possession of LCMs. The bans vary along many dimensions, including maximum bullet capacity of permissible magazines, grandfathering of existing LCMs, and applicable firearms. Moreover, overlaps sometimes exist between assault weapons bans and LCM bans, but not in all states. For example, California instituted a ban on assault weapons in 1989, but LCMs remained unregulated in the state until 1994, when the federal ban went into effect. In 2000, California's own statewide ban on LCMs took effect as a safeguard in the event the federal ban expired, which happened in 2004.[10,11]

LCMs provide a distinct advantage to active shooters intent on murdering numerous people: they increase the number of rounds that can be fired at potential victims before having to pause to reload or switch weapons. Evidence shows that victims struck by multiple rounds are more likely to die, with 2 studies finding that, when compared with the fatality rates of gunshot wound victims who were hit by only a single bullet, the fatality rates of those victims hit by more than 1 bullet were more than 60% higher.[12,13] Being able to strike human targets with more than 1 bullet increases shooters' chances of killing their victims. Analyses of gunshot wound victims at level I trauma centers have suggested that this multiple-impact capability is often attributable to the use of LCMs.[14,15]

In addition, LCMs provide active shooters with extended cover.[16] During an attack, perpetrators are either firing their guns or not firing their guns. While gunmen are firing, it is extremely difficult for those in the line of fire to take successful defensive maneuvers. But if gunmen run out of bullets, there are lulls in the shootings, as the perpetrators are forced to pause their attacks to reload or change weapons. These pauses provide opportunities for people to intervene and disrupt a shooting. Alternatively, they provide individuals in

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harm's way with a chance to flee or hide. Legislative endeavors that restrict access to LCMs are implemented with the express objective of reducing an active shooter's multiple-impact capability and extended cover.[10]

Although mass shootings have received extensive study, there has been little scholarly analysis of LCM bans.[17–24] The studies undertaken that have broached the subject of ammunition capacity have primarily concentrated on the effect of LCM bans on violent crimes other than mass shootings or on the impact of the assault weapons bans on mass shootings.[25–27]

Evidence suggests that firearms equipped with LCMs are involved in a disproportionate share of mass shootings.[10,20,28] Proponents of LCM bans believe that without LCMs, fewer people will be killed in a mass shooting, other things equal. In turn, fewer shootings will cross the threshold required to be classified as what we call a "high-fatality mass shooting" (≥ 6 victims shot to death). If LCM bans are effective, we should expect to find that high-fatality mass shootings occur at a lower incidence rate when LCM bans are in place, and fewer people are killed in such attacks. But have LCM bans actually saved lives in practice? To our knowledge, the impact of LCM bans has never been systematically assessed. This study fills that void.

METHODS

Mass shootings have been defined in a variety of ways, with some analyses setting the casualty threshold as low as 2 people wounded or killed and others requiring a minimum of 7 gunshot victims.[18,22,29] We focused on high-fatality mass shootings—the deadliest and most disturbing of such incidents—which are defined as intentional crimes of gun violence with 6 or more victims shot to death, not including the perpetrators.[20,30,31] After an exhaustive search, we identified 69 such incidents in the United States between 1990 and 2017. We then discerned whether each high-fatality mass shooting involved a LCM—unless otherwise stated, defined consistent with the 1994 federal ban as a detachable ammunition-feeding device capable of holding more than 10 bullets. (See Table 1 for a list of incidents and for additional details on the search and identification strategy we employed.)

The first state to enact an LCM ban was New Jersey in 1990. Since then, another 8 states and the District of Columbia have enacted LCM bans (Table A, available as a supplement to the online version of this article at http://www.ajph.org).[10] With no LCM bans in effect before 1990, a priori we chose that year to begin our analysis to avoid inflating the impact of the bans. Our data set extends 28 years, from 1990 through 2017. As a secondary analysis, we used a 13-year data set, beginning in 2005, the first full year after the federal assault weapons ban expired.

Our primary outcome measures were the incidence of high-fatality mass shootings and the number of victims killed. We distinguished between high-fatality mass shootings occurring with and without a ban in effect. Because the federal ban was in effect nationwide from September 13, 1994, through September 12, 2004, we coded every state as being under an LCM ban during that 10-year timeframe.

Our interest was in the effect of LCM bans. We ran regression analyses to determine if any relationship between LCM bans and high-fatality mass shootings can be explained by other factors. In our state–year panel multivariate analyses, the outcome variables were (1) whether an LCM-involved high-fatality mass shooting occurred, (2) whether any high-fatality mass shooting occurred, (3) the number of fatalities in an LCM-involved high-fatality mass shooting, and (4) the number of fatalities in any high-fatality mass shooting. Our analyses first combined and then separated federal and state LCM bans.

Consistent with the suggestions and practices of the literature on firearm homicides and mass shootings, our explanatory variables are population density; proportion of population aged 19 to 24 years, aged 25 to 34 years, that is Black, and with a college degree; real per-capita median income; unemployment rate; and per-capita prison population.[2,26,27,32] We also added a variable for percentage of households with a firearm. All regression models controlled for total state population. When the dependent variable reflected occurrences of incidents (ordered choice data), we used logit regression; we ran probit regression as a sensitivity analysis. We had multiple observations for individual states. To control for this, we utilized cluster-robust standard errors to account for the clustering of observations. When the dependent variable reflected deaths (count data), we used negative binomial regression; Gius used a Poisson regression, and we used that approach as a sensitivity analysis.[26] We included state fixed effects. We used a continuous variable for year because the rate of high-fatality mass shootings has increased over time. For purposes of sensitivity analysis, we also replaced the linear yearly trend with a quadratic function. We performed multivariate statistical analyses by using Stata/IC version 15.1 (StataCorp LP, College Station, TX).

Population data came from the US Census Bureau, unemployment data came from the Bureau of Labor Statistics, and imprisonment data came from the Bureau of Justice Statistics. The percentage of households with a firearm was a validated proxy (the percentage of suicides that are firearm suicides) derived from Centers for Disease Control and Prevention National Vital Statistics Data.[33]

RESULTS

Between 1990 and 2017, there were 69 high-fatality mass shootings (≥ 6 victims shot to death) in the United States. Of these, 44 (64%) involved LCMs, 16 did not (23%), and for 9 (13%) we could not determine whether LCMs were used (Table 1). The mean number of victims killed in the 44 LCM-involved high-fatality mass shootings was 11.8; including the unknowns resulted in that average falling to 11.0 (not shown). The mean number of victims killed in high-fatality mass shootings in which the perpetrator did not use an LCM was 7.3 (Table B, available as a supplement to the online version of this article at http://www.ajph.org); including the unknowns resulted in that average falling to 7.1 (not shown). When we excluded unknown cases, the data indicated that utilizing LCMs in high-fatality mass shootings resulted in a 62% increase in the mean death toll.

Data sets of mass shooting fatalities by their nature involve truncated data, with the mode generally being the baseline number of fatalities required to be included in the data set (6 fatalities in the current study). Our data

TABLE 1—High-Fatality Mass Shootings in the United States, 1990–2017

Incident	Date	City	State	LCM	Deaths, No.	State LCM Ban	Federal Assault Weapons Ban
1	Jun 18, 1990	Jacksonville	FL	Y	9	N	N
2	Jan 26, 1991	Chimayo	NM	N	7	N	N
3	Aug 9, 1991	Waddell	AZ	N	9	N	N
4	Oct 16, 1991	Killeen	TX	Y	23	N	N
5	Nov 7, 1992	Morro Bay and Paso Robles	CA	N	6	N	N
6	Jan 8, 1993	Palatine	IL	N	7	N	N
7	May 16, 1993	Fresno	CA	Y	7	N	N
8	Jul 1, 1993	San Francisco	CA	Y	8	N	N
9	Dec 7, 1993	Garden City	NY	Y	6	N	N
10	Apr 20, 1999	Littleton	CO	Y	13	Y	Y
11	Jul 12, 1999	Atlanta	GA	U	6	Y	Y
12	Jul 29, 1999	Atlanta	GA	Y	9	Y	Y
13	Sep 15, 1999	Fort Worth	TX	Y	7	Y	Y
14	Nov 2, 1999	Honolulu	HI	Y	7	Y	Y
15	Dec 26, 2000	Wakefield	MA	Y	7	Y	Y
16	Dec 28, 2000	Philadelphia	PA	Y	7	Y	Y
17	Aug 26, 2002	Rutledge	AL	N	6	Y	Y
18	Jan 15, 2003	Edinburg	TX	U	6	Y	Y
19	Jul 8, 2003	Meridian	MS	N	6	Y	Y
20	Aug 27, 2003	Chicago	IL	N	6	Y	Y
21	Mar 12, 2004	Fresno	CA	N	9	Y	Y
22	Nov 21, 2004	Birchwood	WI	Y	6	N	N
23	Mar 12, 2005	Brookfield	WI	Y	7	N	N
24	Mar 21, 2005	Red Lake	MN	Y	9	N	N
25	Jan 30, 2006	Goleta	CA	Y	7	Y	N
26	Mar 25, 2006	Seattle	WA	Y	6	N	N
27	Jun 1, 2006	Indianapolis	IN	Y	7	N	N
28	Dec 16, 2006	Kansas City	KS	N	6	N	N
29	Apr 16, 2007	Blacksburg	VA	Y	32	N	N
30	Oct 7, 2007	Crandon	WI	Y	6	N	N
31	Dec 5, 2007	Omaha	NE	Y	8	N	N
32	Dec 24, 2007	Carnation	WA	U	6	N	N
33	Feb 7, 2008	Kirkwood	MO	Y	6	N	N
34	Sep 2, 2008	Alger	WA	U	6	N	N
35	Dec 24, 2008	Covina	CA	Y	8	Y	N
36	Jan 27, 2009	Los Angeles	CA	N	6	Y	N
37	Mar 10, 2009	Kinston, Samson, and Geneva	AL	Y	10	N	N
38	Mar 29, 2009	Carthage	NC	N	8	N	N
39	Apr 3, 2009	Binghamton	NY	Y	13	Y	N
40	Nov 5, 2009	Fort Hood	TX	Y	13	N	N
41	Jan 19, 2010	Appomattox	VA	Y	8	N	N

Continued

TABLE 1—*Continued*

Incident	Date	City	State	LCM	Deaths, No.	State LCM Ban	Federal Assault Weapons Ban
42	Aug 3, 2010	Manchester	CT	Y	8	N	N
43	Jan 8, 2011	Tucson	AZ	Y	6	N	N
44	Jul 7, 2011	Grand Rapids	MI	Y	7	N	N
45	Aug 7, 2011	Copley Township	OH	N	7	N	N
46	Oct 12, 2011	Seal Beach	CA	N	8	Y	N
47	Dec 25, 2011	Grapevine	TX	N	6	N	N
48	Apr 2, 2012	Oakland	CA	N	7	Y	N
49	Jul 20, 2012	Aurora	CO	Y	12	N	N
50	Aug 5, 2012	Oak Creek	WI	Y	6	N	N
51	Sep 27, 2012	Minneapolis	MN	Y	6	N	N
52	Dec 14, 2012	Newtown	CT	Y	27	N	N
53	Jul 26, 2013	Hialeah	FL	Y	6	N	N
54	Sep 16, 2013	Washington	DC	N	12	Y	N
55	Jul 9, 2014	Spring	TX	Y	6	N	N
56	Sep 18, 2014	Bell	FL	U	7	N	N
57	Feb 26, 2015	Tyrone	MO	U	7	N	N
58	May 17, 2015	Waco	TX	Y	9	N	N
59	Jun 17, 2015	Charleston	SC	Y	9	N	N
60	Aug 8, 2015	Houston	TX	U	8	N	N
61	Oct 1, 2015	Roseburg	OR	Y	9	N	N
62	Dec 2, 2015	San Bernardino	CA	Y	14	Y	N
63	Feb 21, 2016	Kalamazoo	MI	Y	6	N	N
64	Apr 22, 2016	Piketon	OH	U	8	N	N
65	Jun 12, 2016	Orlando	FL	Y	49	N	N
66	May 27, 2017	Brookhaven	MS	U	8	N	N
67	Sep 10, 2017	Plano	TX	Y	8	N	N
68	Oct 1, 2017	Las Vegas	NV	Y	58	N	N
69	Nov 5, 2017	Sutherland Springs	TX	Y	25	N	N

Note. LCM = large-capacity magazine; N = no; U = unknown; Y = yes. From September 13, 1994, until and including September 12, 2004, each and every state, including the District of Columbia, was subject to a ban on LCMs pursuant to the federal assault weapons ban. To collect the data in Table 1, we searched the following news media resources for every shooting that resulted in 6 or more fatalities: America's Historical Newspapers, EBSCO, Factiva, Gannett Newsstand, Google News Archive, Lexis-Nexis, Newspaper Archive, Newspaper Source Plus, Newspapers.com, Newswires, ProQuest Historical Newspapers, and ProQuest Newsstand. We also reviewed mass shooting data sets maintained by *Mother Jones*, the *New York Times*, and *USA Today*. In addition to news media sources, we reviewed reports on mass shootings produced by think tank, policy advocacy, and governmental organizations, including the US Federal Bureau of Investigation Supplementary Homicide Reports, the crowdsourced Mass Shooting Tracker, and the open-source databases maintained by the Gun Violence Archive and the Stanford University Geospatial Center. Finally, when it was relevant, we also reviewed court records as well as police, forensic, and autopsy reports. As a general rule, when government sources were available, they were preferred over other sources. Furthermore, when media sources conflicted on the number of casualties or the weaponry involved, the later sources were privileged (as later reporting is often more accurate).

set of high-fatality mass shootings was no exception. As such, the median average number of fatalities for each subset of incidents—those involving and those not involving LCMs—was necessarily lower than the mean average. Nevertheless, like the mean average, the median average was higher when LCMs were employed—a median average of 8 fatalities per incident compared with 7 fatalities per incident for attacks not involving LCMs.

For the 60 incidents in which it was known if an LCM was used, in 44 the perpetrator used an LCM. Of the 44 incidents in which the perpetrators used LCMs, 77% (34/44) were in nonban states. In the 16 incidents in which the perpetrators did not use LCMs, 50% (8/16) were in nonban states (Table B, available as a supplement to the online version of this article at http://www.ajph.org). Stated differently, in nonban states, 81% (34/42) of high-fatality mass shooting perpetrators used LCMs; in LCM-ban states, only 55% (10/18) used LCMs.

The rate of high-fatality mass shootings increased considerably after September 2004 (when the federal assault weapons ban expired). In the 10 years the federal ban was in effect, there were 12 high-fatality mass shootings and 89 deaths (an average of 1.2 incidents and 8.9 deaths per year). Since then, through 2017, there have been 48 high-fatality mass shootings and 527 deaths (an average of 3.6 incidents and 39.6 deaths per year in these 13.3 years).

Of the 69 high-fatality mass shootings from 1990 to 2017, 49 occurred in states without an LCM ban in effect at the time and 20 in states with a ban in effect at the time. The annual incidence rate for high-fatality mass shootings in states without an LCM ban was 11.7 per billion population; the annual incidence rate for high-fatality mass shootings in states with an LCM ban was 5.1 per billion population. In that 28-year period, the rate of high-fatality mass shootings per capita was 2.3 times higher in states without an LCM ban (Table 2).

Non–LCM ban states had not only more incidents but also more deaths per incident (10.9 vs 8.2). The average annual number of high-fatality mass shooting deaths per billion population in the non–LCM ban states was 127.4. In the LCM ban states, it was 41.6 (Table 2).

For the time period beginning with the first full calendar year following the expiration of the federal assault weapons ban (January 1, 2005–December 31, 2017), there were 47 high-fatality mass shootings in the United States. Of these, 39 occurred in states where an LCM ban was not in effect, and 8 occurred in LCM ban locations. The annual incidence rate for high-fatality mass shootings in states without an LCM ban was 13.2 per billion population; for states with an LCM ban, it was 7.4 per billion population (Table 2). During this period, non–LCM ban states had not only more incidents but also more deaths per incident (11.4 vs 9.4). In terms of high-fatality mass shooting deaths per billion population, the annual number of deaths in the non–LCM ban states was 150.6; in the LCM ban states it was 69.2 (Table 2).

When we limited the analysis solely to high-fatality mass shootings that definitely involved LCMs, the differences between ban and nonban states became larger. For example, for the entire period of 1990 to 2017, of the 44 high-fatality mass shootings that involved LCMs, the annual incidence rate for LCM-involved high-fatality mass shootings in nonban states was 8.1 per billion population; in LCM-ban states it was 2.5 per billion population. The annual rate of high-fatality mass shooting deaths in the non–LCM ban states was 102.1 per billion population; in the LCM ban states it was 23.3. In terms of LCM-involved high-fatality mass shootings, we also found comparable wide differences in incidence and fatality rates between ban and nonban states for the post–federal assault weapons ban period (2005–2017; Table 2).

We found largely similar results in the multivariate analyses (1990–2017). States that did not ban LCMs were significantly more likely to experience LCM-involved high-fatality mass shootings as well as more likely to experience any high-fatality mass shootings (regardless of whether an LCM was involved). States that did not ban LCMs also experienced significantly more deaths from high-fatality mass shootings, operationalized as the absolute number of fatalities (Table 3).

When the LCM bans were separated into federal and state bans, both remained significantly related to the incidence of LCM-involved high-fatality mass shooting events and to the number of LCM-involved high-fatality mass shooting deaths. The associations between federal and state bans and

TABLE 2—High-Fatality Mass Shootings (≥ 6 Victims Shot to Death) by Whether LCM Bans Were in Effect: United States, 1990–2017

	Average Annual Population, No. (Millions)	Total Incidents, No.	Annual Incidents per Billion Population, No.	Total Deaths, No.	Annual Deaths per Billion Population, No.	Deaths per Incident, No.
All high-fatality mass shootings, 1990–2017 (28 y)						
Non–LCM ban states	149.7	49	11.7	534	127.4	10.9
LCM ban states	140.7	20	5.1	164	41.6	8.2
All high-fatality mass shootings, 2005–2017 (13 y)						
Non–LCM ban states	227.8	39	13.2	446	150.6	11.4
LCM ban states	83.4	8	7.4	75	69.2	9.4
LCM-involved high-fatality mass shootings, 1990–2017 (28 y)						
Non–LCM ban states	149.7	34	8.1	428	102.1	12.6
LCM ban states	140.7	10	2.5	92	23.3	9.2
LCM-involved high-fatality mass shootings, 2005–2017 (13 y)						
Non–LCM ban states	227.8	28	9.5	369	124.6	13.2
LCM ban states	83.4	4	3.7	42	38.7	10.5
Non-LCM high-fatality mass shootings, 1990–2017 (28 y)						
Non–LCM ban states	149.7	8	1.9	56	13.4	7.0
LCM ban states	140.7	8	2.0	60	15.2	7.5

Note. LCM = large-capacity magazine.

TABLE 3—Multivariate Results of the Relationship Between LCM Bans and High-Fatality Mass Shootings (≥ 6 Victims Shot to Death), 1990–2017 Combined Federal and State Large Capacity Magazine Bans: United States

	LCM-Involved High-Fatality Mass Shootings, b (95% CI)		All High-Fatality Mass Shootings, b (95% CI)	
	Incidents[a]	No. Deaths[b]	Incidents[a]	No. Deaths[b]
All LCM bans (federal and state)	−2.217 (−3.493, −0.940)	−5.912 (−9.261, −2.563)	−1.283 (−2.147, −0.420)	−3.660 (−5.695, −1.624)
Population density	−0.011 (−0.052, 0.031)	0.013 (−0.068, 0.095)	0.001 (−0.003, 0.006)	0.011 (−0.005, 0.026)
% aged 19–24 y	−0.480 (−1.689, 0.730)	−2.496 (−5.893, 0.901)	0.283 (−0.599, 1.164)	−0.585 (−2.666, 1.495)
% aged 25–34 y	−0.801 (−1.512, −0.089)	−2.390 (−4.391, −0.388)	−0.337 (−0.871, 0.197)	−1.114 (−2.463, 0.235)
% Black	−0.227 (−1.062, 0.607)	−0.654 (−2.831, 1.522)	−0.163 (−0.703, 0.377)	−0.261 (−1.391, 0.870)
% with a bachelor's degree or higher	−0.009 (−0.492, 0.474)	−0.469 (−1.590, 0.652)	0.143 (−0.214, 0.501)	0.183 (−0.715, 1.081)
Percentage of households with a firearm (proxy)	−0.047 (−0.195, 0.101)	−0.147 (−0.546, 0.251)	−0.020 (−0.131, 0.091)	−0.084 (−0.368, 0.200)
Median household income	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)
Unemployment rate	−0.072 (−0.293, 0.149)	−0.476 (−1.081, 0.129)	0.041 (−0.135, 0.216)	−0.182 (−0.628, 0.263)
Imprisonment rate (per 100 000 population)	−0.006 (−0.012, 0.001)	−0.007 (−0.017, 0.004)	−0.001 (−0.006, 0.003)	−0.003 (−0.012, 0.007)
Total population	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)
Pseudo R^2	0.31	0.16	0.26	0.11

Note. CI = confidence interval; LCM = large-capacity magazine. There were a total of 1428 observations in state-years (51 jurisdictions—all 50 states plus Washington, DC—over a 28-year period). Mean variance inflation factor = 3.49.

[a]Logit regression.

[b]Negative binomial regression.

the overall incidence of all high-fatality mass shootings as well as the total number of victims in these events remained strongly negative but was only sometimes statistically significant (Table 4).

In terms of sensitivity analyses, using probit instead of logit gave us similar results (not shown). When the outcome variable was the number of high-fatality mass shooting deaths, we obtained largely similar results concerning the association between LCM bans and the outcome variables, regardless of whether we used Poisson or negative binominal regression (not shown). Moreover, replacing the linear yearly trend with a quadratic function did not change the major results of the analyses (not shown). Variance inflation factors for all the independent variables never exceeded 10.0, with the variance inflation factor for LCM ban variables always being less than 2.0, indicating that there were no significant multicollinearity issues (Tables 3 and 4).

DISCUSSION

In the United States, LCMs are disproportionately used in high-fatality mass shootings (incidents in which ≥ 6 victims are shot to death). In at least 64% of the incidents since 1990, perpetrators used LCMs. (For 23%, we determined that they did not involve LCMs, and a determination could not be made for the remaining 13%.) Previous research has shown that LCM firearms are used in a high share of mass murders (typically defined as ≥ 4 homicides) and murders of police.[9]

We could not find reliable estimates of LCM firearms in the US gun stock. However, it is likely much lower than 64%, given that commonly owned firearms such as revolvers, bolt-action rifles, and shotguns are not typically designed to be LCM-capable. During the decade the federal assault weapons ban was in effect, no firearms were legally manufactured with LCMs for sale in the United States. In the postban era, semiautomatic firearms, especially pistols, are often sold with factory-issue LCMs, but firearms that are not semiautomatic are not sold with such magazines.

Why do we find LCMs so prominent among high-fatality mass shootings? We suspect there are 2 main reasons. The first is that perpetrators probably deliberately select LCMs because they facilitate the ability to fire many rounds without having to stop to reload. The second reason is that the ability of shooters to kill many victims—especially the 6 victims required to be included in our data set—may be reduced if LCMs are not available. In other words, the first explanation is that shooters perceive LCMs to be more effective at killing many people; the second explanation is that LCMs are indeed more effective at killing many people.

High-fatality mass shootings are not common, even in the United States. Between 1990 and 2017, there has been an average of 2.5 incidents per year, with an average of 25 people killed annually in such attacks. However, the number of incidents and the number of people killed per incident have been increasing since the end of the federal assault weapons ban.

In our study, we found that bans on LCMs were associated with both lower incidence of high-fatality mass shootings and lower fatality tolls per incident. The difference in incidence and overall number of fatalities between states, with and without bans, was even greater for LCM-involved high-fatality mass shootings.

The multivariate results are largely consistent with these bivariate associations. When we controlled for 10 independent variables often associated with overall crime rates, as well as state and year effects, states with LCM bans had lower rates of high-fatality mass shootings and fewer high-fatality mass shooting deaths. When we investigated federal and state bans separately in the multiple

TABLE 4—Multivariate Results of the Relationship Between Large Caliber Magazine Bans and High-Fatality Mass Shootings (≥ 6 Victims Shot to Death), 1990–2017 Separate Federal and State Large Caliber Magazine Bans: United States

	LCM-Involved High-Fatality Mass Shootings, b (95% CI)		All High-Fatality Mass Shootings, b (95% CI)	
	Incidents[a]	No. Deaths[b]	Incidents[a]	No. Deaths[b]
Federal LCM ban	−1.434 (−2.622, −0.245)	−3.571 (−7.103, −0.038)	−0.895 (−1.806, 0.016)	−2.570 (−4.902, −0.238)
State LCM bans	−2.603 (−4.895, −0.311)	−8.048 (−15.172, −0.925)	−1.277 (−2.977, 0.422)	−3.082 (−7.227, 1.064)
Population density	−0.012 (−0.055, 0.030)	−0.001 (−0.085, 0.083)	0.001 (−0.003, 0.006)	0.009 (−0.007, 0.024)
% aged 19–24 y	−0.311 (−1.499, 0.878)	−2.589 (−6.057, 0.879)	0.342 (−0.551, 1.236)	−0.531 (−2.759, 1.698)
% aged 25–34 y	−0.812 (−1.532, −0.093)	−2.660 (−4.848, −0.471)	−0.323 (−0.864, 0.217)	−0.848 (−2.236, 0.539)
% Black	−0.229 (−1.101, 0.643)	−0.770 (−3.232, 1.693)	−0.150 (−0.698, 0.398)	−0.154 (−1.321, 1.013)
% with a bachelor’s degree or higher	−0.031 (−0.447, 0.509)	−0.479 (−1.577, 0.618)	0.156 (−0.199, 0.511)	0.269 (−0.567, 1.106)
Percentage of households with a firearm (proxy)	−0.055 (−0.210, 0.101)	−0.227 (−0.651, 0.196)	−0.019 (−0.133, 0.094)	−0.107 (−0.399, 0.186)
Median household income	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)
Unemployment rate	−0.061 (−0.284, 0.162)	−0.420 (−1.041, 0.201)	0.046 (−0.132, 0.224)	−0.157 (−0.619, 0.305)
Imprisonment rate (per 100 000 population)	−0.006 (−0.013, 0.000)	−0.012 (−0.026, 0.002)	−0.002 (−0.007, 0.003)	−0.003 (−0.014, 0.007)
Total population	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)	0.000 (0.000, 0.000)
Pseudo R^2	0.30	0.15	0.26	0.11

Note. CI = confidence interval; LCM = large-capacity magazine. There were a total of 1428 observations in state-years (51 jurisdictions—all 50 states plus Washington, DC—over a 28-year period). Mean variance inflation factor = 3.45.
[a]Logit regression.
[b]Negative binomial regression.

regressions, both were significantly associated with the incidence of LCM-involved high-fatality mass shootings as well as the number of victims in LCM-involved attacks. The relationship between these bans, considered separately, and all high-fatality mass shooting incidence and deaths is often not statistically significant, although this may be attributable to lack of statistical power (number of observations) to find a statistically significant effect.

Our analysis provides answers to 4 important questions:

1. How often are LCMs used in high-fatality mass shootings? At minimum, 64% of high-fatality mass shootings perpetrated between 1990 and 2017 involved LCMs.
2. Are more people killed when LCMs are used? Yes, and the difference in our data set is substantial and statistically significant (11.8 vs 7.3). We should add that our results likely underestimate the difference because we have a truncated sample (we only examined incidents with at least 6 victim fatalities), compounded by the fact that the number of homicide incidents fell as the number of victims increased.
3. Do states with LCM bans experience high-fatality mass shootings involving LCMs at a lower rate and a lower fatality count than those states with no such bans in effect? Yes. In fact, the effect is more pronounced for high-fatality mass shootings involving LCMs than for those not involving LCMs.
4. Do states with LCM bans experience high-fatality mass shootings (regardless of whether they involve LCMs) at a lower rate and a lower fatality count than states with no such bans in effect? Yes.

Limitations

Our study had various limitations. First, although we carefully searched for every high-fatality mass shooting, it is possible that we might have missed some. Nevertheless, we suspect that this is unlikely, because it would mean that others who compiled lists have also missed the same ones, for we checked our list against multiple sources.

Second, our definition of a high-fatality mass shooting is a shooting that results in 6 or more fatal victims. A different threshold criterion (e.g., 6 or more people shot; 5 or more victims killed), might lead to somewhat different results. We expect that as the number of victims in a shooting increases, the likelihood that the perpetrator used an LCM also increases. Indeed, of the 13 high-fatality mass shootings with 10 or more fatalities in our data set, 12 (92%) involved an LCM.

Third, although many high-fatality mass shootings tend to be highly publicized, in 13% of the incidents we reviewed, we could not determine whether an LCM was used. As a sensitivity analysis, we assessed the assumptions that all of the unknown cases first did, and then did not, involve LCMs. Neither assumption appreciably changed our main results (not shown).

Fourth, as a general rule, clustering standard errors is most appropriate when there is a large number of treated units. Although during the decade of the federal assault weapons bans all 50 states plus the District of Columbia regulated LCMs, during the remaining time periods under examination, only 8 jurisdictions regulated LCMs. As a result, there is the possibility that the standard errors were underestimated in our analyses.[34]

Fifth, there were only 69 events that met our criterion for a “high-fatality mass shooting.” Although 69 is a horrific number of incidents, for statistical purposes, it is a relatively small number and limits the power to detect significant associations. For example, we did not have the statistical power (and thus did not even try) to determine whether different aspects of the various LCM laws might have differential effects on the incidence of high-fatality mass shootings. Moreover, because of suboptimal statistical power, there is also the possibility that the magnitude of the effects detected was overestimated.[35]

Public Health Implications

LCMs increase the ability to fire large numbers of bullets without having to pause to reload. Any measure that can force a pause in an active shooting—creating opportunities for those in the line of fire to flee, take cover, or physically confront a gunman—offers a possibility of reducing the number of victims in such an attack. To put it in different terms, if the only firearms available were 18th-century muskets, it is doubtful that mass shootings would be the social problem they are today.

The impact of individual state firearm laws is reduced by the fact that guns often move across state lines—occasionally purchased in locales with more permissive laws and taken to states with more restrictive laws. This is partly why efforts aimed at reducing the frequency and lethality of mass shootings must necessarily be multifaceted and multidisciplinary. Legal restrictions on firearms are merely a part of this broader, public health approach. That being said, the theory behind reducing the availability of LCMs to reduce the number of victims in mass shootings makes sense, and our empirical results, consistent with much of the limited literature on mass shootings, suggest that LCM bans have been effective in saving lives. AJPH

CONTRIBUTORS

L. Klarevas and D. Hemenway designed the study, collected the data, and contributed equally to all parts of the study. A. Conner ran the statistical analyses and helped construct the tables that report the results of the multivariate analyses. All authors approved the final article as submitted.

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CONFLICTS OF INTEREST

L. Klarevas has, in the past 2 years, served as an expert to the states of Colorado and California in civil litigation that involved the constitutionality of state restrictions on large-capacity magazines. The authors have no additional conflicts of interest to report.

HUMAN PARTICIPANT PROTECTION

No protocol approval was needed because no human participants were involved in this study.

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CRIMINOLOGY
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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

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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

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 & Schwieit, 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 quadradic 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

			Private Transfer Laws		Prohibitions Related to Domestic Violence Restraining Orders (DVROs)			
State	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	Assault Weapon Ban	Large-Capacity Magazine Ban	Private Transfer Laws: Purchaser licensing with in-person or fingerprinting	Private Transfer Laws: Point-of-sale background check only	Prohibitions Related to Domestic Violence Restraining Orders (DVROs): Final DVRO only	DVROs: Includes ex parte orders	DVROs: Includes dating partners	DVROs: 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					12/1/95–12/1/97	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					6/4/15			
South Dakota								
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	Assault Weapon Ban	Large-Capacity Magazine Ban	Private Transfer Laws: Purchaser licensing with in-person or fingerprinting	Private Transfer Laws: Point-of-sale background check only	Prohibitions Related to Domestic Violence Restraining Orders (DVROs): Final DVRO only	DVROs: Includes ex parte orders	DVROs: Includes dating partners	DVROs: 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								

State	Concealed Carry Permitting Laws: No issue	Concealed Carry Permitting Laws: May issue	Concealed Carry Permitting Laws: Shall issue with discretion	Concealed Carry Permitting Laws: Strict shall issue	Concealed Carry Permitting Laws: 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)

	Concealed Carry Permitting Laws					
State	**No issue**	**May issue**	**Shall issue with discretion**	**Strict shall issue**	**Permitless carry**	**Violent Misdemeanor Prohibition**
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)

	Concealed Carry Permitting Laws					
State	**No issue**	**May issue**	**Shall issue with discretion**	**Strict shall issue**	**Permitless carry**	**Violent Misdemeanor Prohibition**
North Dakota	pre-1984–8/1/85			8/1/85–8/1/17	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	

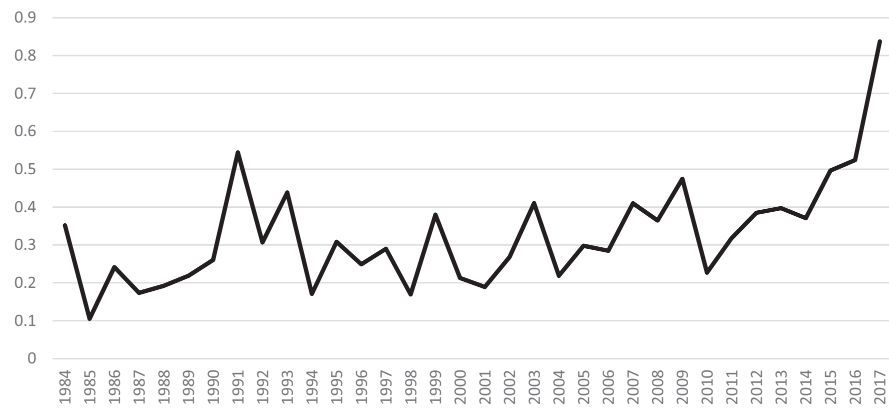

FIGURE 1 Victims in fatal mass shootings per 1 million population per year, 1984–2017

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.

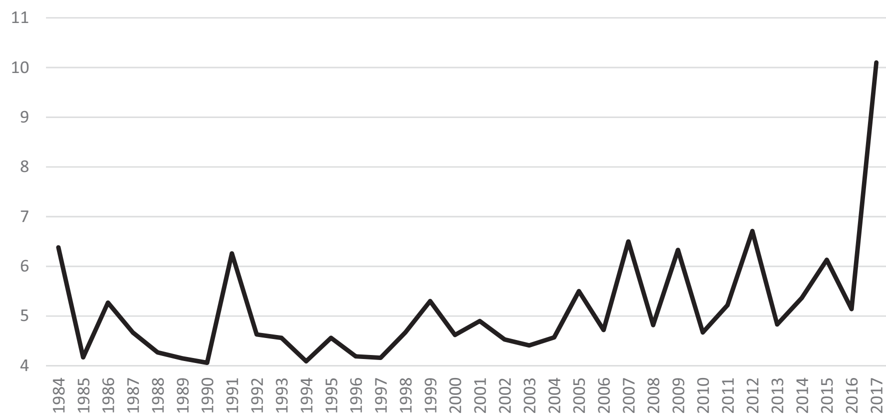

FIGURE 2 Mean number of victims murdered per incident in shootings involving 4+ victim fatalities, 1984–2017

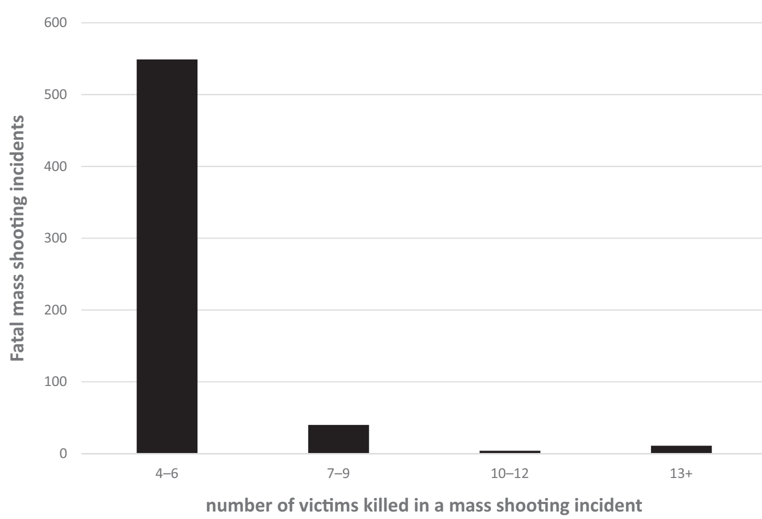

FIGURE 3 Number of incidents of fatal mass shootings by the number of victims killed, united states, 1984–2017

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

	Incidents (n = 604)		Victim Deaths (n = 2,976)	
Variable	**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

	Incidents (n = 182)		Victim Deaths (n = 842)	
Variable	**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

	Incidents (n = 401)		Victim Deaths (n = 2,057)	
Variable	**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; Tale 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.

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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.

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APPENDIX

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

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

(Continues)

TABLE A1 (Continued)

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

(Continues)

TABLE A1 (Continued)

State	All Fatal Mass Shootings: Mean Annual Rate of Mass Shootings per 1 Million Population	All Fatal Mass Shootings: Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population	Domestic-Linked Mass Shootings: Mean Annual Rate of Mass Shootings per 1 Million Population	Domestic-Linked Mass Shootings: Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population	Non–Domestic-Linked Mass Shootings: Mean Annual Rate of Mass Shootings per 1 Million Population	Non–Domestic-Linked Mass Shootings: Mean Annual Rate of Fatalities from Mass Shootings per 1 Million Population
South Carolina	.18	.88	.05	.20	.14	.68
South Dakota	.08	.34	.08	.34	.00	.00
Tennessee	.07	.29	.02	.07	.05	.20
Texas	.09	.47	.02	.11	.06	.34
Utah	.07	.40	.04	.19	.04	.21
Vermont	.10	.38	.00	.00	.10	.38
Virginia	.08	.48	.03	.13	.06	.35
Washington	.08	.38	.03	.12	.05	.26
West Virginia	.14	.64	.08	.34	.06	.30
Wisconsin	.04	.24	.01	.06	.03	.15
Wyoming	.12	.47	.12	.47	.00	.00
Overall	.07	.36	.03	.12	.04	.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 (n = 604 shootings) IRR (IRR[a])	95% CI (95% CI[a])	Fatalities in All Fatal Mass Shootings (n = 2,976 fatalities) 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)

	All Fatal Mass Shooting Incidents (n = 604 shootings)		Fatalities in All Fatal Mass Shootings (n = 2,976 fatalities)	
Variable	**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]

[a]Parsimonious model results.
[b]Handgun 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 (n = 182 shootings) IRR (IRR[a])	95% CI (95% CI[a])	Fatalities in Domestic-Linked Mass Shootings (n = 842 fatalities) 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 (*n* = 182 shootings) IRR (IRR[a])	95% CI (95% CI[a])	Fatalities in Domestic-Linked Mass Shootings (*n* = 842 fatalities) 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]

[a]Parsimonious model results.

[b]Handgun 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 (n = 401 shootings) IRR (IRR[a])	95% CI (95% CI[a])	Fatalities in Non–Domestic-Linked Mass Shootings (n = 2,057 fatalities) 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 (n = 401 shootings)		Fatalities in Non–Domestic-Linked Mass Shootings (n = 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]

[a]Parsimonious model results.

[b]Handgun 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

	All Fatal Mass Shooting Incidents (n = 604 shootings)		Fatalities in All Fatal Mass Shootings (n = 2, 976 fatalities)	
Variable	**IRR**	**95% CI**	**IRR**	**95% CI**
Concealed carry permit—may issue reference	.88	[.52, 1.48]	1.31	[.74, 2.32]
No issue				
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]

[a]Handgun 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 (n = 182 shootings) IRR	95% CI	Fatalities in Domestic-Linked Mass Shootings (n = 842 fatalities) 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]

[a]Handgun 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 (*n* = 182 shootings) IRR	95% CI	Fatalities in Non–Domestic-Linked Mass Shootings (*n* = 2,057 fatalities) 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]

[a]Handgun 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) IRR	95% CI	Fatalities in All Fatal Mass Shootings (n = 2, 976 fatalities) 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]

[a]Handgun 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 (n = 182 shootings) IRR	95% CI	Fatalities in Domestic-Linked Mass Shootings (n = 842 fatalities) 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]

[a]Handgun 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) IRR	95% CI	Fatalities in Non–Domestic-Linked Mass Shootings (n = 2,057 fatalities) 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]

[a]Handgun 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 (n = 602 shootings)		Fatalities in All Fatal Mass Shootings (n = 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]

[a]Handgun 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

	Domestic-Linked Fatal Mass Shooting Incidents (n = 181 shootings)		Fatalities in Domestic-Linked Mass Shootings (n = 815 fatalities)	
	Law Variables + Covariates		Law Variables + Covariates	
Variable	**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]

[a]Handgun 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 (n = 181 shootings) IRR	95% CI	Fatalities in Non–Domestic-Linked Mass Shootings (n = 2,045 fatalities) 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]

[a]Handgun 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) IRR	95% CI	Fatalities in All Fatal Mass Shootings (n = 1, 352 fatalities) 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]

[a]Handgun 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) IRR	95% CI	Fatalities in All Fatal Mass Shootings (n = 822 fatalities) 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]

[a]Handgun purchaser licensing with in-person application and/or fingerprinting of applicant.

*p = .05.

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The Relation Between State Gun Laws and the Incidence and Severity of Mass Public Shootings in the United States, 1976–2018

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Objective: In this study, we analyzed the relationship between state firearm laws and the incidence and severity (i.e., number of victims) of mass public shootings in the United States during the period 1976–2018. ***Hypotheses:*** We hypothesized that states requiring permits to purchase firearms would have a lower incidence of mass public shootings than states not requiring permits. We also hypothesized that states banning large-capacity ammunition magazines would experience a lower number of victims in mass public shootings that did occur than states without bans. ***Method:*** We developed a panel of annual, state-specific data on firearm laws and mass public shooting events and victim counts. We used a generalized estimating equations logistic regression to examine the relationship between eight state firearm laws and the likelihood of a mass public shooting. We then used a zero-inflated negative binomial model to assess the relationship between these laws and the number of fatalities and nonfatal injuries in these incidents. ***Results:*** State laws requiring a permit to purchase a firearm were associated with 60% lower odds of a mass public shooting occurring (95% confidence interval [CI: −32%, −76%]). Large-capacity magazine bans were associated with 38% fewer fatalities (95% CI [−12%, −57%]) and 77% fewer nonfatal injuries (95% CI [−43%, −91%]) when a mass shooting occurred. ***Conclusion:*** Laws requiring permits to purchase a gun are associated with a lower incidence of mass public shootings, and bans on large capacity magazines are associated with fewer fatalities and nonfatal injuries when such events do occur.

Public Significance Statement

We cannot definitively conclude that implementing a specific law would lead to a change in the incidence or severity of mass public shootings. However, laws that limit potential shooters' access to firearms by requiring permits may reduce the incidence of mass shootings, and laws that limit the number of shots that can be fired before reloading may reduce the severity of mass public shootings when they do occur. Such laws must be balanced with citizens' right to bear arms under the Second Amendment of the U.S. Constitution.

Keywords: firearms, mass public shootings, homicide, state laws, policy

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The data set, methods, and code used in this research are available online at https://osf.io/mucsh/.

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The recent occurrence of high-profile mass shootings, such as the tragedies in Parkland (Florida), Las Vegas (Nevada), El Paso (Texas), and Dayton (Ohio), has led to growing frustration and vigorous debate regarding policies intended to prevent these events (Nagin, Koper, & Lum, 2020; Wintemute, 2018). Although mass public shootings are a rare form of violence, there is general agreement—based on combined data from both the supplementary homicide reports and searches of online newspaper databases—that both the incidence and the severity of these events have increased in recent years (Duwe, 2020). Given this increase in morbidity and mortality, and the fear these incidents instill, it has never been more important to identify laws that will help curtail the incidence and/or severity of mass public shootings in the United States. However, there is scant research into the effectiveness of gun laws in preventing mass public shootings or reducing the number of victims in such incidents.

In this study, we analyzed the relationship between state firearm laws and the incidence and severity (i.e., number of victims) of mass public shootings in the United States during the period 1976–2018. We proceed by: (a) presenting the theoretical basis for believing that certain firearm laws may reduce the incidence or severity of mass public shootings; (b) reviewing the existing literature on the effect of state firearm laws on mass shootings; (c) discussing the limitations of the existing research in terms of both the predictor variable (i.e., definition of firearm laws) and outcome variable (quantification of mass shootings); and (d) providing an overview of the present study and how it advances the literature by addressing these limitations.

Conceptual Basis for Hypothesizing a Potential Impact of Specific State Firearm Laws on Mass Shooting Incidence or Severity

We used a theoretical model that was derived from studies of the relationship between gun availability and violent crime (Cook, 1983). This model combines criminological and economic theories to posit that laws that restrict criminals' access to guns deter firearm violence by reducing the availability of guns, both through legal and illicit markets, and therefore increase the effective cost of obtaining a highly lethal weapon. Cook argued that "despite the vast arsenal of guns in private hands, guns remain a scarce commodity. This scarcity surely prevents some criminals from obtaining them or using them in violent crime . . ." (pp. 76–77). This theory suggests not only that limiting the availability of firearms will make it more difficult to purchase a gun legally but that it will also limit the supply of or increase the costs of obtaining guns through illicit markets (Cook, 1983). Detailed study of a sample of mass murderers revealed that specific precipitating events are extraordinarily common (Hempel, Meloy, & Richards, 1999). If a potential perpetrator does not already own a firearm, the cost of obtaining one might be a critical factor in his ability to commit a mass shooting.

At the population level, several studies have documented a relationship between increased access to firearms and higher rates of violent crime, both for access to legal (Miller, Azrael, & Hemenway, 2002; Siegel, Ross, & King, 2013) and illegal firearms (Stolzenberg & D'Alessio, 2000). At the individual level, a recent study demonstrated that neighborhood firearm availability was related to more than a doubling of the odds for the commission of gun violence among adolescents with a previous history of conviction for a felony or a gun-related misdemeanor (Gonzales & McNiel, 2020). A previous study had shown that the availability of guns in the home was a significant risk factor for adolescent gun violence, regardless of whether the youth had a history of gun possession or violent crime (Ruback, Shaffer, & Clark, 2011). Thus, even among offenders with a history of gun-related crime, the availability of guns may be a significant factor in whether they carry out future acts of firearm violence.

This study focused on eight state firearm laws for which there is a conceptual basis for believing that they may impact either the incidence of mass shootings or the number of casualties resulting from such an event by limiting the availability of highly lethal firearms and/or ammunition. Each of these laws, described below, may increase the effective cost of obtaining any firearm, a specific type of firearm (e.g., an assault weapon), or a specific type of ammunition (e.g., high-capacity magazines). The laws either limit access to these weapons by people who are at high risk of violence or restrict the sale of particular types of guns or ammunition.

Assault Weapon Bans

Assault weapons are military-style weapons typically defined as semiautomatic firearms that accept a detachable magazine and have one or more military features such as flash suppressors, bayonet lugs, grenade launchers, pistol grips, and barrel shrouds. A survey of experts in public health, law, and criminology revealed that they ranked bans on assault weapons as an effective strategy to prevent mass shootings (Sanger-Katz & Bui, 2017). The first conceptual basis for the hypothesis that bans on military-style assault weapons may help prevent mass shootings or limit their severity is the finding that assault weapons have been used in a large proportion of such events. Although definitive data are not available, among mass shooting incidents in which weapon information was sufficient, 36% involved the use of an assault weapon (Koper, Johnson, Nichols, Ayers, & Mullins, 2018). The second conceptual basis for an effect of assault weapon bans is the finding that attacks in which the assailant uses a military-style weapon, such as an assault rifle, result in a greater number of shots fired, victims wounded, and severe or multiple wounds (de Jager et al., 2018; Koper, 2020; Reedy & Koper, 2003). Thus, reducing the stock of assault weapons could decrease the likelihood that a shooting incident results in enough fatalities to be classified as a mass shooting (de Jager et al., 2018; Koper, 2020).

Bans on Large-Capacity Ammunition Magazines

The conceptual basis behind restricting the size of ammunition magazines as a strategy to confront mass shootings is that large-capacity magazines "increase the ability to fire large numbers of bullets without having to pause to reload. Any measure that can force a pause in an active shooting—creating opportunities for those in the line of fire to flee, take cover, or physically confront a gunman—offers a possibility of reducing the number of victims in such an attack" (Klarevas, Conner, & Hemenway, 2019, p. 1,761). Nearly 20% of mass shootings during the period 2009–2016 involved weapons with a large-capacity magazine (Koper et al., 2018), whereas two thirds of high-fatality mass shootings (i.e., six or more fatal victims) between 2006 and 2015 involved this type of magazine (Klarevas, 2016). Restrictions on the size of magazines are conceptually more likely to be effective than banning assault weapons because these weapons are not functionally different from other semiautomatic firearms but are typically equipped with high-capacity magazines (Koper, 2020). Moreover, large-capacity ammunition magazine bans pertain to a much larger number of firearms because there is a sizable class of semiautomatic weapons that are not assault weapons but that accept high-capacity magazines (Koper, 2020).

Extreme-Risk Protection Orders

Also called red flag laws or gun violence restraining orders, these statutes allow law enforcement officers, family members, or both to petition a court for an emergency order to disarm a person who is judged to be a danger to themselves or others following a due-process hearing. The conceptual basis for their potential in averting mass shootings is the finding that nearly four fifths of those who committed mass shootings had either implicitly or explicitly expressed an intent to carry out such an attack (Laqueur & Wintemute, 2020; United States Secret Service National Threat Assessment Center, 2018). Investigators in California have identified at least 21 cases in which an extreme-risk protection order was used to disarm an individual who had been planning a mass shooting (Wintemute et al., 2019).

Limiting Firearm Access for High-Risk Individuals

Nagin et al. (2020) have put forth recommendations for a general approach to curtailing mass shootings. In addition to restricting high-capacity magazines, they recommend policies that restrict firearm access for people who are at a high risk for violence. States have taken a number of approaches to accomplish this.

Permit requirements. One of the most basic approaches is to require a permit or license to purchase or possess a firearm (Webster, McCourt, Crifasi, Booty, & Stuart, 2020). Seven states (e.g., Massachusetts, New Jersey) currently have permit requirements in place.

"May-issue" laws. A related approach is one that allows law enforcement officials discretion in deciding whether or not to approve an application for a concealed carry license. This is called a may-issue law and stands in contrast from shall issue laws that give no discretion to police; unless the applicant has been convicted of a specified offense, jis or her application must be approved. Nine states (e.g., California, Connecticut) currently have may-issue laws in place.

Violent misdemeanor laws. Another approach is to prohibit firearm possession by people who are at the highest risk of violence, namely those who have a history of violence. Federal law prohibits gun possession only by those convicted of a felony or certain misdemeanors (i.e., domestic violence and gun offenses). Some states, however, have enacted violent misdemeanor laws that extend the federal prohibition to include all violent crimes. Four states (e.g., Hawaii, Maryland) currently have violent misdemeanor laws in place.

Relinquishment laws. Approximately 46% of the assailants in mass shootings during the period 2014–2017 were legally prohibited from purchasing or possessing a firearm (Zeoli & Paruk, 2020). This is the rationale behind relinquishment laws that provide for the confiscation of firearms from all individuals who become prohibited from possessing them, even if they initially acquired the gun legally. Seven states (e.g., Illinois, Pennsylvania) currently have relinquishment laws in place.

Universal background checks. Firearm ownership prohibitions may not work unless a state has a system of universal background checks, requiring that every gun purchaser be screened at the point of sale to determine whether they meet any criterion that would disqualify them from gun purchase under federal and/or state law (Webster et al., 2020). Eleven states (e.g., Colorado, Oregon) currently have universal background check laws in place.

Research on the Impact of Firearm Laws on Mass Shootings

The early research in this area focused on assessing the impact of the 1994 federal ban on assault weapons and large-capacity ammunition magazines, yielding inconsistent results (Morral et al., 2018). These studies are difficult to interpret in the absence of a comparison group and therefore limited evidence upon which to identify the counterfactual. More recently, research has focused on studying the effects of state firearm laws, which allows multiple group or panel study designs because there is indeed a wide variation in the adoption of firearm laws across states and across time (Siegel, et al., 2017).

Whereas research remains limited, there is some evidence that more permissive state gun laws are associated with higher rates of mass shootings (Reeping et al., 2019). Reeping et al. (2019) reported that for each 10-unit increase in the permissiveness of state gun laws (measured on a 100-point scale), the rate of mass shootings in a state increased by 11.5%. However, this study did not examine the impact of any specific firearm laws. In addition, it relied on a travel guide to assess state laws and did not independently verify the validity of the database. Also, in contrast, Lin, Fei, Barzman, and Hossain (2018) failed to find a statistically significant relationship between the permissiveness of state gun laws and the rate of mass shootings, although it is not clear what laws were included in their gun law index.

In 2015, Gius (2015) reported the results of the first study to examine the impact of state laws on mass shootings. He found that during the period 1982–2011, state-level assault weapons bans were associated with a significantly lower number of fatalities in mass shootings. In a more recent state-level study using a panel design, Klarevas et al. (2019) investigated the relationship between the incidence and number of deaths in high-fatality mass shootings (those with at least six fatalities, not including the perpetrator) and state-level large-capacity magazine bans. They found that these policies were associated with a significantly lower incidence of these mass shooting events and with a significantly lower death count. Unfortunately, this study considered the impact of only one type of firearm law and by virtue of the high-victim threshold was based on a particularly small number of cases.

Most recently, Webster et al. (2020) advanced the literature by examining the impact of a number of specific state laws on the incidence of fatal mass shootings from 1984 through 2017. They found that two laws—required licenses for handgun purchase and large-capacity magazine bans—were associated with fewer mass shootings. Additionally, required licenses reduced the number of fatalities in mass shootings.

Limitations of the Predictor Variable in Existing Research: Classification of State Firearm Laws

The primary limitation of the previous studies in terms of their classification of state firearm laws is that none of them provide clearly defined criteria to determine what counts as having a particular law and what does not. State firearm laws often have various exemptions, exceptions, and differences in application of restrictions. Without a clear definition of what is meant by a particular law, there is ambiguity in how that law should be coded (Siegel, et al., 2017). Thus, for any particular study, it is not precisely clear what is meant by the presence or absence of a particular law.

For example, Gius (2015) classified Hawaii as having enacted an assault weapons ban in 1992. However, Hawaii's statute restricts only the sale of assault pistols; the law does not apply to assault rifles. Without having clearly defined the meaning of an assault weapons ban, most readers would probably assume that assault rifles are banned in Hawaii, but that is not the case (Hawaii Revised Statutes, 2020). This law would not be expected to affect the incidence or severity of mass shootings, but it is included in the treatment group in the study. Similarly, Klarevas et al. (2019) classified Hawaii as having a ban on large-capacity magazines. However, this ban applies only to detachable magazines for pistols. There is no limit to the magazine capacity for rifle ammunition (Hawaii Revised Statutes, 2020).

Reeping et al. (2019) obtained their state firearm law data from the *Traveler's Guide to the Firearms Laws of the Fifty States*. The book focuses almost exclusively on laws governing where one can carry a concealed firearm. Thus, the gun permissiveness scale is relevant only to one small subset of firearm laws. Lin et al. (2018) do not even describe how they derived their gun law permissiveness index, although it appears that it may have been solely based on the state's concealed carry permitting law.

Limitations of the Outcome Variable in Existing Research: Methods Used to Quantify Mass Shootings

Most of the existing research is limited because it relies on one of two sources to quantify mass shootings: (a) the Federal Bureau of Investigation (FBI)'s Supplementary Homicide Reports; or (b) news coverage (Duwe, 2020). Each of these approaches to identify mass shootings has serious flaws.

Studies relying on the Supplementary Homicide Reports. At least three studies used the FBI's Supplementary Homicide Reports (SHR) as the main basis of their analyses, identifying those incidents in which four or more victims are fatally shot (Gius, 2015; Reeping et al., 2019; Webster et al., 2020). In addition to its limited range of variables, the SHR unfortunately presents a number of pitfalls for analytic efforts of this sort. There are situations in which separate and unrelated homicides are reported by a law enforcement agency on the same record giving the false appearance of a mass killing. In addition, occasionally a record will include an injured victim along with three fatalities also wrongly suggesting a mass killing. On the other hand, there are many mass shootings that for various reasons are omitted from the SHR. Some states are excluded from the SHR entirely for certain years because of issues with their data collection or reporting, and some jurisdictions fail to report all their homicides to the FBI (Fox, 2004).

Beyond these validity concerns, one must approach the SHR carefully with respect to particularly large-scale shootings. Because each data record is limited to 11 victims, certain mass shootings necessarily span several records, falsely suggesting multiple events. In Reeping et al.'s (2019) data, for example, Virginia is recorded as having 13 mass shootings when in fact several of these are just additional records needed to cover all the victims killed at Virginia Tech in 2007. At least one study indicated that the accuracy rate of the SHR in identifying mass shootings is only 61% (Overberg, Upton, & Hoyer, 2013).

Studies relying on media reports. Two studies relied on news reports compiled by *Mother Jones* (Gius, 2015; Lin et al., 2018). One combined data from *Mother Jones* with information from the SHR (Gius, 2015), whereas the other relied on *Mother Jones* as the sole data source (Lin et al., 2018). The *Mother Jones* list of mass shootings missed more than 40% of the incidents that occurred during the period 1982–2013, and its underreporting was particularly severe for the earlier 2 decades (Duwe, 2020). Although most mass shootings receive media attention, many are covered only in local media (Duwe, 2020). Moreover, accuracy is dependent on the extensiveness of media outlet coverage by a news media database and by the precise search terms used (Duwe, 2020). For example, a search for the term mass shooting will miss incidents described by a reporter as a quadruple shooting (Duwe, 2020). In addition, because the term mass shooting is relatively new, searches relying only on that phrase will likely undercount incidents from before the 2000s (Duwe, 2020).

Study Overview and Hypotheses

In this study, we took advantage of two new databases to further the existing research on the association between state firearm laws and mass public shootings by addressing limitations in both the predictor and outcome variables. First, we used a novel database that coded the status of 89 different state gun laws from 1976 to the present, using clearly defined criteria for identifying each law. Second, we used a comprehensive database of mass public shooting incidents from 1976 through 2018 assembled by combining all existing mass shooting databases and extensively evaluating each identified case. This triangulated data collection strategy incorporated information from the SHR, from existing databases that utilized news media reports, and from original searches of the entire database of news stories at multiple media resource websites. Institutional review board approval was not needed for this study because the data were obtained from secondary, publicly available sources.

Mass shootings have typically been defined as events in which four or more victims are fatally shot during a short period of time (Duwe, 2020). Whereas the public tends to envision mass shootings as incidents in which a shooter indiscriminately fires into a crowd of people in a public place, prior research indicates the majority of mass murders—about 70%—are actually familicides or felony-related killings, which are types of events less likely to be covered by the media (Duwe, 2020). The term, mass public shootings, is used to connote the former incidents: gun-related incidents in which strangers are killed in a public location absent other criminal activity (Duwe, 2020).

There are a few reasons that, in this paper, we focused exclusively on mass public shootings. Studies have previously examined the relationship between gun laws and shooting events with at least four fatalities, regardless of where the shooting took place. A large number of these mass shootings are domestic incidents involving the killing of family members that may have occurred in a private home rather than in a public place, as was the case with the Reeping et al. (2019) and Webster et al. (2020) studies. A second large subset of these mass shootings consists of those committed as part of an underlying criminal activity in which the killing is not the primary intended purpose but is necessary or becomes necessary to carry out the planned crime. Although hardly unimportant, these are not the types of events that typically receive widespread media coverage and may not be consistent with the public's and policymakers' conception of a mass shooting. They are also not the shootings that drive the campaign for stronger gun-control legislation (Duwe, 2020).

Our two major hypotheses were as follows: (a) States requiring permits to purchase firearms will have a lower incidence of mass public shootings than states not requiring permits and (b) states that ban large-capacity ammunition magazines will experience a lower number of victims in mass public shootings that do occur than states without bans.

Method

Data Sources

To examine the association between state-level gun laws and the incidence and severity of mass public shootings from 1976 to 2018, we relied on two primary data sets. The first includes a recently developed comprehensive list of mass public shootings using strict definitional criteria, and the second includes a comprehensive list of state laws from a publicly available dataset on all 50 states starting in 1991 that we extended back to 1976.

Mass public shootings. We assembled a database of mass public shootings using a variety of sources to capture all possible events and then researching each in detail to identify those that met our predetermined definition of a mass public shooting. Specifically, we defined a mass public shooting as an incident in which four or more victims are fatally shot in a public location within a 24-hr period in the absence of other criminal activity, such as robberies, drug deals, and gang conflict.

The process by which we collected data on mass public shootings consisted of three main phases. First, the vast majority of the cases in our sample were derived from the data set compiled by Duwe (2020), who used both the SHR and news reports as data sources. Despite its limitations, the SHR is still the most comprehensive source of U.S. homicide data that contain information on the year and month when murders occurred as well as the state and city (or county) where they took place. After relying on the SHR to identify when and where gun-related mass murders occurred in the United States, Duwe searched online newspaper databases to collect additional information not included in the SHR, such as the number of injured victims and the specific location in which the incident took place. As a result of using this triangulated data collection strategy, which was also adopted by *U.S.A. Today* (Overberg et al., 2013) and the Congressional Research Service (Krause & Richardson, 2015), Duwe was able to correct errors in the SHR data while also identifying cases that were either not reported to the SHR or were unlikely to be captured through sole reliance on news coverage.

Second, to help ensure inclusion of every mass public shooting that occurred in the United States between 1976 and 2018, we also consulted unpublished data sets (Brot, 2016; Krause and Richardson, 2015) as well as publicly available ones such as those published by Louis Klarevas (Klarevas et al., 2019); *U.S.A. Today* (2018); *Washington Post* (Berkowitz & Alcantara, 2019); Stanford University (2020); Mother Jones (2020); Everytown for Gun Safety (2020); and FBI active-shooter events (Federal Bureau of Investigation, 2020).

Finally, we conducted a consensus review to determine whether cases qualified as a mass public shooting by our operational definition. More specifically, three of the authors for this study reviewed whether the cases identified through the first two phases met the following criteria: (a) at least four of all victims were killed by gunfire; (b) at least four of the victims were killed in a public place or else at least half of all fatalities occurred in a public place; and (c) the shooting did not occur in a private residence, although those that occurred in a nonprivate residence (e.g., group home or motel) were retained. If all three authors agreed these criteria had been satisfied, the incident was included in this study as a mass public shooting. If there was any disagreement, the coders discussed the case until they reached agreement on the classification.

For each case, the coders classified the incident as yes, no, or maybe. Of the 188 possible cases identified, all three coders agreed on the classification being yes or being no for 175 of the cases (93.1%). In an additional three cases, two coders agreed on the classification and the third was not sure. There was disagreement or uncertainty for 10 cases. The interrater reliability was assessed using an extension of Cohen's kappa for more than two raters (Stata Base Reference Manual, 2017). Cohen's kappa was 0.82, which indicates very good agreement between coders (Altman, 1999).

As a result of this rigorous data-collection methodology, we assembled a comprehensive database, consisting of 156 mass public shootings from 1976 through 2018 that involved 2,839 victims, of which 1,090 were fatally shot, another 41 died by other means, and the remaining 1,708 were injured. We omitted one incident, the fatal shooting of 12 victims in Washington, DC, from the analyses, given the focus on the laws enacted by the 50 states, leaving the final counts of 155 incidents and 2,827 victims for this study. We developed a panel by calculating the number of events, killings, and nonfatal shootings by year and state. With data for 50 states across 43 years, the panel consisted of 2,150 observations in total.

State firearm laws. We relied on the State Firearm Law Database, a publicly available database of the presence or absence of 134 state firearm law provisions across 14 categories in all 50 states for the period 1991 to the present that was developed by individual examination of state statutes and historical session laws with detailed criteria defining each provision (Siegel, 2020a, 2020b; Siegel, et al., 2017). For 89 of these law provisions, we extended the database back to 1976 by examination of historical state statutes and session laws using the Hein Online and Westlaw

Edge databases. We focused on these 89 provisions because they represent the policies most commonly considered by state lawmakers to reduce intentional firearm violence (Morral et al., 2018). The provisions we excluded from the extended database were either minor policies or those designed to reduce unintentional injuries or to help identify offenders once crimes have already been committed. For example, we excluded laws such as record-keeping requirements for gun stores, ballistic fingerprinting of guns, gun storage liability laws, and personalized gun technology.

Measures

Predictor variables. From the expanded state firearm law database, we selected eight specific laws for analysis based on two criteria: (a) laws that were analyzed in previous studies of mass shootings and (b) laws for which we could identify published literature providing a conceptual basis to believe they may be effective in averting mass shootings or reducing casualties in such events. The laws were: (a) assault weapons bans; (b) large-capacity magazine bans; (c) laws requiring a permit to purchase or possess a gun; (d) extreme-risk protection order laws; (e) universal background checks; (f) may-issue concealed-carry laws; (g) relinquishment of guns required when people become disqualified from ownership; and (h) laws prohibiting gun possession by people with a history of a violent misdemeanor crime. Online Supplemental Table A displays the laws analyzed, their definitions, and the states that had these laws in effect in 2018. Laws were lagged by 1 year in the analysis; that is, we considered the potential effect of a law only in the full first year after its enactment.

Outcome variables. There were three major outcome variables that measured the incidence and severity of mass public shootings.

Incidence of mass public shootings. Because this outcome variable was dichotomous (the presence or absence of a mass public shooting in a given state during a given year), we used a logistic regression model for this analysis. To account for clustering by state, we used a generalized estimating equations (GEE) approach with an exchangeable working correlation matrix. We included both linear and quadratic trend variables. We generated standard errors that accounted for state clustering and were robust to the correlation structure assumptions (White, 1980). There were a few cases in which a state experienced more than one event in the same year (e.g., California experienced three mass public shootings in 1993). However, these were so few that modifying the outcome variable was not warranted.

Number of fatalities per shooting event. Because of the small number of events, our data set contained a great majority of zero counts (2,007 of 2,150 observations). For this reason, we used a zero-inflated negative binomial model (Yau, Wang, & Lee, 2003). In this approach, we modeled the likelihood of an event occurring separately from the number of fatalities assuming that an event did occur. We used logistic regression to model the likelihood of an event and negative binomial regression to model the number of fatalities when an event did occur. As above, we included linear and quadratic time trends and generated cluster robust standard errors.

One advantage of the zero-inflated model is that the factors associated with event occurrence and with the number of victims given that an event took place can be analyzed separately and with different predictor variables. For the logistic regression of event occurrence, we used all of the same control variables specified above. However, we did not anticipate that these demographic variables would influence the fatal victim count, assuming that an event occurs. For example, the divorce rate might impact the likelihood of a mass shooting, but there is no conceptual reason to believe that the divorce rate influences the number of fatalities resulting from a shooting. Therefore, the only predictors used for the count part of the model were the time trends (included to capture secular trends in the severity of mass public shootings), population, population density, and the state laws, which were the variables of interest.

As a sensitivity analysis, we performed negative binomial GEE regressions on the number of deaths per event using the same limited set of regressors but restricting the analysis to observations when an event occurred ($N = 143$). In this way, the model assessed the relationship between state laws and the number of fatalities in a mass shooting event, independent of any association between these laws and the likelihood of an event occurring in the first place.

Number of nonfatal injuries per shooting event. We conducted a post hoc analysis to investigate whether large-capacity magazine bans are associated with the number of nonfatal injuries when an event occurs. To do this, we performed a zero-inflated negative binomial regression but used only the time trends, population, population density, and large-capacity magazine ban laws to predict the number of injuries per event. Finally, we executed a sensitivity analysis, repeating the above model specification using a negative binomial regression restricted to observations in which an event occurred.

Control variables. We compiled an annual, state-specific panel of data on variables that might be related to both mass shooting rates and the adoption of firearm laws, therefore confounding the results. Because of the limited literature on predictors of mass shooting incidence and severity at the state level, we selected control variables based on their demonstrated association with state rates of overall firearm violence in previous studies. The variables included and the studies documenting their association with firearm violence at the state level were: (a) state population (Knopov et al., 2019; Siegel & Boine, 2019); (b) population density (Knopov et al., 2019; Siegel, Pahn, Xuan, Fleegler, & Hemenway, 2019); (c) proportion identified as Black (Campbell, Siegel, Shareef, & Rothman, 2019; Siegel et al., 2020); (d) proportion of males among young adults (ages 15–29 years) (Knopov et al., 2019; Siegel, Pahn, et al., 2019); (e) poverty rate (Powell & Tanz, 1999; Siegel, Pahn, et al., 2019); (f) unemployment rate (Campbell et al., 2019; Siegel, Pahn, et al., 2019); (g) per-capita alcohol consumption (Siegel, Pahn, et al., 2019, Siegel et al., 2020); (h) divorce rate (Díez et al., 2017); (i) incarceration rate (Campbell et al., 2019; Siegel et al., 2013); (j) household gun ownership (Campbell et al., 2019), using a commonly used proxy: the proportion of suicides committed with a firearm (Azrael, Cook, & Miller, 2004); and (k) the violent crime rate (Campbell et al., 2019; Siegel, Pahn, et al., 2019). We also included the firearm homicide rate and the suicide rate because these are direct measures of the overall magnitude of firearm violence in a state. We linearly interpolated missing years of data. Online Supplemental Table B shows the variables, definitions, data sources, and years with missing data.

Multicollinearity assessment. A unique contribution of this study is its ability to examine a wide range of firearm laws and to isolate the independent effect of laws by controlling for the presence of the others. A potential drawback of this approach is the possibility of multicollinearity. We assessed the potential for high multicollinearity and thus inflated standard error terms by computing variance inflation factors.

We estimated all models using Stata/SE version 15 (StataCorp, College Station, TX). Online Supplemental Table C provides the command syntax for the analyses. The data set, methods, and code used in this research are available online at https://osf.io/mucsh/.

Results

Descriptive Findings

During the period 1976–2018, there were a total of 155 mass public shootings resulting in 1,078 deaths and an additional 1,694 nonfatal injuries in the United States, excluding one event that occurred in nation's capital because it does not fall under the jurisdiction of any state (see Table 1, Figure 1, and Figure 2). The average mass public shooting rate ranged from a high of 0.1963 per million population in Idaho to a low of zero in nine states (see Table 1). California had the greatest number of events (25) and deaths (164), whereas Nevada had the greatest number of overall victims (915) as a result of the massive shooting in Las Vegas in 2017. The number of mass public shootings remained stable or slightly elevated between 1976 and 2002, but there was a sharp increase from 2002 through 2018 (see Figure 1). The number of mass shootings waned during the period 2013–2016 but rose sharply in 2017 and 2018. The trend in deaths followed a similar pattern (see Figure 2).

State Firearm Laws and the Likelihood of a Mass Public Shooting

In the logistic regression GEE model, one law—permit requirements—was associated with 60% lower odds of a mass public shooting (95% confidence interval [CI: −32%, −76%]) as shown in Table 2. No other laws were related to the likelihood of a mass public shooting. Other factors associated with the occurrence of a mass public shooting were population, unemployment rate, divorce rate, firearm homicide rate, and suicide rate.

In the logistic regression portion of the zero-inflated negative binomial model, one law—permit requirements—was associated with 59% lower odds of a mass public shooting (95% CI [−31%, −76%]) as displayed in Table 3. Other factors related to the likelihood of a mass public shooting were population, divorce rate, firearm homicide rate, and suicide rate. These results were consistent with that of the logistic regression.

State Firearm Laws and the Number of Fatalities in a Mass Public Shooting

In the count part of the zero-inflated negative binomial model, one law—large-capacity magazine bans—was associated with fewer deaths when a mass public shooting occurred (see Table 3). A large-capacity magazine ban was associated with 38% fewer fatalities (95% CI [−12%, −57%]). No other laws were significantly associated with a lower number of deaths in a mass public shooting.

In the sensitivity analysis in which we modeled the number of fatalities resulting from mass public shootings using a GEE negative binomial model restricted to only those observations for which an event occurred, large-capacity magazine bans were associated with 37% fewer fatalities (95% CI [−10%, −57%]), as shown in Table 4. No other laws were significantly associated with a lower number of deaths in a mass public shooting. These results

Table 1
Average Mass Public Shooting Rate and Total Number of Events and Deaths—By State, 1976–2018

State	Average rate	Events	Deaths	Nonfatal injuries	Total victims
Alaska	0.1963	4	25	2	27
Idaho	0.0405	2	8	1	9
Mississippi	0.0331	4	20	11	31
Oregon	0.0309	4	23	55	78
Nevada	0.0283	3	66	849	915
Colorado	0.0265	5	37	104	141
Washington	0.0249	7	34	33	67
Rhode Island	0.0244	1	4	0	4
Kentucky	0.0243	4	22	18	40
Connecticut	0.0199	3	39	4	43
New Hampshire	0.0196	1	4	4	8
Hawaii	0.0192	1	7	0	7
Arkansas	0.0189	2	9	13	22
Texas	0.0189	16	134	128	262
Florida	0.0182	12	123	101	224
California	0.0175	25	164	161	325
Wisconsin	0.0165	4	23	9	32
Pennsylvania	0.0132	7	37	15	52
Nebraska	0.0130	1	8	4	12
Missouri	0.0124	3	14	3	17
North Carolina	0.0118	4	20	15	35
South Carolina	0.0108	2	13	4	17
Louisiana	0.0106	2	9	5	14
Georgia	0.0102	4	21	15	36
New York	0.0099	8	46	34	80
Utah	0.0090	1	5	4	9
Minnesota	0.0089	2	15	7	22
Kansas	0.0085	1	5	2	7
Iowa	0.0083	1	5	1	6
Maryland	0.0080	2	9	2	11
Illinois	0.0076	4	19	27	46
Michigan	0.0071	3	14	10	24
Oklahoma	0.0071	1	14	6	20
Tennessee	0.0070	2	9	6	15
Arizona	0.0068	2	12	14	26
Alabama	0.0052	1	4	1	5
Ohio	0.0042	2	8	7	15
Indiana	0.0038	1	4	2	6
Massachusetts	0.0037	1	7	0	7
New Jersey	0.0032	1	6	0	6
Virginia	0.0030	1	32	17	49
Delaware	0	0	0	0	0
Maine	0	0	0	0	0
Montana	0	0	0	0	0
New Mexico	0	0	0	0	0
North Dakota	0	0	0	0	0
South Dakota	0	0	0	0	0
Vermont	0	0	0	0	0
West Virginia	0	0	0	0	0
Wyoming	0	0	0	0	0
All states	0.0129	155	1,078	1,694	2,772

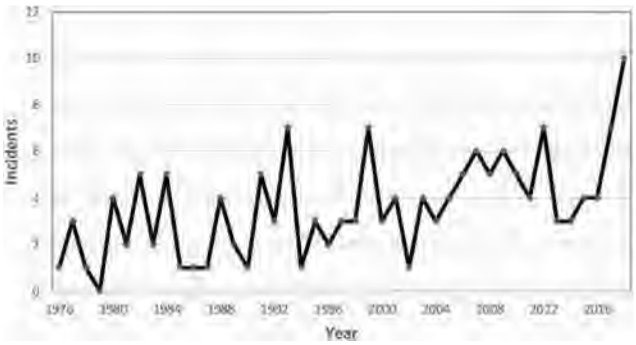

Figure 1. Number of mass public shootings by year—United States, 1976–2018. See the online article for the color version of this figure.

were almost identical to those from the zero-inflated negative binomial model.

Large-Capacity Magazine Bans and the Number of Nonfatal Injuries in a Mass Public Shooting

Large-capacity magazine bans were associated with 77% fewer nonfatal injuries (95% CI [−43%, −91%]), as shown in Table 5. In the sensitivity analysis in which we modeled the number of fatalities resulting from mass public shootings using a GEE negative binomial model restricted to only those observations for which an event occurred, large-capacity magazine bans were associated with 70% fewer nonfatal injuries (95% CI [−29%, −87%]), also shown in Table 5.

Multicollinearity Assessment

Whether we included all regressors or just those pertaining to guns, none of the gun law variables revealed a variance inflation factor above four, a conventional benchmark for concern.

Discussion

To our knowledge, this is the first paper to examine state firearm laws and their separate relationship with the likelihood of a mass public shooting and with the number of fatalities when such an event occurs. We found a robust relationship between state laws that require permits for the purchase and/or possession of guns and the incidence of mass public shootings and between large-capacity magazine bans and the number of deaths resulting from a mass public shooting if one does occur. However, we did not find any significant association between assault weapons bans or other firearm laws and either of these outcomes. Additionally, we found that large-capacity magazine bans are also associated with a lower number of nonfatal injuries when a mass public shooting occurs.

Incidence of Mass Public Shootings

Our finding that laws requiring permits to purchase or possess firearms are associated with a lower incidence of mass public shootings is consistent with those of Webster et al. (2020), who reported that laws requiring handgun permits were associated with a lower number of mass shooting incidents. This supports the theoretical framework that we adapted from Cook (1983), which posits that limiting the availability of firearms may reduce the incidence of mass public shootings by increasing the costs of obtaining a gun in both the legal and illegal markets and that this increased cost could be enough to deter a potential mass shooter. State gun permit requirements have been shown to decrease firearm homicide rates (Crifasi et al., 2018; Webster, Crifasi, & Vernick, 2014) and to reduce straw purchasing or trafficking of guns that diverts them into the illegal market (Collins et al., 2018; Crifasi, Buggs, Choksy, & Webster, 2017).

Similar to Webster et al. (2020), we did not find that universal background check laws are related to the likelihood of mass public shootings. Background checks are typically conducted through the FBI National Instant Criminal Background Check System, which consults only national databases. State mental health, drug use, and criminal databases are not searched, and several studies have documented severe limitations of state reporting to the National Instant Criminal Background Check System database (Goggins & Gallegos, 2016; Mayors Against Illegal Guns, 2011). In contrast to the federal background check system, states that require their own gun permits typically have detailed procedures that involve a check of multiple state databases and often require fingerprints rather than relying solely on self-reported information (Webster et al., 2020). Also, states that conduct their own background checks or delegate this responsibility to local authorities have lower firearm homicide rates than states that rely solely on federal background checks (Sumner, Layde, & Guse, 2008). Requiring permits to purchase or possess firearms is an effective mechanism for conducting effective criminal background checks at the local level.

Severity of Mass Shootings

Our finding that state laws prohibiting large-capacity ammunition magazines are associated with fewer fatalities and nonfatal injuries in mass public shootings is consistent with that of Klarevas et al. (2019), who reported that state-level large-capacity magazine bans were associated with a reduction in the number of deaths in high-fatality (six or more victims shot to death) mass shootings and that of Webster et al. (2020), who observed that laws banning large-capacity magazines were associated with a lower number of deaths from mass shootings. It is plausible that a ban on large-capacity magazines would not stop mass shootings per se but could

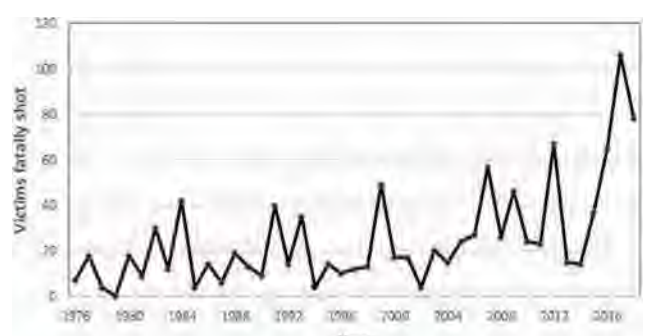

Figure 2. Number of deaths from mass public shootings by year—United States, 1976–2018. See the online article for the color version of this figure.

Table 2
Logistic Regression Model Results: Factors Affecting Occurrence of a Mass Public Shooting, 1976–2018[a]

Factor	*OR* [95% CI]	Statistical significance
Population (in millions)	**1.11**[b] **[.09, 1.14]**	$p < .001$
Population density (in people per .01 square miles)	0.96 [0.84, 1.08]	$p = .47$
Percent Black	0.97 [0.93, 1.02]	$p = .23$
Percent male of young adults	1.22 [0.93, 1.61]	$p = .15$
Poverty rate	0.98 [0.92, 1.05]	$p = .57$
Unemployment rate	**1.10**[b] **[1.00, 1.22]**	$p = .05$
Per-capita alcohol consumption	1.45 [0.93, 2.26]	$p = .10$
Divorce rate	**1.15**[b] **[1.00, 1.32]**	$p = .05$
Incarceration rate (per 1,000 population)	0.99 [0.83, 1.18]	$p = .93$
Household gun ownership	1.00 [0.96, 1.04]	$p = .93$
Age-adjusted firearm homicide rate	**1.20**[b] **[1.02, 1.41]**	$p = .03$
Age-adjusted total suicide rate	**0.85**[b] **[0.74, 0.98]**	$p = .02$
Violent crime rate	0.96 [0.82, 1.12]	$p = .59$
Assault weapons ban	1.36 [0.38, 4.86]	$p = .64$
Large-capacity ammunition magazine ban	0.44 [0.13, 1.44]	$p = .18$
Permit requirement	**0.40**[b] **[0.24, 0.68]**	$p = .001$
Extreme-risk protection order law	1.08 [0.22, 5.19]	$p = .93$
Universal background checks at point of sale	0.51 [0.18, 1.43]	$p = .20$
May-issue concealed-carry law	1.26 [0.76, 2.08]	$p = .37$
Relinquishment law	1.05 [0.52, 2.11]	$p = .90$
Violent misdemeanor law	0.64 [0.23, 1.79]	$p = .40$

Note. *OR* = odds ratio; CI = confidence interval.
[a] Outcome variable is whether or not a mass public shooting occurred in a given state in a given year. State clustering was accounted for using generalized estimating equations. All models include linear and quadratic trends. Standard errors are robust and adjusted for state-level clustering. [b] Coefficient is statistically significant from zero ($p < .05$), also shown in bold type.

at least reduce the number of fatalities and nonfatal injuries in such events because the shooter can fire fewer rounds before having to reload (Klarevas et al., 2019; Koper, 2020; Webster et al., 2020). This is consistent with a body of literature demonstrating that fatality counts in mass shootings are higher when a large-capacity magazine is used by an assailant (Koper, 2020; Koper et al., 2018).

In contrast to high-capacity magazine bans, we did not find support for the often-claimed association between assault weapon bans and mass public shootings. This conflicts with Gius' (2015) contention but is in accord with that of Webster et al. (2020). Our failure to identify an association of assault weapons bans and the incidence of, or fatalities in, mass public shootings could be explained by the fact that assault weapons are typically defined by cosmetic features rather than characteristics that directly affect the lethality of the firearm (Siegel & Boine, 2019) or by the relative infrequency of assault weapon use in mass public shootings (Duwe, 2007). Most semiautomatic firearms are not assault weapons as defined by state laws but are functionally equivalent. They are manufactured without the accessories, such as bayonet lugs, flash suppressors, and grenade launchers, that characterize assault weapons. Moreover, the firing rate of all semiautomatic weapons is the same, regardless of whether they are military-style assault weapons or just handguns, namely the speed at which the shooter can squeeze the trigger. What makes assault weapons so lethal is not any particular functional feature but simply the fact that these firearms are designed to accommodate high-capacity magazines. This may explain our finding that large-capacity magazine bans, but not assault weapon bans, were related to the number of casualties in mass public shootings.

Our finding that only two policies—permit requirements and large capacity magazine bans—were related to mass public shootings is consistent with that of Webster et al. (2020), who reported a similar result. Like Webster et al. (2020), we failed to find a relation between may-issue laws or violent misdemeanor laws and mass public shootings. Because may-issue laws affect only the ability to carry a concealed gun not the ability to purchase a firearm, one might not expect these policies to affect mass public shootings. Violent misdemeanor laws are designed to prevent adjudicated violent criminals from possessing firearms; however, in a substantial proportion of mass shootings, there is no history of a criminal conviction for a violent crime or the crime involves domestic violence (Hempel et al., 1999). Studies have documented serious loopholes in the confiscation of firearms from domestic violence offenders (Mascia, 2015). Strengthening the procedures for the surrender of firearms by persons adjudicated for domestic violence or served with restraining orders may be necessary to observe a measurable effect of these policies on rare mass public shooting events. Similarly, our failure to find a relationship between relinquishment laws and mass public shootings could have more to do with the lack of enforcement of these laws than with a conceptual problem with the idea of limiting potential shootings by making sure that people who become prohibited from possessing a firearm are disarmed.

Perhaps the most surprising negative finding was that extreme-risk protection orders were not related to the incidence of mass public shootings. However, our definition of extreme-protection order laws included those in which law enforcement personnel are authorized to initiate a proceeding, regardless of whether family

Table 3

Zero-Inflated Negative Binomial Model Results: Factors Affecting Occurrence of a Mass Public Shooting and Number of Deaths if a Mass Shooting Occurs, 1976–2018[a]

Factor	Logistic model		Negative binomial model	
	OR [95% CI]	Statistical significance	Incidence rate ratio [95% CI]	Statistical significance
State population (in millions)	**1.11**[b] **[1.09, 1.14]**	$p < .001$	1.01 [1.00, 1.03]	$p = .07$
Population density (per .01 square miles)	0.96 [0.85, 1.08]	$p = .49$	0.99 [0.91, 1.09]	$p = .90$
Percentage Black	0.97 [0.93, 1.02]	$p = .23$		
Percentage male (of young adults)	1.22 [0.93, 1.61]	$p = .15$		
Poverty rate	0.98 [0.92, 1.05]	$p = .57$		
Unemployment rate	1.10 [1.00, 1.22]	$p = .05$		
Per-capita alcohol consumption	1.45 [0.93, 2.26]	$p = .10$		
Divorce rate	**1.15**[b] **[1.00, 1.33]**	$p = .05$		
Incarceration rate (per 1,000 population)	0.99 [0.83, 1.19]	$p = .94$		
Household gun ownership	1.00 [0.96, 1.04]	$p = .93$		
Age-adjusted firearm homicide rate	**1.20**[b] **[1.02, 1.42]**	$p = .03$		
Age-adjusted total suicide rate	**0.85**[b] **[0.75, 0.98]**	$p = .03$		
Violent crime rate	0.96 [0.82, 1.12]	$p = .57$		
Assault weapons ban	1.36 [0.36, 5.11]	$p = .65$	1.04 [0.57, 1.90]	$p = .89$
Large-capacity ammunition magazine ban	0.45 [0.13, 1.55]	$p = .21$	**0.62**[b] **[0.43, 0.88]**	$p = .008$
Permit requirement	**0.41**[b] **[0.24, 0.69]**	$p = .001$	0.80 [0.50, 1.30]	$p = .37$
Extreme-risk protection order law	1.04 [0.21, 5.07]	$p = .96$	1.55 [0.65, 3.69]	$p = .32$
Universal background checks at point of sale	0.51 [0.17, 1.53]	$p = .23$	0.83 [0.41, 1.68]	$p = .61$
May-issue concealed-carry law	1.23 [0.74, 2.04]	$p = .42$	1.21 [0.90, 1.63]	$p = .20$
Relinquishment law	1.04 [0.51, 2.14]	$p = .91$	1.13 [0.47, 2.69]	$p = .79$
Violent misdemeanor law	0.67 [0.24, 1.88]	$p = .45$	0.80 [0.37, 1.74]	$p = .58$

Note. *OR* = odds ratio; CI = confidence interval.
[a] Models include linear and quadratic trends. Standard errors are robust and adjusted for state-level clustering. [b] Coefficient is statistically significant from zero ($p < .05$), also shown in bold type.

members can do so. We could not examine extreme-risk protection order laws that allow family members to intervene because only two states had such laws in place for more than 1 year during the study period. It may be that family members are in the best position to recognize people with access to guns who are at great risk of harming others or themselves. If this were the case, it could explain our failure to find any significant association between mass public shootings and laws that rely on law enforcement officials to identify at-risk individuals.

Policy and Research Implications

Because of the cross-sectional nature of this study, we cannot definitively conclude that implementing a specific law would lead to a change in the incidence or severity of mass public shootings. Nevertheless, our research suggests three potential policy implications that must be balanced with citizens' right to bear arms under the Second Amendment of the U.S. Constitution. First, to reduce the incidence of mass shootings, the primary objective

Table 4

Negative Binomial GEE Model Results: Factors Affecting the Number of Fatalities in a Mass Public Shooting, 1976–2018[a]

Factor	Negative binomial model incidence rate ratio [95% CI]	Statistical significance
State population (in millions)	**1.01**[b] **[1.00, 1.03]**	$p = .03$
Population density (per .01 square miles)	1.00 [0.92, 1.08]	$p = .92$
Assault weapons ban	1.08 [0.63, 1.85]	$p = .78$
Large capacity ammunition magazine ban	**0.63**[b] **[0.43, 0.90]**	$p = .01$
Permit requirement	0.83 [0.54, 1.29]	$p = .41$
Extreme-risk protection order law	1.65 [0.74, 3.70]	$p = .22$
Universal background checks at point of sale	0.79 [0.45, 1.38]	$p = .41$
May-issue concealed-carry law	1.15 [0.88, 1.52]	$p = .31$
Relinquishment law	1.07 [0.53, 2.15]	$p = .85$
Violent misdemeanor law	0.86 [0.44, 1.69]	$p = .66$

Note. CI = confidence interval; GEE = generalized estimating equations.
[a] This model is restricted to observations when a mass shooting event occurred. It includes linear and quadratic trends. Standard errors are robust and adjusted for state-level clustering. [b] Coefficient is statistically significant from zero ($p < .05$), also shown in bold type.

Table 5
Zero-Inflated Negative Binomial Model and Negative Binomial GEE Model Results: Factors Affecting the Number of Nonfatal Injuries in a Mass Public Shooting if a Mass Shooting Occurs, 1976–2018[a]

Factor	Incidence rate ratio [95% CI] [statistical significance]: Zero-inflated negative binomial model	Negative binomial GEE model
State population (in millions)	**1.04**[b] **[1.01, 1.06]** [p = .001]	**1.02 [1.02, 1.06]** [p = .32]
Population density (per .01 square miles)	**0.65**[b] **[0.62, 0.85]** [p < .001]	**0.70**[b] **[0.53, 0.92]** [p = .01]
Large-capacity ammunition magazine ban	**0.23**[b] **[0.09, 0.57]** [p = .002]	**0.30**[b] **[0.13, 0.71]** [p = .006]

Note. CI = confidence interval; GEE = generalized estimating equations.
[a] The negative binomial regression is restricted to observations in which an event occurred. Both models include linear and quadratic trends. Standard errors are robust and adjusted for state-level clustering. Nevada was excluded from the models because of outlying data that prevented model convergence. [b] Coefficient is statistically significant from zero (p < .05), also shown in bold type.

should be to limit potential shooters' access to firearms generally. One interpretation of our findings is that requiring permits to purchase or possess a firearm may limit potential shooters' access to firearms. Furthermore, laws requiring permits to purchase or possess firearms may be more effective than universal background checks because they rely on state or local officials, who have the most direct access to criminal, mental health, and drug- and alcohol-related records. In contrast, universal background checks rely on FBI data, which are often incomplete.

Second, to reduce the severity of mass public shootings when they do occur, the primary goal should be to limit the number of shots that can be fired before the shooter has to reload. This can be accomplished by restricting ammunition magazines to no more than 10 rounds. The 1994 Assault Weapons Ban is an example of a policy that sought to limit the severity of mass shootings. Included in that legislation was a ban on magazines that could hold more than 10 rounds (United States Congress, 1994). Recently several prominent voices have called for a renewal of the Assault Weapons Ban (Ingraham, 2018). Because our results did not show any association between assault weapons bans and mass public shootings, it may be more effective to focus on magazine capacity rather than trying to define assault weapons in general.

Third, our failure to find a relationship between laws that prohibit people with a history of violence from possessing firearms and that require relinquishment of firearms by people who do become prohibited from possessing them may indicate weaknesses in the practical application of these laws. Few states have statutory-based procedures for confiscating firearms from people who are adjudicated for violent misdemeanors—such as domestic violence offenses—or who are served with protection orders (Zeoli et al., 2020). Future studies should examine not only the enactment of laws but also their enforcement.

The methods and findings of this paper have implications for future research in the area of state firearm laws and mass public shootings. First, we used clearly defined and explicit criteria to categorize both our predictor and outcome variables. The public availability of both our mass public shooting data set and the extended State Firearm Law Database will allow researchers to conduct their own analyses to further the work described here. Second, we have demonstrated the use of the zero-inflated negative binomial model to simultaneously but separately identify factors associated with the incidence of mass public shootings and with the number of victims when such an event occurs. Our results suggest that there are separate laws associated with the incidence and severity of mass public shootings; thus, modeling the effect of firearm laws in a simple count regression may not be sensitive enough to distinguish these relationships.

Limitations

By far, the most notable limitation of this study stems from the fact that we sought to investigate mass public shootings, a small subset of all mass shootings. The sample size for analysis was therefore unavoidably small (N = 155 events), resulting in fairly wide confidence intervals on many of our point estimates and making it difficult to conclude that laws we found to be unassociated with mass public shootings do not affect these events. The number of events in our analysis was considerably less than the 604 mass shootings examined by Webster et al. (2020) and the 344 mass shootings studied by Reeping et al. (2019) but was higher than the 69 high-fatality mass shootings examined by Klarevas et al. (2019), the 57 in Gius (2015), and the 44 in DiMaggio et al. (2019).

Compounding this problem is the fact that some of the state laws were enacted in a small number of states, further limiting the effective sample size and reducing our power to detect an effect of these laws if one exists. This is particularly true for the violent misdemeanor laws, which were in effect in only four states in 2018.

Finally, because we were unable to control fully for confounding factors that could explain the observed results, we cannot infer causality from this study. Nevertheless, we did control for a wide range of variables known to be associated with rates of firearm violence, including sociodemographic factors, household gun ownership, violent crime rate, firearm homicide rate, and suicide rate. Any unrecognized confounding variable would have to be not only associated with both the enactment of permit or magazine capacity laws and with mass public shootings but would also have to be not strongly associated with any of the above variables.

Conclusion

Despite these limitations, our estimates of the association between state permit requirements and the incidence of mass public shooting events and between large-capacity magazine bans and fatalities and injuries occurring in such events were robust to different model specifications and are consistent with the findings of previous research. In particular: (a) our GEE logistic regression estimates and zero-inflated negative binomial estimates of the association between gun permit laws and the incidence of mass shootings were nearly identical and (b) our estimates of the association between large-capacity magazine bans and the number of fatalities as well as number of nonfatal injuries were also nearly identical when modeled using a zero-inflated negative binomial model and when modeled using a negative binomial regression model restricted to observations in which a mass public shooting occurred.

This study provides evidence that state laws requiring permits to purchase a gun are related to a lower incidence of mass public shootings and that state bans on large capacity magazines are related to fewer fatal and nonfatal injuries when such events do occur. Policymakers wanting to address specifically the morbidity and mortality from mass shootings would be prudent to adopt permit-to-purchase laws and large-capacity ammunition magazine bans to reduce both the incidence of mass public shootings and the number of casualties if such events do occur. They should take these findings into account in combination with the substantial body of research on the effect of state firearm laws on other types of firearm violence (Morral et al., 2018; Siegel, Pahn, et al., 2019) and with consideration of citizens' right to bear arms under the Second Amendment of the U.S. Constitution (*McDonald v. City of Chicago,* 2010).

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TABLE C: Studies Examining the Relationship Between the Use of High Capacity Ammunition Magazines and the Number of Casualties in Mass Public Shootings

Study, Date (years covered) No. of events	**Average Number of Casualties When Large Capacity Magazine Was Used**	**Average Number of Casualties When Large Capacity Magazine Was Not Used**	**Conclusion**
Koper et al., 2018[1] (2009-2015) 47 events	**13.7**	**5.2**	In mass shootings when an LCM was used, there were **2.6 times more casualties** than when an LCM was not used.
Cannon, 2018[2] (1984-2016) 82 events	**20.2**	**8.9**	In mass shootings when an LCM was used, there were **2.3 times more casualties** than when an LCM was not used.
Dillon, 2013[3] (1982-2012) 31 events	**22.6**	**9.9**	In mass shootings when an LCM was used, there were **2.3 times more casualties** than when an LCM was not used.
Koper and Roth, 2001[4] (1984-1993)	**29**	**13**	In mass shootings when an LCM was used, there were **2.2 times more casualties** than when an LCM was not used.

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Criminal Use of Assault Weapons and High-Capacity Semiautomatic Firearms: an Updated Examination of Local and National Sources

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Abstract Policies restricting semiautomatic assault weapons and large-capacity ammunition magazines are intended to reduce gunshot victimizations by limiting the stock of semiautomatic firearms with large ammunition capacities and other military-style features conducive to criminal use. The federal government banned such weaponry from 1994 to 2004, and a few states currently impose similar restrictions. Recent debates concerning these weapons have highlighted their use in mass shootings, but there has been little examination of their use in gun crime more generally since the expiration of the federal ban. This study investigates current levels of criminal activity with assault weapons and other high-capacity semiautomatics in the USA using several local and national data sources including the following: (1) guns recovered by police in ten large cities, (2) guns reported by police to federal authorities for investigative tracing, (3) guns used in murders of police, and (4) guns used in mass murders. Results suggest assault weapons (primarily assault-type rifles) account for 2–12% of guns used in crime in general (most estimates suggest less than 7%) and 13–16% of guns used in murders of police. Assault weapons and other high-capacity semiautomatics together generally account for 22 to 36% of crime guns, with some estimates upwards of 40% for cases involving serious violence including murders of police. Assault weapons and other high-capacity semiautomatics appear to be used in a higher share of firearm mass murders (up to 57% in total), though data on this issue are very limited. Trend analyses also indicate that high-capacity semiautomatics have grown from 33 to 112% as a share of crime guns since the expiration of the federal ban—a trend that has coincided with recent growth in shootings nationwide. Further research seems warranted on how these weapons affect injuries and deaths from gun violence and how their regulation may impact public health.

Keywords Firearms · Assault weapons · Violence

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Introduction

Firearm violence imposes a significant burden on public health in the USA. From 2010 through 2012, the nation experienced an annual average of 11,256 firearm homicides and 48,534 non-fatal assault-related gunshot victimizations that cost society nearly $22 billion a year in lifetime medical and work-related costs [1]. One type of policy response to reduce gun violence involves restricting or mandating design changes in particular types of firearms that are considered to be especially dangerous and/or attractive for criminal use.

Restrictions on assault weapons (AWs) represent one particularly controversial and highly contested form of such legislation that has featured prominently in gun policy debates in recent decades. In general, AW laws restrict manufacturing, sales, and ownership of semiautomatic firearms with large ammunition capacities and other military-style features that appear useful in military and criminal applications but unnecessary in shooting sports or self-defense [2]. Examples of such features include pistol grips on rifles, flash hiders, folding rifle stocks, threaded barrels for attaching silencers, and barrel shrouds on pistols. AW laws also commonly include restrictions on large-capacity magazines (LCMs), which are typically defined as ammunition feeding devices holding more than ten rounds of ammunition (some laws have higher limits). LCM restrictions are arguably the most important components of AW laws in that they also apply to the larger class of high-capacity semiautomatic firearms without military-style features. In the broadest sense, AW-LCM laws are thus intended to reduce gunshot victimizations by limiting the stock of semiautomatic firearms with large ammunition capacities and other features conducive to criminal use. The federal government enacted a national ban on AWs and LCMs in 1994 but allowed it to expire in 2004. Currently, eight states and the District of Columbia have AW and/or LCM restrictions, as do some additional localities [3].

Recent discussion and debates concerning these weapons have largely focused on their use in mass shootings. However, there has been little examination of the use of AWs and LCMs in gun crime more generally since the expiration of the federal ban. Studies conducted around the time of the federal ban found that AWs accounted for up to 8% of guns used in crime (generally between 1 and 6% and averaging around 2%) and that the broader class of firearms equipped with LCMs (including AWs and other semiautomatic firearms equipped with LCMs) accounted for up to a quarter [2, 4–12]. Criminal use of such weaponry declined during the years of the federal ban [2, 13, 14], but trends since then have only been examined in the state of Virginia, where LCM use rose following the ban's expiration [14]. Semiautomatic weapons with LCMs and/or other military-style features are common among models produced in the contemporary gun market [15, 16], but precise estimates of their production and ownership are unavailable. Growth in the use of such weapons could have important implications for public health as these weapons tend to produce more lethal and injurious outcomes when used in gun violence [2, 17]. This study provides an updated examination of the AW issue by investigating current levels of criminal activity with AWs and other LCM firearms as measured in a variety of national and local data sources.

Data and Methods

There is no national data source that can be used to count the numbers of homicides, non-fatal shootings, or other crimes committed with AWs and other LCM firearms. Therefore, criminal use of these weapons was approximated by examining and triangulating across several local and national data sources on guns used in different types of crimes.

Local Data Sources

The local-level analyses are based on guns recovered by police over multiple years (defined below) in a convenience sample of ten cities including Hartford (CT), Rochester (NY), Syracuse (NY), Baltimore (MD), Richmond (VA), Minneapolis (MN), Milwaukee (WI), Kansas City (MO), Seattle (WA), and Sacramento (CA). Large cities were selected for the analysis (these cities range in size from roughly 124,000 to 684,500) due to the concentration of gun violence in urban areas [18, 19]. Patterns and trends in these particular cities may not be indicative of those elsewhere; further, some (Baltimore, Hartford, Rochester, Syracuse, and Sacramento) are covered by state AW and LCM restrictions that were in effect during all or portions of the study period (this study does not attempt to evaluate the implementation and effects of these laws or variations therein). Nonetheless, these cities constitute a geographically diverse set of ban and non-ban locations, thus strengthening generalizations. The data were obtained from law enforcement authorities in these jurisdictions except where otherwise noted. Information available in most of the police databases included the type, make, model, and caliber of each confiscated firearm; the date when it was recovered; and the type of crime with which it was associated.

Guns recovered by police (often referred to as "crime guns") are the only readily available data with which to study patterns and trends in the types of guns used in crime across jurisdictions, and they are commonly used in research on gun markets, gun violence, and gun policy [2, 9, 20–37]. Guns confiscated by police include guns recovered in violent crime investigations as well as those recovered in connection with weapon offenses (illegal possession, carrying, and discharges), drug violations, property crimes, and other incidents. These samples thus represent guns known to have been used in violence as well as guns possessed and/or carried by criminal and otherwise high-risk persons. As others have noted, they represent a sample from the population of guns that are at greatest risk of misuse [24] and thereby provide a probable sample of guns used to commit crimes [21]. As caveats, nonetheless, it should be noted that police do not recover all guns used and possessed illegally, and it is possible that the types of guns they confiscate differ from those of unrecovered guns linked to illegal possessors and users. The analyses highlighted below are based on all confiscated firearms in the study jurisdictions. Additional analyses conducted with just those guns clearly connected to a violent offense, which represented at least 13 to 19% of guns across the cities, produced very similar results except where noted (separate offense-type analyses could not be conducted with the Syracuse and Rochester gun data or the Richmond LCM data).

National Data Sources

National-level analyses were conducted using three data sources and compilations. The first consists of information on firearms recovered by law enforcement agencies throughout the nation and reported to the federal Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) for investigative tracing of their sale histories. Guns reported to ATF provide a national sample of crime guns numbering in the hundreds of thousands annually (predominantly from urban jurisdictions), but they do not constitute a statistically representative sample for the nation given that gun tracing is voluntary (agencies trace guns as needed for specific investigations and/or analysis of illegal gun markets) and varies between agencies and over time [24, 27, 38–40]. Further, publicly available data on traced guns are limited to aggregate figures on basic types and calibers of the weapons, thus limiting the analyses that could be conducted as described below. The other national data sources included information on guns used in murders of police officers and mass murder incidents. Prior research has shown that AWs and LCM firearms are used in a higher share of these crimes, due presumably to their lethality and attractiveness to the types of offenders who commit these offenses [2, 4], and this has been a prominent issue in the AW debate. Information on firearms used in murders of police, including the type, make, model, and caliber of each weapon, was obtained from the Federal Bureau of Investigation (FBI), which compiles these data from reports by police agencies throughout the country. Information on firearms used in mass murder shooting incidents was collected from lists and reports compiled by several organizations since there is no single official data source that regularly provides detailed and comprehensive information on mass murders and the guns used in these incidents [41–50]. Consistent with many prior studies of this issue, firearm mass murders were defined as incidents in which four or more people were murdered with a firearm, not including the death of the shooter if applicable and irrespective of the number of additional victims shot but not killed. This increased the number of sources that could be used to gather information. As described below, however, detailed weapon information could not be found in public sources for many of the cases.

Methods

There is no universal definition of an AW that applies across current and past AW laws. For example, the expired federal ban and some current state laws define AWs as having two military-style features, whereas other state bans and a recent (2013) proposal for a new federal ban use a one feature criterion [2, 51]. For this study, AWs were defined based on the weapons that have most commonly been identified as such based on the old federal ban, current state laws, and the recently proposed federal ban. This list included more than 200 make-model combinations covered by either of the federal lists (2004 and 2013) or at least two of the state laws. Based on preliminary analyses showing that most recovered AWs are assault rifles (as opposed to assault pistols or assault shotguns), an additional ceiling estimate of AW use was calculated based on the prevalence of semiautomatic rifles. This was also done to compensate for imprecision in the AW estimates (due, for example, to missing or partial gun model data, lack of information about the specific features or configurations of the weapons that could affect their AW status, and possible omissions from the operational AW list).

Use of guns with LCMs could only be measured precisely for the Syracuse, Baltimore, and Richmond analyses, which are based on data sources having an indicator for magazine capacity (which is typically missing from police gun databases), and some of the mass murder incidents. For most analyses, use of LCM firearms was approximated based on recoveries of semiautomatics that are commonly manufactured and sold with LCMs, referred to below as LCM-compatible firearms. Identification of these models was based on gun catalogs (such as the *Blue Book of Gun Values* and *Gun Digest*) and examination of gun manufacturers' websites. This method likely overstates LCM use to some degree since many LCM compatible firearms can also be equipped with smaller magazines. As a rough guide, inspection of all recoveries of a small number of LCM-compatible handgun models in the Baltimore data revealed that approximately four of five were equipped with LCMs. Conversely, LCM use can also be undercounted for guns that were missing complete model information or equipped with aftermarket LCMs, which are available for some guns not sold with LCMs at retail. LCM use was not estimated for Rochester and Sacramento since New York and California have had longstanding restrictions on magazines with more than ten rounds (hence, it seems less likely that LCM-compatible guns recovered in those jurisdictions were actually equipped with LCMs).

Data were collected from 2014 through 2016. Current estimates of AW and LCM use were developed using the most recent 2–3 years of data from the local police databases and ATF data. Data spanning the most recent 5–6 years were used to generate contemporary estimates of AW and LCM use in murders of police and mass murders due to the rarity of these events. As described below, some data sources were also used to estimate trends in the use of semiautomatic rifles and LCM firearms since the expiration of the federal ban. Reported figures highlight AWs and LCM firearms as a share of crime guns in order to control for differences in the volume of gun crime and overall gun recoveries between places and over time. Other noteworthy aspects of the data and analyses are discussed below.

Results

Local Analyses

Results of the local analyses are presented in Table 1. For each site, estimates are based on data spanning different portions of the 2011–2014 period. The number of guns analyzed ranged from 281 in Syracuse to 4994 in Kansas City and totaled 21,551 across all data sources.

Estimates of the prevalence of AWs among crime guns ranged from a low of 2.4% in Baltimore to a high of 8.5% in Syracuse. Assault rifles (e.g., variations of the AR-15 or AK-47) accounted for the majority of AWs in all sites and more than three-quarters in all but one (Richmond). The remaining AWs consisted entirely (or nearly so) of assault pistols (e.g., the TEC-9 or TEC-22). The share of crime guns consisting of semiautomatic rifles of any sort is also displayed in Table 1 for localities that had gun databases with gun-type designations (i.e., handgun/rifle/shotgun, semiautomatic/non-semiautomatic). These estimates ranged from a low of 4.1% in Hartford to 12.4% in Rochester but were less than 9% for most cities. (The Milwaukee estimate is based on the percentage of crime guns that were rifles of any sort as semiautomatic/non-semiautomatic designations were unavailable.) As noted, the semiautomatic rifle estimates, which include both AW-type and non-AW-type rifles, provide a likely ceiling for estimates of AW prevalence.

The percentage of crime guns clearly equipped with an LCM (including AWs and other high-capacity semiautomatics, most of which are pistols) was 16.5% in Baltimore during the 2012–2014 period, but this figure rose to 21.5% for guns that were connected to a violent crime. These findings are similar to those from a recent news report (involving a separate and independent analysis of Baltimore data) indicating that 18.4% of guns recovered in Baltimore had LCMs for the period of 2010 through 2016 [52]. In Richmond, 22% of crime guns were equipped with LCMs during 2008 and 2009 based on data collected by the Virginia State Police and initially reported by *The Washington Post* [14] (the *Post's* reported figures have been reanalyzed here to focus on the most recent available years and to assess trends). Crime guns were least likely to be equipped with LCMs in Syracuse (14.6%), where New York State LCM restrictions have been in effect since the early 2000s.

For the other sites, the prevalence of LCM-compatible guns ranged from 22.2% in Hartford to 36.2% in both Kansas City and Seattle, with the majority of the estimates (3 of 5) higher than one-third. In most of these cities, the prevalence of LCM guns was similar whether focusing on all guns or those connected to a violent crime. In Hartford, however, 30% of violent crime guns were LCM compatible in contrast to 22.2% for all guns. Further, a supplemental analysis of guns linked to assault-

Table 1 Prevalence of assault weapons, semiautomatic rifles, and semiautomatics with large-capacity magazines among guns recovered by police: estimates for selected cities and years

Location and sample	Assault weapons as % of guns	Semiautomatic rifles as % of guns	Semiautomatics with large-capacity magazines as % of guns
Hartford, CT (2011–2012, *N* = 854)	2.6%	4.1%	22.2% overall, 30% for guns linked to violent crime
Rochester, NY (2012–July 2014, *N* = 1687)	4.9%	12.4%	Not estimated
Syracuse, NY (2012–May 2014, *N* = 281)	8.5%	12.1%	14.6%
Baltimore, MD (2012–Sep. 2014, *N* = 4680)	2.4%	5.4%	16.5% overall, 21.5% for guns linked to violent crime
Richmond, VA (AW analysis: 2012–2013, *N* = 1180) (LCM analysis: 2008–2009, *N* = 1960)	2.7%	Not estimated	22.0%
Minneapolis, MN (2012–Aug. 2014, *N* = 2178)	3.4%	6.4%	25.1% overall, 46.3% for guns linked to shootings
Milwaukee, WI (Jul. 2013–Jun. 2014, *N* = 1868)	4.6%	< 9.4%	35.5%
Kansas City, MO (2012–Aug. 2014, *N* = 4994)	6.1%	6.3%	36.2%
Seattle, WA (2012–July 2014, *N* = 596 guns linked to violent crimes or weapons violations)	6.4%	7.9%	36.2%
Sacramento, CA (Aug. 2013–Jul. 2014, *N* = 1273)	6.0%	Not estimated	Not estimated

Estimates are based on general gun recovery samples except where noted. Estimates were similar for guns known to have been connected to violent crimes except where noted. Large-capacity magazine (LCM) estimates for Syracuse, Baltimore, and Richmond are based on known LCM recoveries (the Richmond estimates are based on Virginia State Police data initially reported by *The Washington Post*). Other LCM estimates are based on recoveries of LCM compatible firearm models. The Milwaukee semiautomatic rifle estimate is based on the prevalence of all rifles

related shootings in Minneapolis (using gunshot victimization data provided by Minneapolis police) revealed that 46.3% were LCM compatible, though this was based on a small sample (n = 80 guns).

National Analyses

Results of the national analyses are presented in Table 2. AW prevalence was approximated in the national ATF tracing data for 2012 and 2013 (n = 481,632) based on traces of guns in calibers .223, 5.56, and 7.62 mm. These are common calibers for AW-type semiautomatic rifles, though not all firearms in these calibers are AWs, and not all AWs fall into these calibers. This method nonetheless yielded an estimate of 5%, which is within the range of estimates provided by the local analyses. Further estimates of semiautomatic rifles and LCM firearms were not possible given the limitations of published tracing data.

Guns used in murders of police were analyzed for the years 2009 through 2013 (n = 219, excluding cases involving the officers' own weapons, which are often LCM firearms). AWs accounted for an estimated 13.2% of the firearms used in these crimes overall and varied between 8 and 18% from year to year. Virtually all of the AWs (97%) were assault rifles. Semiautomatic rifles overall accounted for 15.5% of the firearms used in these cases and ranged from 5 to 23% annually. LCM-compatible firearms more generally constituted 40.6% of the murder weapons, ranging from 35 to 48% annually.

AW and LCM use in firearm mass murders was examined for a sample of 145 incidents that occurred from 2009 through 2015 but could only be estimated within broad ranges due to high levels of missing weapons data in public accounts. AWs were used in at least 10.3% of these incidents. However, only 42 incidents had sufficiently detailed weapon information to make a definitive determination regarding AW use; among these cases, 35.7% involved AW use. All but one AW case involved an assault rifle. (A separate estimate for semiautomatic rifle use is not presented because only two additional cases clearly involved a semiautomatic rifle with an unclear or non-AW designation.) LCM firearms overall were involved in at least 18.6% of the incidents based on cases that involved clear possession of LCMs, AWs, or other LCM-compatible models. Although many additional cases involved semiautomatic firearms, an LCM coding could

Table 2 Prevalence of assault weapons, semiautomatic rifles, and semiautomatics with large-capacity magazines among national samples of guns recovered by police, guns used in murders of police, and guns used in mass murders

Data source and sample	Assault weapons as % of guns	Semiautomatic rifles as % of guns	Semiautomatics with large-capacity magazines as % of guns
Federal Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF): guns recovered by police and reported to ATF for investigative tracing (2012–2013, $N = 481{,}632$)	5%	Not estimated	Not estimated
Federal Bureau of Investigation: guns used in murders of police (2009–2013, $N = 219$)	13.2%	15.5%	40.6%
Public reports of firearm mass murders (4+ killed) (2009–2015, $N = 145$)	10.3–35.7%	Not estimated	18.6–57.4%

Assault weapon estimate for ATF data is based on reported firearms in calibers .223, 5.56, and 7.62 mm. LCM estimates are based on recoveries of LCM compatible firearm models in the FBI data and recoveries of both LCMs and LCM compatible firearms in the mass murder data

only be made for 47 cases, 57.4% of which involved an LCM firearm. The identified AW and LCM cases typically occurred in public locations (80%) and resulted in more than twice as many people shot on average as did other incidents (13.7 victims on average for AW-LCM cases versus 5.2 for other cases; *t* test p level < 0.01).

Trend Analyses

Trends in the use of AWs and LCM firearms since the end of the federal AW ban or the early post-ban years were also estimated using selected data sources that had sufficiently detailed weapon information and spanned the period of interest. First, trends in recoveries of semiautomatic rifles were used to approximate trends in crime with AWs using the FBI national data on police murders (2003–2013) and data from the following cities and time periods: Baltimore (2004–2014), Rochester (2004–2014), Syracuse (2004–2014), Milwaukee (2006–2014, based on all rifles), Seattle (2008–2014), Minneapolis (2006–2014), and Kansas City (2008–2014). In summary, these analyses (not shown) revealed little evidence of upward trends in the use of semiautomatic rifles across sites.

Second, trends in crimes with LCM firearms were estimated based on guns used in murders of police (2003–2013) as well as guns recovered in Baltimore (2004–2014), Richmond (2003–2009), and Minneapolis (2006–2014). Table 3 shows changes over time in the percentage of guns that were LCM firearms using the earliest and latest years of each data source. In relative terms, the prevalence of LCM firearms increased from 33 to 49% in the Baltimore, Minneapolis, and national (FBI) data (note that Maryland restricted LCMs with more than 20 rounds throughout this period and extended these restrictions to LCMs with more than 10 rounds in late 2013). The largest increase occurred in Richmond, where LCM firearms increased 111.5%, rising from 10.4% of recovered guns in 2003–2004 (the final years of the federal AW ban) to 22% in 2008–2009. Similar trends have also been reported for the state of Virginia overall [14]. All of these changes were statistically significant ($p < 0.05$) based on chi-square tests of the equality of proportions.

Discussion

Subject to caveats noted above, this examination of several national and local data sources suggests that AWs are used in between 2 and 9% of gun crimes in general with most estimates being less than 7%. Upper bound estimates of AW use based on semiautomatic rifles range from 4 to 12% in most data sources and are typically less than 9%. These estimates are broadly similar to those generated in the early 1990s prior to the federal AW ban [2], though they are perhaps somewhat higher on average. However, comparisons of these estimates with others should be made cautiously, as operational definitions of an AW have varied across studies and estimates presented here are based on the most contemporary definitions of AWs. One clearly notable

Table 3 Changes in prevalence of semiautomatics with LCMs: estimates for selected local and national data sources and time frames, 2003–2014

Data source/location	LCM firearm prevalence: early time period	LCM firearm prevalence: late time period	Change in LCM firearm prevalence
Baltimore crime guns	11.1% (2004, 2006, $N = 5369$ total firearms)	16.5% (2012–Sep. 2014, $N = 4381$ total firearms)	+ 48.6%**
Richmond, VA crime guns	10.4% (2003–2004, $N = 2413$ total firearms)	22.0% (2008–2009, $N = 1960$ total firearms)	+ 111.5%**
Minneapolis crime guns	16.8% (2006–2007, $N = 2564$ total firearms)	25.1% (2012–Aug. 2014, $N = 2178$ total firearms)	+ 49.4%**
National (FBI): guns used in murders of police	30.4% (2003–2007, $N = 224$ total firearms)	40.6% (2009–2013, $N = 219$ total firearms)	+ 33.6%*

Change in proportions statistically significant at $p < 0.05$ (*) or $p < 0.01$ (**)

Estimates are based on general gun recovery samples except where noted. LCM estimates for Baltimore and Richmond are based on known LCM recoveries (the Richmond estimates are based on Virginia State Police data initially reported by *The Washington Post*). The early period estimate for Baltimore excludes the year 2005 due to an unusually large number of guns appearing that year within the buyback/turn-in/safekeeping category. Other LCM estimates are based on recoveries of LCM compatible firearm models

recent change is that assault rifles, rather than assault pistols, now account for a substantial majority of AWs used in crime in contrast to prior estimates [2]. This implies an increase over time in the average lethality of AWs used in violence.

LCM firearms, which include AWs as well as other high-capacity semiautomatics, appear to account for 22 to 36% of crime guns in most places, with some estimates upwards of 40% for cases involving serious violence. These estimates are comparable to or higher than earlier estimates of LCM use. However, the higher-end estimates may overstate LCM use somewhat as most are based on measurement of LCM-compatible guns that may not all have been equipped with LCMs.

Consistent with prior research, this study also finds that AWs and LCM firearms are more heavily represented among guns used in murders of police and mass murders. AWs account for 13–16% of guns used in murders of police, while LCM weapons overall account for about 41% of these weapons. Estimates for firearm mass murders are very imprecise due to lack of data on the guns and magazines used in these cases, but available information suggests that AWs and other high-capacity semiautomatics are involved in as many as 57% of such incidents. Further, they are particularly prominent in public mass shootings and those resulting in the highest casualty counts.

Importantly, trend analyses suggest that LCM firearms have grown substantially as a share of crime guns since the expiration of the federal ban on AWs and LCMs. This implies possible increases in the level of gunfire and injury per gun attack during this time. Consistent with this inference, national statistics from the Centers for Disease Control and Prevention (CDC) and the FBI show that the ratio of gun homicides and assaultive non-fatal shootings to overall reported violent gun crimes (homicides, assaults, and robberies) rose from an average of 0.163 for 2003–2005 to an average of 0.21 for 2010–2012 (calculated from CDC [53] and FBI [54] data). This change was driven by non-fatal shootings, which have been trending upward since the early 2000s and recently reached their highest levels since 1995 [1]. The findings presented in this study suggest the possibility that greater use of high-capacity semiautomatics has contributed to this upward trend in shootings.

Further study would seem warranted on LCM use trends with additional jurisdictions and data sources. Research on this issue could be facilitated by more systematic efforts to collect detailed information on crime guns and magazines in local police databases as well as through national data collection systems like the Supplemental Homicide Reports and the National Violent Death Reporting System. Study of these weapons is also hampered by lack of public data on production of LCMs and LCM-compatible firearms. The need for better data on this issue may become more pressing if there continue to be significant changes in the lethality of commercially available firearms.

Additional research is also needed to quantify the effects that LCM use has on injuries and deaths from gun attacks—and by extension on the costs to society from gun violence. Research suggests that gunfire attacks involving semiautomatics produce more lethal and injurious outcomes [2, 10, 17, 55] and that 4–5% of assault-related gunshot victims are wounded in attacks involving more than ten shots fired [2]. However, such evidence is extremely limited at present. Studies of this issue, combined with evaluation research on the effects of current state and local LCM laws, could provide additional insights into the efficacy of expanding LCM restrictions at the local, state, and/or national levels. Research illuminating the public health and safety benefits of AW-LCM restrictions could also inform the courts as they continue to adjudicate recent challenges to the constitutionality of these statutes. Although this study does not directly evaluate any AW-LCM law, it provides further evidence that the federal ban curbed the spread of high-capacity semiautomatic weapons when it was in place and, in so doing, may have had preventive effects on gunshot victimizations.

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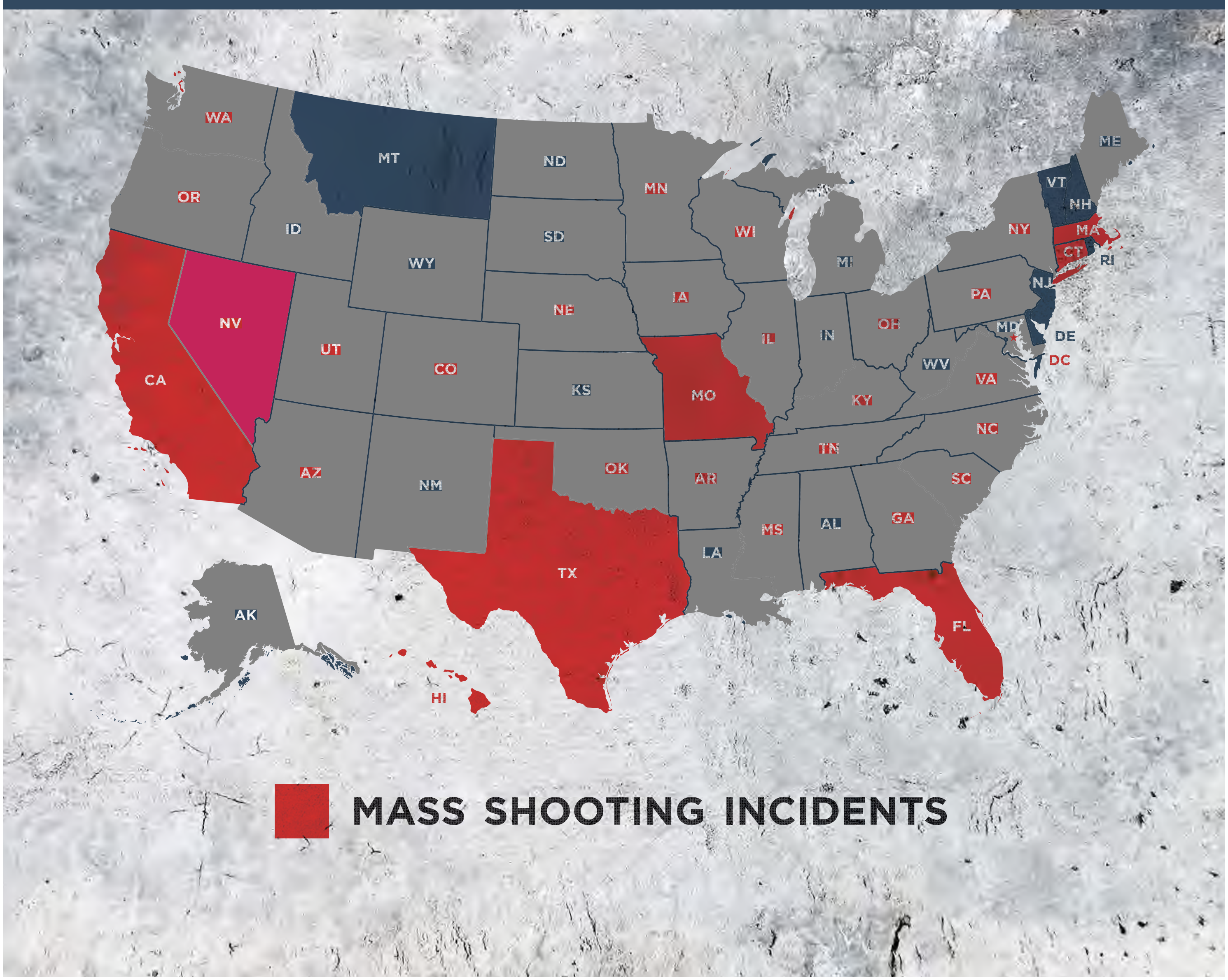
Citizens Crime Commission
of New York City

MAYHEM MULTIPLIED

MASS SHOOTERS & ASSAULT WEAPONS

BY ASHLEY CANNON



Mass shootings have taken place consistently throughout American history, in every region of the country. Over the last 30 years, however, assault weapons and firearms equipped with large-capacity ammunition magazines—which hold more than 10 rounds—have proliferated, allowing assailants to become much more destructive. As the following analysis shows, the results have been deadly for Americans.

As part of our non-partisan mission to prevent violence at the Citizens Crime Commission of New York City, we track mass shootings. Our *Mass Shooting Incidents in America* database catalogs shootings in which four or more victims were killed in a public place unrelated to another crime since 1984. Between June 1984 and June 2016, there were 72 such incidents—46 (64%) of which involved a perpetrator armed with an assault weapon or firearms equipped with a large-capacity magazine.

Assault weapons and large-capacity ammunition magazines were outlawed for 10 years between 1994 and 2004 as part of the federal Assault Weapons Ban, providing us with periods for comparison in order to determine the ban's impact on mass shooting casualties. **The results are startling.**

JUST SEVEN STATES AND THE DISTRICT OF COLUMBIA BAN ASSAULT WEAPONS AND IMPOSE RESTRICTIONS ON LARGE-CAPACITY AMMUNITION MAGAZINES (CA, CT, HI, MD, MA, NJ & NY).

LAX ENFORCEMENT IN OTHER STATES STILL MAKES THESE STATES VULNERABLE TO HEAVILY ARMED MASS SHOOTERS.

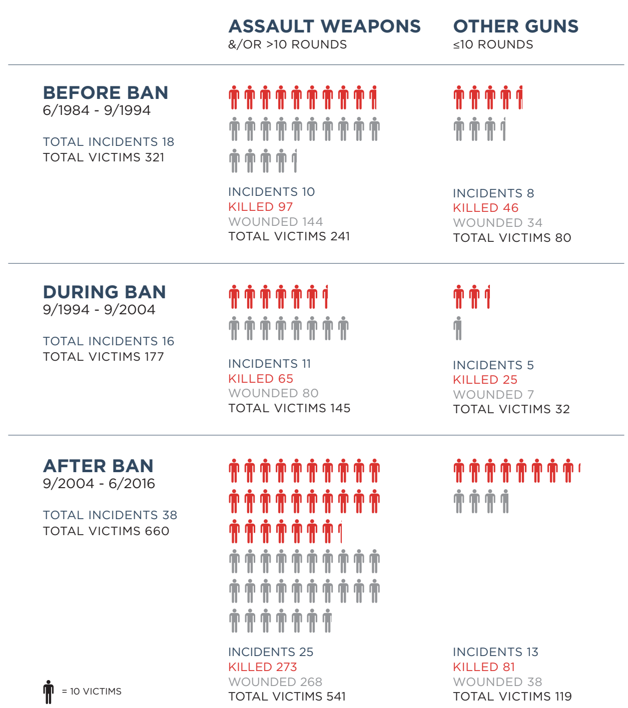
Between June 1984 and June 2016, shooters who used assault weapons and large-capacity magazines killed or injured 301% more people than those who did not. There were nearly 1,000 victims in those incidents—186% more killed than when a non-assault weapon or regular-capacity magazine was used, and 523% more injured.

Perhaps the most important finding is that the federal ban clearly reduced mass shooting casualties: The number of people killed or injured in mass shootings involving assault weapons and large-capacity ammunition magazines during the decade of the ban was nearly half what it was in the decade before (145 v. 241); and it was a third of the number of casualties since (541 from September 2004 through June 2016).

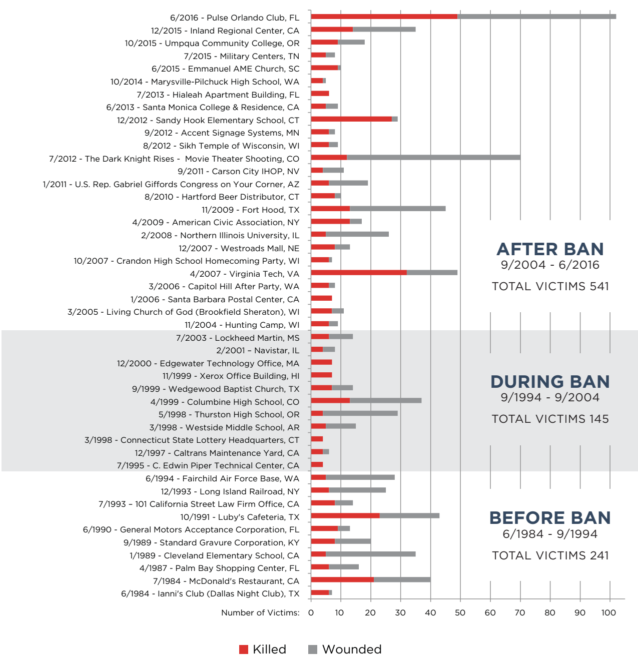
SHOOTERS WHO USE ASSAULT WEAPONS AND LARGE-CAPACITY AMMUNITION MAGAZINES ARE MUCH MORE DESTRUCTIVE THAN THOSE WHO DO NOT.

THE RESULT HAS BEEN DEADLY FOR AMERICANS.

Assault weapons and magazines holding more than 10 rounds were made illegal by the Assault Weapons Ban in 1994. Since it expired in 2004, the number of people killed and injured from mass shootings where an assault weapon or firearm equipped with a large-capacity magazine was used has TRIPLED.

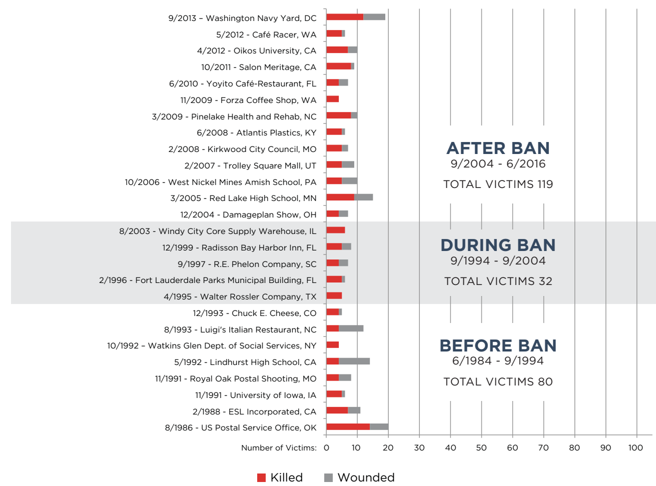


ASSAULT WEAPONS & LARGE-CAPACITY MAGAZINES



MORE THAN HALF OF MASS SHOOTINGS BETWEEN JUNE 1984 AND JUNE 2016 INVOLVED A PERPETRATOR ARMED WITH AN ASSAULT WEAPON OR FIREARM EQUIPPED WITH A LARGE-CAPACITY AMMUNITION MAGAZINE.

OTHER GUNS ≤10 ROUNDS



301% MORE KILLED AND INJURED WITH ASSAULT WEAPONS & LARGE-CAPACITY MAGAZINES
THAN WITH OTHER GUNS (6/1984 – 6/2016)

ASSAULT WEAPONS &/OR >10 ROUNDS: **927**

OTHER GUNS ≤10 ROUNDS: **231**

CITIZENS CRIME COMMISSION
OF NEW YORK CITY

MAYHEM MULTIPLIED

MASS SHOOTERS & ASSAULT WEAPONS

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This analysis was prepared by Ashley Cannon, with assistance from Evan Thies, Colin Wolfgang , and Jack Schrader.

For more information about the Crime Commission's Large-Capacity Ammunition Magazine Initiative and Mass Shooting Incidents in America database visit our website: www.nycrimecommission.org

Layout and design by Peter Green.

THE CITIZENS CRIME COMMISSION OF NEW YORK CITY IS A NON-PARTISAN NON-PROFIT ORGANIZATION WORKING TO MAKE CRIMINAL JUSTICE AND PUBLIC SAFETY POLICIES AND PRACTICES MORE EFFECTIVE THROUGH INNOVATION, RESEARCH, AND EDUCATION.

METHODOLOGY

To identify mass shootings and the weapons used, the Crime Commission reviewed descriptions of shootings found in news reports and lists created by government entities and advocacy groups. For the purpose of the this report, mass shooting is defined as four or more victims killed. Additional analysis criteria: occurred in a public place, and was unrelated to another crime (e.g., robbery, domestic violence). Information for this analysis has been compiled from publicly available sources. Every effort has been made to obtain the most accurate information, however, contradictions may exist between this analysis and other sources. As the ATF does not require police departments to collect data related to the capacity of a firearm's ammunition magazine and the media does not always report the details of the weapons used, this analysis does not cover an exhaustive list of mass shootings.

CITIZENS CRIME COMMISSION
OF NEW YORK CITY

www.nycrimecommission.org

MASS SHOOTINGS IN THE UNITED STATES: AN EXPLORATORY STUDY OF THE TRENDS FROM 1982-2012

by

Luke Dillon

A Thesis
Submitted to the
Graduate Faculty
of
George Mason University
in Partial Fulfillment of
The Requirements for the Degree
of
Master of Arts
Criminology, Law and Society

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Mass Shootings in the United States: An Exploratory Study of the Trends from 1982-2012

A Thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts at George Mason University

by

Luke Dillon
Bachelor of Science
Kutztown University, 2010

Chairman: Christopher Koper, Associate Professor
Department of Criminology, Law and Society

Fall Semester 2013
George Mason University
Fairfax, VA

DEDICATION

This is dedicated to my loving fiancé Abby, my two amazingly supportive parents Jim and Sandy, and my dogs Moxie and Griffin who are always helpful distractions.

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ABSTRACT

MASS SHOOTINGS IN THE UNITED STATES: AN EXPLORATORY STUDY OF THE TRENDS FROM 1982-2012

Luke Dillon, M.A.

George Mason University, 2013

Thesis Chairman: Dr. Christopher Koper

Past studies on mass murder have included public mass shootings along with familicides, felony murders, and gang associated murders. While all of these instances involve the murders of four or more people, there are not many other similarities between each classification. Therefore, public mass shootings are not truly accounted for in previous studies since they are rare events as opposed to familicides. This thesis examined in depth all public mass shootings occurring from 1982 to 2012 in the U.S. Specifically, trends in overall incidents, offense characteristics, and use of weapons were analyzed. The findings indicated that mass shootings are increasing slightly with almost half of all mass shootings analyzed occurring in the past eight years. Meanwhile, the trend of mass shooting incidents was not consistent with general homicide and stranger homicide levels which have decreased over the same time period. When assessing trends in offense characteristics, the significant findings were that offenders are becoming younger, mental illness is becoming an increasing factor, and venues for mass shootings are moving away from the more common workplace shootings of the 1980s.

Additionally, assault weapons or large capacity magazines were used in more than half of all cases with significant increases in fatalities, injuries, and total victim counts identified.

INTRODUCTION

Over the past decade, several highly publicized and horrendous murders involving multiple victims have occurred in the United States. Just in 2012, there were four high profile incidents over a span of six months including: James Holmes' Colorado movie theater shooting killing 12 people and injuring 58 others, Wade Page's Wisconsin Sikh temple shooting which killed 6 people and injured 4 others, Andrew Engeldinger's Minneapolis workplace shooting which killed 5 people and injured 4 others, and Adam Lanza's Connecticut Sandy Hook Elementary shooting which killed 26 people. The aforementioned incidents are what can be referred to as a mass murder or the act of killing at least four victims at any one immediate time (Federal Bureau of Investigation 2010). Since each of these mass murderers chose a firearm as their weapon of choice and each occurred in a public location, they are referred to as public mass shooting events.

Public mass shootings tend to get the largest amount of media attention and therefore have the widest spans of devastation. The problem facing criminal justice personnel and politicians alike is that there is a wide range of research on the topic of mass shootings, but very little is scholarly in nature and the small amount of scholarly research done on the subject does not address the more current issues. These personnel hold a public trust in the sense that they have a responsibility to create a safe environment for all citizens to enjoy their lives peacefully. However, in the minds of many, public mass shootings create a disruption in their lives since they seem to be so random while occurring at types of places that they might visit frequently including stores, schools, and churches. It is this feeling of the unknown that creates the greatest fears for people. The purpose of the current study is to gain a better understanding as to if mass shooting incidents are increasing while attempting to analyze trends in the characteristics and natures of these violent actions. With the popular debate about gun control and assault weapons ban, a specific element which the study will address is the availability of assault weapons and the role that assault weapons and large capacity magazines play in mass shooting incidents. For the purpose of creating research that criminal justice practitioners and politicians can use as a reference, the present study will seek to dispel several pressing questions including: Have instances of public mass shootings been on the rise in recent years? Are there trending characteristics in public shooting incidents when focusing on offenders, settings, general methods, or typologies? What is the role of assault weapons and large capacity magazines in mass public shootings?

This study will focus specifically on mass public shootings since the majority of prior research has been skewed with a large proportion involving instances of family annihilation (Holmes and Holmes 1992) or familicides. While these instances of mass murder are still important to understand, murders involving family members tend to have completely different characteristics, motivations, and methods than the more public mass killings. The current study will contribute to the established literature by: exploring trends of mass shootings over a time period (1982-2012) where there have been gaps or inconsistencies evident in past studies; analyzing clusters of characteristics or methods which are evident across time; and addressing the role of firearms, specifically assault weapons and large capacity magazines, in mass shootings. The present study is important since it focuses on trends and characteristics associated with one particular type of mass murder, pubic mass shootings, which have largely been ignored by scholarly works.

Overall, there has been little agreement over whether mass murder is a growing trend in the current American society and most studies have either included an entire century of cases or a small sample involving a short time frame. As evidenced in other works, a large proportion of the most violent crimes in American history have occurred since the 1980s (Fox and Levin 2012). Previous studies have not analyzed the trends in mass murders beginning from the start of this more violent generation leading into the current millennium. Also, there is substantial research which has indicated the difficulties in determining a profile for mass murder so that a crime prevention tactic could be applied (Holmes and Holmes 1992). The current study will explore this time period and address the recent trends of mass shootings while seeking to create a better understanding of the characteristics and weaponry involved in mass shootings. With the findings of this study, there are significant public policy and theoretical implications which could be considered regardless of any specific result. Public mass shootings are a pressing problem in today's society and any statistical research to assist in future policies is greatly needed.

Generally, the United States is a less violent country than it was even just a couple of decades ago. Homicide rates peaked in the early 1990s and have since rapidly declined to an unprecedented level last seen in the early 1960s (Cook and Ludwig 2000). However, there has not been a corresponding decline in mass murder (Fox and Levin

2012, Duwe 2000, Duwe 2007). The questions on this issue are exactly why do these senseless acts of violence happen and how can they be stopped? Similar to the causes of regular homicide, the major schools of theories could all address some underlying cause when attempting to make sense out of mass murders. However, whether supernatural, biological, psychological, or sociological theories have been applied to individual reasons for the commission of mass murder, there has been a corresponding lack of research to indicate a causal relationship. Additionally, there is a shortage of scholarly research on addressing the trends of mass shootings and possible macro level causes for the trends. While the present study will not causally test any particular individual or macro level theory, it will produce analyses which are necessary for future works to develop and test theories of mass shootings.

Along with mixed theoretical foundations, mass murder might also be influenced by an easy accessibility to weaponry in the United States. Guns are often the weapon of choice for mass murders for a number of reasons mentioned by Fox and Levin (2012). First, firearms produce greater lethality and spread of carnage as opposed to more blunt objects or knives. Second, the murderer is more able to be selective with their targets with the use of firearms instead of bombs or fire which maim or kill all individuals within a specific radius. Third, guns also distance the attacker psychologically from their victims which in the case of Adam Lanza might have contributed to his capacity to senselessly murder so many children. Finally, high-powered weaponry provide the offender with more control over the situation and thus more of a likelihood for success if their intent is indeed to kill specific targets or as many individuals as possible.

When assessing these benefits to using a firearm to commit mass murder, it is also easy to extrapolate how assault weapons might be favored instead of handguns. There have been ongoing debates about defining assault weapons, but federal laws have defined assault weapons based on the features of the weapon. These definitions have included semi-automatic rifles with detachable magazines and at least two of the following features: pistol grip, folding stock, flash suppressor, threaded barrel, bayonet mount, grenade launcher, or other military style additions (Koper 2004). Additionally, semi-automatic pistols or semi-automatic shotguns with two or more military style features are also included in an assault weapon definition. Assault weapon characteristics, especially with the addition of high capacity magazines, could feasibly enable an intent killer to shoot more people quicker and thus expand not only the lethality of the incident, but also the range of the incident as indicated in the number wounded.

Generally, the statistics on mass murder indicate that it is a phenomenon which does not appear to track with other types of violent crime. A majority of the carnage of these attacks defies comprehension, not only because of the magnitude of one single action, but also because there seems to be no clear consensus on a motive or theory which might be of a guide to stopping future events. Some killings might be motivated by a desire for vengeance, hate, politics, love, money, power, expression, fame, or maybe no observed motivation at all.

LITERATURE REVIEW

Defining Mass Murder

There is a lot of disagreement among criminologists on the definition of mass murder with some using the term to cover all multiple homicides such as serial killings or any other occasion in which someone kills more than a single person. Other sources indicate that a mass murder must have at least three victims (Dietz 1986, Holmes and Holmes 1992, Petee et al 1997) with some setting the minimum at four victims (Levin and Fox 1985, Ressler et al 1988, Fox and Levin 1998, Duwe 2000, Duwe 2007). Overall, there is some agreement that the definition of mass murder is based on an element of time with multiple murders occurring in immediate succession to one another and the total number of victims killed (Dietz 1986, Levin and Fox 1985, Holmes and Holmes 1992, Fox and Levin 1998, Hempel et al 1999). Some other criteria which have also been used in the definition of mass murder are the location of the murder and distance between locations (Holmes and Holmes 1992), type of weapon used (Hempel et al 1999), offender motive (Rappaport 1988, Hempel et al 1999), the number of offenders (Dietz 1986), and the number of wounded victims (Dietz 1986). Mass murder can be carried out with bombs, poison, stabbing, firearms, or even choking in some instances. According to the FBI's Crime Classification Manual, someone who kills four or more people in close succession in a single location or in closely related locations is classified as a mass murderer (Federal Bureau of Investigation 2010). The FBI's classification of mass murder is the most commonly used definition across previous works (Levin and Fox 1985, Resslet et al 1988, Fox and Levin 1998, Duwe 2000, Duwe 2007), and is the working definition for the present study.

On the other hand, spree killers, who might have similar motives and ambitions as mass murderers, are defined as committing their acts over several unrelated locations and having a passage of time in between separate incidents. With spree killings, the element of time is not any definitive amount, but rather is an indication that the murders occur separately while still being connected in the same act of violence. The general definition of spree murder is two or more murders committed by an offender or offenders, without a cooling off period (Federal Bureau of Investigation 2008). The lack of a cooling off period then marks the difference between a spree murder and a serial murder. Serial murder typically consists of three or more separate events in three or more separate locations with a cooling off period between the homicides (Federal Bureau of Investigation 2008). The serial murderer might have a cooling off period of hours, days, weeks, months, or years.

A mass murder will typically occur in a single location with the killing of as many victims as possible. Under this definition, individuals, organizations, or governments may commit mass murder. In the past, mass murderers have been defined and categorized with different methods because not every incident fits into a specific mold. Fox and Levin (1985) presented one of the more popular mass murder typologies based on categories of power, terror, loyalty, revenge, and profit. The power-oriented mass murderer seeks to satisfy a thirst for power and control who bears multiple weapons, dressing similar to a soldier, and seeking a manner they feel will signal their power over others. The revenge oriented mass murderer feels that everybody in their lives is to blame for their hardships and should pay the price. The loyalty oriented mass murderer is typical of a family annihilator who has a warped sense of love for others close to them that the ultimate sacrifice is to save them from living. The profit oriented mass murderer is one who while in commission of a crime kills all others present in order to be more successful in their criminal act. Lastly, the terror oriented mass murderer is reminiscent of terrorism where the mission is to raise the panic in a society where the message is of a higher purpose to a belief system.

Holmes and DeBurger (1988) present a different set of typologies focusing on the motivations of intrinsic or extrinsic stimuli as a triggering effect for the event. The disciple killer has an extrinsic motivation to please the leader of some unit or organization and kills upon such leader's command. The family annihilator is much like the loyalty oriented mass murderer who feeds on an intrinsic feeling that his or her family is better off dead than living. The pseudo-commando typically has a stockpile of military-graded weapons and an intrinsic fear of not being in control of their lives. The disgruntled employee has an intrinsic motivation in that he or she feels that they have been wronged by their employment whether it is through the act of firing, punishment, or denied promotional opportunities. Finally, the set and run mass murderer can have a combination of motivations, but their method of operation consists of using means that enable them to kill from a far distance and observe the event.

Holmes and Holmes (2001) present the last of the predominant typologies of mass murderers modifying the original typology of Holmes and DeBurger (1988). Holmes and Holmes' (2001) typology includes all of the previous categories (disciple, family annihilator, set and run, and disgruntled employee) while replacing the pseudo-commando with three other categories: ideological, disgruntled citizen, psychotic, and youthful killers. The ideological mass murderer attempts to fulfill an agenda and considers their victims as just collateral damage to a higher mission. The disgruntled citizen mass murderer is upset with some element of society that they wind up lashing out at with violent actions. The psychotic mass murderer is detached from reality because of some underlying disorder and believes that the only escape from such a state is to commit violence. Youthful killers seek revenge against fellow classmates and teachers making them pay for something wrong in their own lives.

Offender Characteristics

While earlier research had focused on defining the difference between serial and mass murder (Levin and Fox 1985), others focused on developing typologies (Holmes and DeBurger 1988, Holmes and Holmes 2001), and some research had focused on larger numbers of case studies (Chester 1993, Kelleher 1997, Leyton 1996). Around the turn of the century right after the Columbine Killings, the main focus was more on developing a behavioral profile on offenders because the prior conception was that these would-be offenders came out of nowhere to commit these horrible acts. Hempel et al (1999) studied a nonrandom sample of North American mass murderers between 1949 and 1998 finding that the majority of them were single or divorced males beyond the age of 40 and had paranoid, depressive conditions as well as narcissistic, schizophrenic, and antisocial behaviors. Additionally, they were classified as having an almost warrior mentality after suffering a major loss just prior to the commission of the murders (Hempel et al 1999). In a comparison of mass murder between other cultures and North Americans, it was found that there was a commonality between syndromes of uncontrollable rage, aggressive behavior, social isolation, loss, depression, anger, narcissism, paranoia, and psychosis (Hempel et al 2000). Meanwhile, Cantor et al (2000) analyzed a sample of cases from Australia, Britain, and New Zealand finding a common trend that the subjects killed mostly indiscriminately among randomly selected victims. The average age of their sample was 29 while the offenders were unsuccessful socially, resentful, egocentric, rigid, obsessional, and narcissistic (Cantor et al 2000). Also, Cantor et al (2000) indicated that the murderers were suffering from a deteriorating life course which combined with resentment and fantasies provided them with a breaking point.

When studying younger mass murderers, McGee and DeBernardo (1999) worked on a profile of a classroom avenger where the trending characteristics were a white male, age 16, raised in a middle class rural or suburban environment, and no history of any mental illness or disability. Although perceived as a loner with no history of violent behavior, the young offender has a background of attachment difficulties and is quite interested in violence, spending a large amount of his time involved in violent fantasies (McGee and DeBernardo 1999). Contrarily, another analysis of juvenile mass killers found that insufficient recognition of a mental illness was an important aspect in the killings (Fessenden 2000). Vossekuil et al (2000) argued that youth mass murder incidents were rarely impulsive with most shooters having previously used guns. In addition with their access to firearms, young mass shooters were identified as bullying targets and those people around them were generally concerned about their behaviors prior to any external acts of violence (Vossekuil et al 2000). Meanwhile, Velinden et al (2000) identified five different trending factors among youthful killers: individual, family, school and peer, societal, and situational factors. Individual factors consisted of depression, threatening violence, uncontrolled anger, and blaming others while family factors were more indicated in a lack of parental supervision or troubled relationships within family structure. School and peer factors included rejection by peers or social isolation, as well as an identification with a deviant peer group. Societal factors focused on an access to firearms or gun enthusiast and a clustering of previous murders reported by the media while situational factors included a recent loss, stress, or humiliation which placed the juvenile in a dire situation.

Mass Shooting Incidence and Trends

Mass murders committed with the use of firearms or in other words, mass shootings, dominate political discussions on violence and gun control. However, these incidents make up a tiny fraction of the overall gun crime. Less than one percent of gun murder victims recorded by the FBI in 2010, were killed in incidents with four or more victims (Federal Bureau of Investigation 2010). A recent study analyzed every mass shooting which had occurred between January 2009 and January 2013 finding a total of 43 mass shootings or nearly one per month that had occurred in 25 states (Mayors Against Illegal Guns 2013). Another analysis by USA Today found that 934 people were killed in 146 mass shooting incidents in the United States since 2006, but just under half of the victims were killed by family members (Schouten 2013). The same analysis indicated that mass killings occur about once every two weeks with more than three quarters involving the use of a firearm (Schouten 2013). These statistics illustrate the rarity of mass shootings, but they also highlight the multitude of these incidents occurring at a pace that in many minds seems as if it is almost every other week, in a different town, across the country.

Public mass murder is frequently conducted with the assistance of a gun. Of the 250 incidents that took place in a public location from 1900 through 1999, 191 involved offenders who used firearms and even if instances are excluded which occurred in connection with criminal activity, there were still 116 mass public shootings in the twentieth century (Duwe 2007). Also, mass murder in itself, is a rare offense with an average of 27 incidents per year or around two per month since 1976 (Duwe 2007). So if there are approximately 20,000 homicides each year as a historical average, mass murders account for only 0.1% of all homicides and approximately 0.7% of all homicide victims (Duwe 2007).

There has been much debate over whether mass shootings have actually increased over the years or if brutal attacks such as the ones in Colorado or Connecticut have created the mirage that mass shootings are rapidly abundant. Fox (2013), a criminologist at Northeastern University, argues that there has been no trajectory upward or downward with some years that have been particularly bad while others were not. Fox uses FBI and police data on shootings between 1976 and 2010 indicating that there are around 20 mass murders per year with an annual death toll of about 100 with fatality counts fluctuating wildly from year to year (Fox 2013).

Meanwhile, Duwe (2007) in his examination of mass murder throughout the entirety of the twentieth century found that there were several trends in mass murder over three periods of time: 1900-1939, 1940-1965, and 1966-1999. During these trends, there were spikes in the amount of mass murders per year, but also valleys where mass murder was a rarity. Illustrating the reasoning behind these trends in the twentieth century, Duwe (2007) indicated that incidents of mass murder during the earliest part of the century consisted of race riots, bombings, familicides related to divorce and poverty, labor union strikes, and felony robberies. Throughout 1940-1965, there were overall lower crime rates in general along with fewer instances of mass murder which Duwe (2007) suggests might have been a result of the increased prosperity in the nation leading to increased employment, educational opportunities, and a rise in conformity. Additionally, there was a scarcity of a strong drug market during this time. However, some of the mass murder incidents included war veterans being offenders, parents being killed by their children, and murders related to the civil rights battle or racial tension. Then, the period of 1966-1999 is characterized as the second wave of mass murder with racism, extreme poverty, and a heightened social activism. During this time period, there was an increase in drug related and felony related killings as well as an increase in the amount of high profile school shootings and workplace related mass public shootings (Duwe 2007).

The frequency with which mass public shootings have occurred has accelerated since the 1960s where from 1900 through 1965 there were 21 shootings, but from 1966 through 1999 there were 95 (Duwe 2007). Duwe (2007) suggests that the rise in mass public shootings occurred during the 1980s and 1990s attributing the rise to substantial cultural and social developments during this period: a declining marriage rate, an increasing divorce rate, an increase in the number of single-parent households, and the growing amount of social isolation experienced by the adult population. Additionally, the rise in homicide and crime rates a few decades earlier might have been related to the increase of unattached, alienated, and unemployed or under employed young males (Duwe 2007).

Statistics compiled in the 2000s indicate mass murders are on the rise depending on how they are defined. Hargrove (2012) reported FBI statistics which showed that homicides involving two or more victims rose from 1,360 incidents in 2008 to 1,428 incidents in 2009. However, mass murders involving four or more victims have also been on the rise, at least indicated by Hargrove. During a three year period from 2006 to 2008, an annual average of 163 Americans were victims of mass killing, up slightly from the average of 161throughout the 1980s (Hargrove 2012). These increases oppose the views of Fox (2013) who argued that incidents of mass murder are not recently increasing. Hargrove (2012) does not definitively indicate a cause as to why mass killings might be increasing, but he does propose the influence of the media and copycat killers as a possible reason.

In the same time frame, the upward trends in mass murder seem to be in contrast to the large drop in single victim murder which has declined more than 40% since 1980 (Cook and Ludwig 2000). 2012 has been especially bloody according to the data set issued by Mother Jones magazine which the present study will also use. While the data set limits counts of mass murder to only public attacks and excludes robberies or gang violence, 2012 has been the deadliest for mass shootings since 1982 when its counts actually began. In its count, 80 people have been shot to death in mass incidents last year. While there is not a real consensus as to whether mass murder and mass shootings are increasing or decreasing, the high profile incidents have caused public fears to rise while influencing leaders to address possible solutions.

Micro and Macro Explanations for Trends

One possible solution has been to better control the availability and possession of firearms in the U.S. Additionally, there are other possible explanations to a recent upsurge in public mass shootings instead of increases in the availability of more high powered weaponry. However, the problem rests that there has not been any empirical analysis on applying any particular theory to mass shootings. Also, there is a level of uncertainty as to whether macro or individual level theories account for a larger indication of trends in mass shootings.

When focusing on why certain individuals might be more prone to commit public mass murder, psychological and sociological approaches have been applied conceptually (Duwe 2007), but not empirically. Psychological causes of violence hinge on the development of antisocial behavior through an individual's childhood and developmental years. Some children might have been physically and mentally mistreated or just simply were not effectively socialized to the norms of society leading to a failure to develop a capacity to bond with other people. Lorenz (1966) denied that behavior is a reaction to environmental conditions and argued instead that it results from internal and spontaneous forces where, like animals, humans have a destructive disposition to violence. Building upon Lorenz, Fromm (1973) divided aggression into instrumental where violence is a means to an end and expressive aggression where violence is an end in itself learned in response to failures of society to not satisfy individuals' needs. Mental illness might also be a commonality in mass murders as well as in general crime (Fox and Levin 2012).

Contrasting the psychological approaches which believe violence is innate, social learning theory asserts that aggressive behavior involves skills that are learned from others and can be seen as a cause for a macro level increase in mass shooting incidents. There is a common assumption that the mass media provides powerful models for aggressive conduct; however, there is little evidence that clearly supports a causal link between violent media and aggressive behavior (Ferguson and Ivory 2012). Others though believe that there is a phenomenon called the copycat effect with regards to mass murder as there tend to be clusters of incidents after a previous incident has been widely reported in the media (Coleman 2004). Coleman (2004) argues that the media's over-saturation of mass murders feeds on the desires of other would-be offenders to become famous much like those publicized. Fox and Levin (2012) emphasize that a large number of mass murderers commit these acts because they crave attention in some manner and the media could be not only used as a source of learning methods to carry out their actions, but also as a motivation to be famous like those who have killed before.

Another possible reason behind the learning process involves the work of Sutherland's (1947) differential association theory or Akers (2000) differential reinforcement theory. Differential association asserts that criminal behavior is learned during adolescence from those closest to the individual such as their family, friends, and peers. If surrounding attitudes are supportive towards violence, the individual is likely to develop pro-violence tendencies. Also, it is possible that they may develop criminal skills through these associations such as learning to shoot a firearm proficiently. Meanwhile, differential reinforcement theory suggests that accepting violence does not come from just the closest intimate group, but from associating with a group which reinforces violent behavior while punishing law-abiding behavior. Eric Harris and Dylan Klebold, the Columbine Killers, are clear examples of this theory in action. Harris and Klebold were social pariahs in their school, turning to both themselves and their group of fellow outcasts, the Trench Coat Mafia. Between one another, Harris and Klebold were fed up with being put down at school and in life so they constantly bounced violent ideas of vengeance back and forth. These violent actions were accepted and thus reinforced by both parties leading up to the plan being put in action and followed through on.

One of the more common explanations to both regular homicides and mass shooting incidents involves the frustration aggression hypothesis. Similar to Merton (1957), Messner and Rosenfeld (2007), and Agnew (1992), the frustration-aggression hypothesis proposes that frustration always causes some form of aggression and that aggression is always preceded by frustration (Dollard et al 1939). Therefore, if anything interferes with an individual's movement toward a goal, this restriction will cause frustration for the individual, leading to aggression, and in some cases might escalate to external acts of violence. Additionally, the tendency for frustration to lead to aggression is at an absolute high when the frustration is severe and unexpected. Palmer (1960) found strong empirical support for this concept in all 51 murderers whom he had studied. This approach has yet to be empirically tested in the totality of mass shooting incidents. However, the frustration aggression hypothesis has been successfully used to explain certain individuals' motivations to commit mass murders (Holmes and Holmes 1992, Fox and Levin 2012) and can seemingly be used as reasoning behind possible increases in recent years with the restrictions imposed due to the economic downturn.

Another social perspective involves control theories where criminal behavior is a result of a lack of control rather than a component of learning. Hirschi's (1969) social control theory proposed that individuals only commit crime when their bonds – attachment, commitment, involvement, and beliefs – are weakened or absent. Mass murderers are commonly typified as loners who seem to lack connections with others as well as with any of society's activities or ideals. Similarly, Sampson and Laub (1993) suggested that these informal controls are instrumental in individuals' desistance from crime, but implied that an individual's status and thus controls in life may become detached or reattached repeatedly throughout one's life course. This approach appears to mirror the frustration-aggression hypothesis where there is a sudden change or severing of one's informal ties leading to the commission of a violent act. The mass murderer who comes back to their workplace after receiving a punishment or being fired is consistent with this theory in that the individual holds value in their lives through their work and when that is taken from them, their only purpose seems to be violence.

Assault Weapons in Mass Shootings

In the United States, a motivated mass murderer has easy access to a serious means of mass destruction, firearms. While massacres can happen in other countries with more rigid gun control measures, there is no match to the bloodshed in the United States because of the widespread availability of high-powered weaponry and ammunition (Fox and Levin 2012). According to the National Institute of Justice in 1994, 44 million people and approximately 35% of households owned a total of 192 million firearms with 74% of those individuals having reported more than one firearm (Krouse 2012). By the end of 1996, approximately 242 million firearms were in circulation. In 2000, the number of firearms had increased to 259 million: 92 million handguns, 92 million rifles, and 75 million shotguns (Krouse 2012). By 2007, the number of firearms had increased to 294 million. It can be safe to say that over the last few decades, the number of firearms has consistently increased beyond the normal population trends (Krouse 2012). Compared to similar nations, the U.S. homicide rates are 6.9 times higher than rates in other high-income countries, driven by firearm homicide rates which were 19.5 times higher (Richardson and Hemenway 2011).

While large capacity magazines have not been discussed in prior mass murder studies, their characteristics make them conducive to public mass shootings. Having the ability to carry multiple ammunition clips with more than ten bullets each clip facilitates firing of high quantities more rapidly. In the mid-1990s, approximately 40 percent of semiautomatic firearms being manufactured and sold had large capacity magazines included or at least the ability to accept large capacity magazines (Koper 2004). Overall, a previous study found that 18% of all civilian-owned firearms were equipped with large capacity magazines (Cook and Ludwig 1996).

The more lethal a weapon may be, a motivated assailant who seeks to kill large numbers of victims can be more successful at reaching their desired outcome. Additionally, a mass murderer who seeks out certain people for revenge is especially more likely to use firearms because they are more predictable and controllable in their destructiveness than other explosive methods for example. As previously mentioned, there has been a growing number of high-powered, rapid fire weaponry available for private use in the U.S. Out of all of the deadliest mass murders in America, three quarters have occurred since 1980 with most of those involving firearms as the exclusive or primary weapon (Fox and Levin 2012).

Contrary to the popular belief, assault weapons are used very rarely in mass killings. Duwe (2007) discovered only 16, or 2% of all incidents, from 1900-1999 which involved the use of an assault weapon with all taking place since 1977. This statistic is somewhat misleading as it covers a time frame when the availability of assault weapons in the U.S. was smaller than more recent numbers. A more current statistic indicates that 12 of the mass shooting incidents since 2009 or 28% of all mass shootings involved assault weaponry (Mayors Against Illegal Guns 2013). While the use of assault weaponry is obviously higher than the numbers from the 20th century, their usage is still the minority weapon chosen in mass shooting incidents. However, despite the infrequent use of assault weapons, there is an increased likelihood of greater fatalities and number of wounded due to their semiautomatic abilities and capacity to have large ammunition clips. Compared to other mass murders, incidents involving assault weapons have about one more fatality, but around twice as many wounded victims as other mass killings (Duwe 2007). A critical aspect of these findings is that the difference between assault weapon lethality and other mass murder lethality would have been higher if large death tolls as a result of a bomb or fire such as the Oklahoma City bombing were disregarded in the counts. Also, the findings include family murders which typically involve the use of a handgun at a close proximity leading to a higher fatality rate.

Duwe (2007) additionally presents an interesting concept about how the media portrays mass murder incidents especially those events where an assault weapon is used. Out of all mass murders expressed by the media and academia through 1900 to 1999, over 18% involved the use of an assault weapon as opposed to that actual 2% of the total incidents which actually used an assault weapon (Duwe 2007). The overemphasis on assault weapons being associated with mass shootings might be exaggerated by the media. Also, since assault weapons were banned from 1994 to 2004, there is a presumption that their availability has risen as the ban expired. In both cases, it references a particular angle that future research should address.

METHOD

The present study attempts to answer some questions about mass shooting incidents that have been previously contested, such as whether the recent trends of incidents have been increasing, decreasing, or remaining constant as compared to earlier time frames. Another highly contested issue is the nature of mass shootings specifically whether assault weapons are used in the majority or minority of the cases. The current study uses the theoretical framework involving the availability of high powered weaponry in the United States as a starting point towards answering both of these questions. As mentioned above, the availability of high powered weaponry such as assault weapons with large capacity magazines have increased over the past several decades. It is hypothesized that mass shooting incidents have increased more recently due to the easy access to high powered weaponry. Therefore, it is also proposed that the role of assault weapons in these incidents has likewise increased leading to higher fatality and injured counts as compared to non-assault weapon shootings. Additionally, the present study will attempt to address the nature of these cases to identify trends in the offenders, locations, or general characteristics of these incidents. There have been numerous theories and typologies used to provide the reasoning behind public mass shootings. Some of the more common approaches include an aspect of a frustration-aggression hypothesis where a triggering event precedes the external act of violence. However, there might be other trends located within the data of these cases that have yet to be unveiled including the mental stability of the offender. The hope to the current study's results is to provide a better indication of the trends and characteristics of these deadly incidents so that formal prevention efforts could then at the very least provide warning or early detection of troublesome individuals and events.

Unit of Analysis

The unit of analysis in this study is classified as each individual mass shooting event occurring in the U.S. from 1982-2012. While several definitions of mass murder have previously been applied, the present study uses the FBI crime classification definition consisting of an individual killing four or more people in a single incident not including the suicide of him or her. Also included are high profile spree killing cases that fit closely with the criteria for mass murder, but that the killings occurred in more than one location over a brief period of time. Technically, the shooting at Sandy Hook Elementary School would be considered a spree killing since the suspect, Adam Lanza, had killed his mother at their house prior to going to the elementary school. However, this tragedy in Newtown as well as five other similar spree killings has been included since the details surrounding the offense are closely related. Excluded are instances of mass murder involving the commission of a felony, gang-related activity, or family annihilation. The present study seeks to only focus on public mass shooting incidents involving the fatalities of four or more people for several reasons. These include the fact that previous studies have focused on mass murders in general which are predominantly family killings that skew any results towards that one typology, seemingly random mass shooting incidents typically invoke the typologies of offenders who will more often use assault weaponry, the majority of the high profile mass murder incidents which have been linked to political debates and litigations have been public mass shootings not tied to any other criminal activity, and public instances offer the best case scenario for developing trends in order to formulate formal criminal justice related prevention efforts.

Data

This specific analysis uses data conducted from an investigation on mass shootings by Mother Jones Magazine, a nonprofit news organization which specializes in investigative, political, and social justice reporting. The investigative team from Mother Jones consisted of Mark Follman, Gavin Aronsen, and Deanna Pan. Their investigation attempted to uncover every incidence of a mass shooting in the United States from 1982-2012. The investigation discovered 62 incidents of public mass shootings throughout this time frame. Mother Jones provided public access to their data set on their website (www.motherjones.com). This data set was selected for use in this study because of initial availability, but also because it covers a thirty year time frame which had relatively been understudied given the extensiveness of violence throughout this time period. Also, the investigation's purpose was to specifically detail the weapons used in each case of mass shooting and how each weapon was obtained by the shooter. Additional measures recorded in the data set are incident name, location, date, year, summary, fatalities, injured, total victims, venue, mental health/illness, race, and gender of the shooter. The importance involved in a data set such as this one is the inclusion of variables that are not available in the Supplementary Homicide Reports (SHR). Typically, studies involving a similar topic tend to make use of the SHR; however, the SHR does not provide the level of detail necessary to analyze the locations, offenders, weapons, and circumstances surrounding the particular types of mass public shootings which are the interest of the current study.

Initially, there was some hesitation to use secondary data for a compilation of mass murder incidents because every researcher tends to define it differently, thus including or excluding certain cases. The Mother Jones data set which the present study uses has handpicked the events based on specific criteria: the killings are carried out by a lone shooter (except Columbine and Westside Middle School Killings), the shootings happened during a single incident in a public place, and the shooting involved the deaths of at least four people excluding the killer. Specifically, instances involving gang-related activity, commission of a felony, or family murders were excluded. In a critique of the Mother Jones investigation, Fox (2013) focused more on the cases that were not included on account of the aforementioned stipulations and the inconsistencies at which some of the conditions have been applied. For example, Fox (2013) referenced two instances of mass murder which had occurred at a business and were also classified as a robbery in addition to the mass murder. However, one event was included because it was committed by a former employee while the other was excluded because it was a stranger to the business and was seen as just mass murder while in the commission of a felony. It is significant to note that despite Fox's criticisms, there are only a couple problematic cases he identified out of the complete data set. On the other hand, Fox (2013) argues that in eliminating instances of family murder and gang-related murder, there are a large number of total cases which are ignored which can affect the strength of any conclusions from the data.

Additionally, the Mother Jones data set does not rely on information contained within the Supplemental Homicide Reports. Instead it uses searches from media accounts and other sources to populate its cases so that a higher level of detail for individual cases could be ascertained. By using these methods to create the data set, it raises a question about the reliability of the data since other secondary sources might not be entirely accurate and the results of the searches might be sensitive depending on the methods that one uses.

Therefore, to adequately test the data set, other data sets were used solely as sources of validation. One of the data sets was conducted by the organization, Mayors Against Illegal Guns (2013). This data provided every mass shooting between January 2009 and January 2013 which granted a comparison of the most recent cases included in the Mother Jones data set. Mayors Against Illegal Guns (2013) defined a mass shooting similarly as any incident where at least four people were murdered with a gun, but did not choose to exclude any other occurrence as long as the victim count was at four. In their investigation, they indicated that 43 mass shootings had occurred in this four year period as opposed to the Mother Jones data set which included only 15 events during the same time period. Of the 28 extra instances covered by Mayors Against Illegal Guns while not included by Mother Jones, 20 events were family murders, 6 events were either gang-related or in the commission of a felony, 1 event only had three victims, and the remaining case seemed as if it should have been included because it fit Mother Jones' criteria. The missing case involved a shooter opening fire on a group of people outside of a bar in Buffalo while killing four and wounding four others. After researching the incident, it was discovered that there was insufficient evidence to include the Buffalo bar killing to the data set. The information found on this instance was inconsistent across different media sources and there was not enough details to gather a proper diagnosis of the event. Overall, the comparison with this one data set provides an aspect of validity for the Mother Jones data set because almost all of the cases were included and the absent cases in the data set were mostly family mass murders with some felony and gang-related murders as well.

Another comparison of the same time frame used a listing of mass shootings in the United States since 2005 provided by the Brady Center to Prevent Gun Violence (2013). This compilation of mass shootings includes all substantial, as determined by the Brady Campaign investigators, acts of violence involving a gun and causing at the very least multiple fatalities or wounded victims. There are no other specific criteria to this data set which includes family, gang-related, and felony mass murders. Additionally, there are also events included which have no fatalities and several wounded or a combination of fatalities and wounded which are not sufficient under the Mother Jones' criteria of four fatalities. Therefore, it is already expected that the data set will contain a large amount of events which are not included in this current study's data set. However, it is still important to analyze roughly how many instances are excluded by the Mother Jones data set and what are some of the characteristics of these exclusions. By just focusing on the same time frame as the previous comparison of January 2009 to January

2013, the Brady Campaign listed a total of 300 cases compared to the 15 cases included in the Mother Jones investigation. Of those cases not included in this study's data set, 65 (22.8 %) involved the murder of family members and 47 (16.6%) involved either gang-related or felony murder. While a majority of those cases also did not meet the four fatality criteria, an additional 172 (60.3 %) involved shootings where three or fewer victims were killed. This analysis also left just one undecided case which was also the Buffalo bar shooting that the previous comparison had shown was missing from the Mother Jones data. By expanding the comparison between the data sets further from January 2005 to December 2008, the Brady Campaign listed a total of 171 cases compared to the 12 cases included in the Mother Jones investigation. Of those cases not included in this study's data set, 34 (21.4%) involved the murder of family members, 23 (14.4%) involved either gang-related or felony murder, and 98 (61.6%) did not meet the four fatality criteria. The analysis left four undecided cases, but all four of these cases while meeting the other criteria elements were not public shootings in nature so they do not fit with the purpose of the present study.

Due to these two comparisons, the present study felt comfortable that the data set included, with a high level of certainty, every necessary instance of mass shooting which met the criteria. While Fox (2013) has raised some important concerns regarding the selectiveness involved in the Mother Jones investigation, the current study wishes to focus specifically on instances of mass public shootings without the extra components which are consistent in family, gang-related, or felony murders. By being selective with just a couple of typologies of mass murder, the present study can more effectively highlight individual trends of certain instances as well as detail the role that some of the more high powered weaponry plays in mass shootings.

Independent and Dependent Variables

Since the present study is exploratory in nature, there are several different variables which will be used and applied as either an independent or dependent variable. Similar to previous research on mass murder or mass shootings, this analysis uses variables such as offender age, gender, race, mental capacity, offense location or venue, weapons type, legality, and lethality. All of the aforementioned variables are obtained from the Mother Jones data set. Offender age and lethality of the event are measured numerically while every other variable is measured nominally indicating a yes or no response as to an investigation uncovering a presence or absence of a variable or categorically such as venue or race. Due to the purpose of the study and the variety of methods to define such variables, two significant operationalizations of variables to note involve assault weapons and large capacity magazines. The Mother Jones data set makes use of the assault weapon and large capacity magazine definition involved in the proposed Assault Weapons Ban of 2013. Dianne Feinstein's (2013) legislation would ban the sale, transfer, manufacturing, and importation of:

- All semiautomatic rifles that can accept a detachable magazine and have at least one military feature: pistol grip; forward grip; folding, telescoping, or detachable stock; grenade launcher or rocket launcher; barrel shroud; or threaded barrel.
- All semiautomatic pistols that can accept a detachable magazine and have at least one military feature: threaded barrel; second pistol grip; barrel shroud; capacity

to accept a detachable magazine at some location outside of the pistol grip; or semiautomatic version of an automatic firearm.

- All semiautomatic rifles and handguns that have a fixed magazine with the capacity to accept more than 10 rounds.
- All semiautomatic shotguns that have a folding, telescoping, or detachable stock; pistol grip; fixed magazine with the capacity to accept more than 5 rounds; ability to accept a detachable magazine; forward grip; grenade launcher or rocket launcher; or shotgun with a revolving cylinder.
- All ammunition feeding devices (magazines, strips, and drums) capable of accepting more than 10 rounds (Feinstein 2013).

The complete account of mass shootings used in the present study is shown in Appendix A.

Method of Analysis

In order to accomplish the purpose of the present study, there will be an assessment of the recent trends of mass shootings by comparing the instances of the earlier years in the data set to the later years while performing a chi-square analysis. To assess trends during recent years (2005-2012), the study will examine the likelihood of a public mass shooting occurring during a given month and use chi-square tests to determine if this likelihood has changed over time. Although the entire time frame of the data set (1982-2012) will be analyzed, a greater emphasis will be placed on the recent time frame (2005-2012) due to the extra validation of these cases. Additionally, there will be several visual plots to analyze the general trends over the time frames. To rule out the possibility of a historical threat or that the instances are just following a more general trend, the trends of other data sets will be compared to this study's data set while using statistical analyses to see if trends are similar. In addition, a comparison will be made to other stranger murders recorded in the Uniform Crime Reports to rule out the historical threat of homicides involving strangers.

The last portion of analysis will consist of identifying individual trends on the nature of mass shootings and is more exploratory in nature. An important part of this analysis is the role of assault weapons in the facilitation of these types of crimes. The proposed analysis of assault weapons will attempt to test the following two things: compare the use of assault weapons and large capacity magazines in public mass shootings to their use in gun crime in general; and compare the numbers of deaths and injuries in mass public shootings that involved assault weapons or large capacity magazines to those that did not involve such weaponry. Other analyses will be descriptives of characteristics including those of the offender and location of the incidents. Ultimately, the end goal is to learn about the complete nature of these violent acts including the use of high powered weaponry so possible solutions can be identified.

ANALYSIS

Mass Shooting Incidents over Time

In order to analyze the amount of incidents over time and determine whether events are increasing, time periods are separated into half (1982-1997 and 1998-2012) and then divided into quarters (1982-1988, 1989-1996, 1997-2004, and 2005-2012). The first step in this analysis is to observe basic statistics for each period of years. When observing the number of incidents in the years 1982 to 1997, there were a total of 23 public mass shootings which equates to an average of 1.64 per year. Meanwhile, during the years of 1998 to 2012, there were a total of 39 shootings equating to an average of 2.79 incidents per year. Referenced in Table 1, from 1982 to 1988, there were 6 total incidents with an average of 0.86 per year. The next two time periods account for 15 and 14 total shootings respectively with an average of less than 2 per year. However, from 2005 to 2012, there were 27 mass shootings, almost half of the 31 year total equating to an average rate of 3.38 incidents per calendar year. When performing a basic ordinary least squares regression on this trend shown in Figure 1, the increase is moderately significant at $p<0.10$. Throughout the time periods, there was an increase of over 6 mass shooting incidents per each clustering of years. The regression analysis has an R-squared measure of 0.85 meaning that the occurrence of time accounts for 85% of the variation in observed public mass shooting incidents.

Table 1. Mass Shootings Per Year During Time Periods

Time Period	Total N of Shooting Incidents	Shooting Incidents Per Year During Time Period
1982-1988	6	0.86
1989-1996	15	1.88
1997-2004	14	1.75
2005-2012	27	3.38

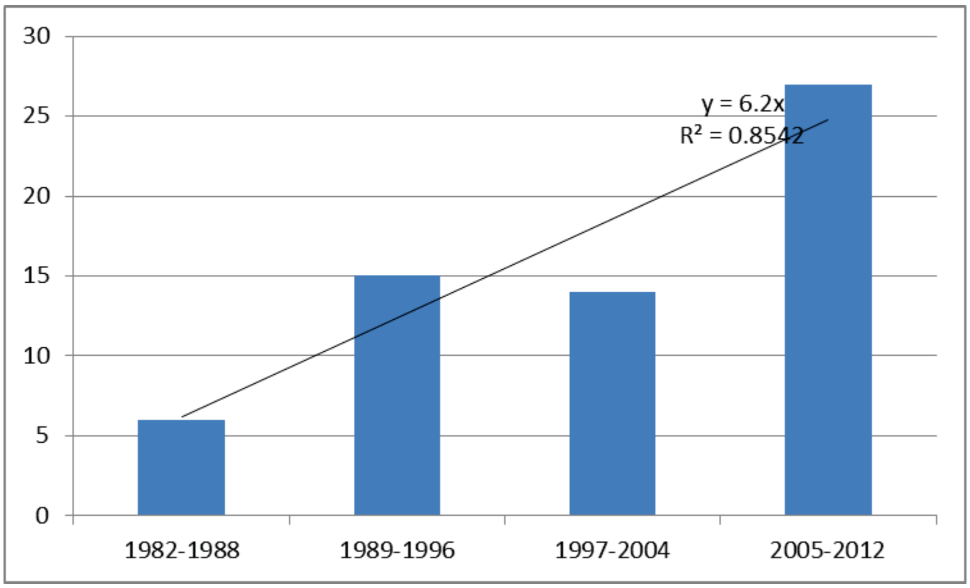

Figure 1: Total Mass Shootings during Time Periods

Since the current study provided additional validation for the data set during the time period of 2005-2012, extra analyses will be conducted with this most recent time frame. In order to establish if mass shooting incidents have increased over this eight year time period, a 2x2 chi-square analysis was conducted based on incidents per month. The results for this analysis can be referenced in Table 2. Between 2005 and 2012, there were a total of 24 months where there were at least one or more public mass shootings as opposed to 72 months which did not have any such event. By separating the last eight years into two groups, there was a mass shooting recorded in 10 of the 48 months during 2005 to 2008 while 14 such events of 48 months were recorded between 2009 and 2012. In performing a chi-square analysis, however, the difference among the two time periods was not statistically significant at a $p<.05$ level. Therefore, the analysis showed no indication that the actual count of 10 and 14 months respectively are statistically different from the expected count of 12 months recording an event out of every 48 months.

Table 2. Chi-Square Monthly Analysis 2005-2008 vs 2009-2012

		N of Mass Shooting Months	
Time Period		**No**	**Yes**
2005-2008	Actual Count	38	10
	Percent Within Time Period	79%	21%
2009-2012	Actual Count	34	14
	Percent Within Time Period	71%	29%

However, even with this analysis not being statistically significant, any minor difference between the time periods is significant to note due to the nature of the crime. For example, during 2005 to 2008, a public mass shooting occurred around once every five months or an average of 2.5 months per calendar year. Meanwhile, during 2009 to 2012, a public mass shooting occurred around once every three to four months or an average of 3.5 months per calendar year. The average shooting incident occurred at almost a two month faster pace the past four years as it had the previous four year period from 2005 to 2008. This increased rate can be seen in Figure 3 towards the end of 2011 and 2012 where the bars which represent each month seem to blend together. After performing another basic OLS regression analysis, this trend is not statistically significant with a p-value over 0.25. In addition, the data only accounts for less than 2% of the variation in shooting incidents. While statistical tests for this time period do not indicate any significant increases, there was still an increase in observed incidents as discussed earlier. Overall, the faster incident rate accrued to an additional shooting incident per year. When the human casualties for each mass shooting are at a minimum of four victims, each additional incident is significant.

By expanding the analysis to the complete time frame 1982-2012, the results are similar. Figure 2 shows this complete time frame with the additional OLS regression line. Over time, there has been a very slight increase in the amount of observed public mass shooting incidents as indicated by the positive slope. The regression analysis was statistically significant at $p<.01$, but again with the R-squared less than 0.03 the analysis does not account for any real variation in shooting incidents over time. Still, it is significant to note that the most recent time frame 2005 to 2012 and the complete time frame 1982 to 2012 have witnessed an increasing level of public mass shootings. This result is a significant finding regardless of the actual values or significance measures.

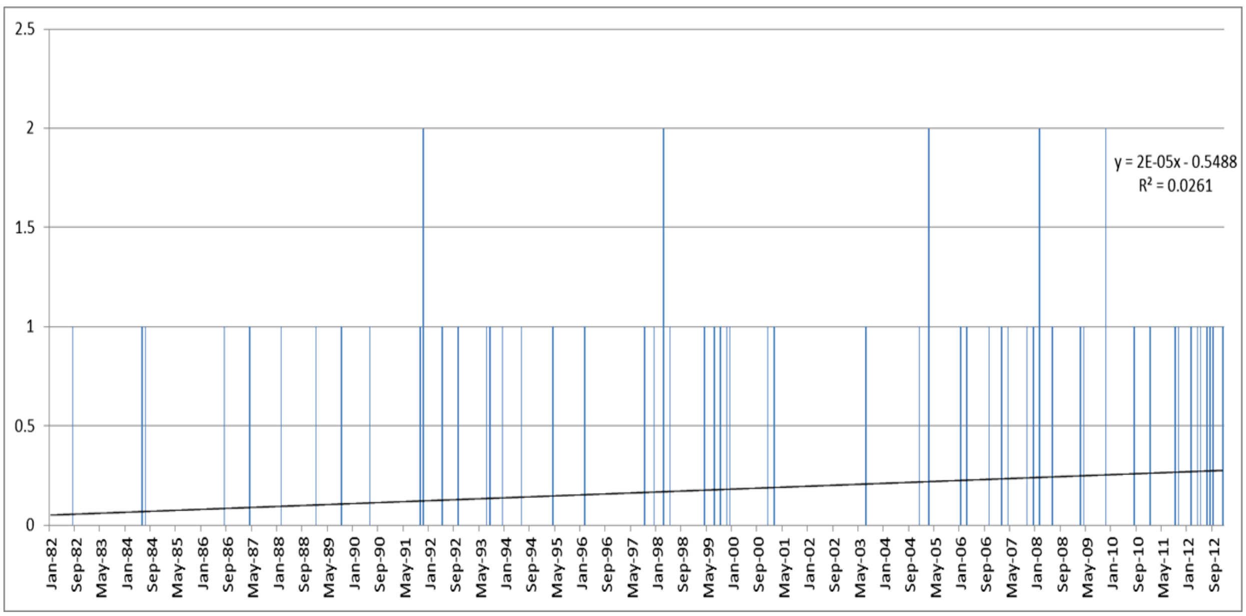

Figure 2: Number of Shooting Incidents per Month 1982-2012

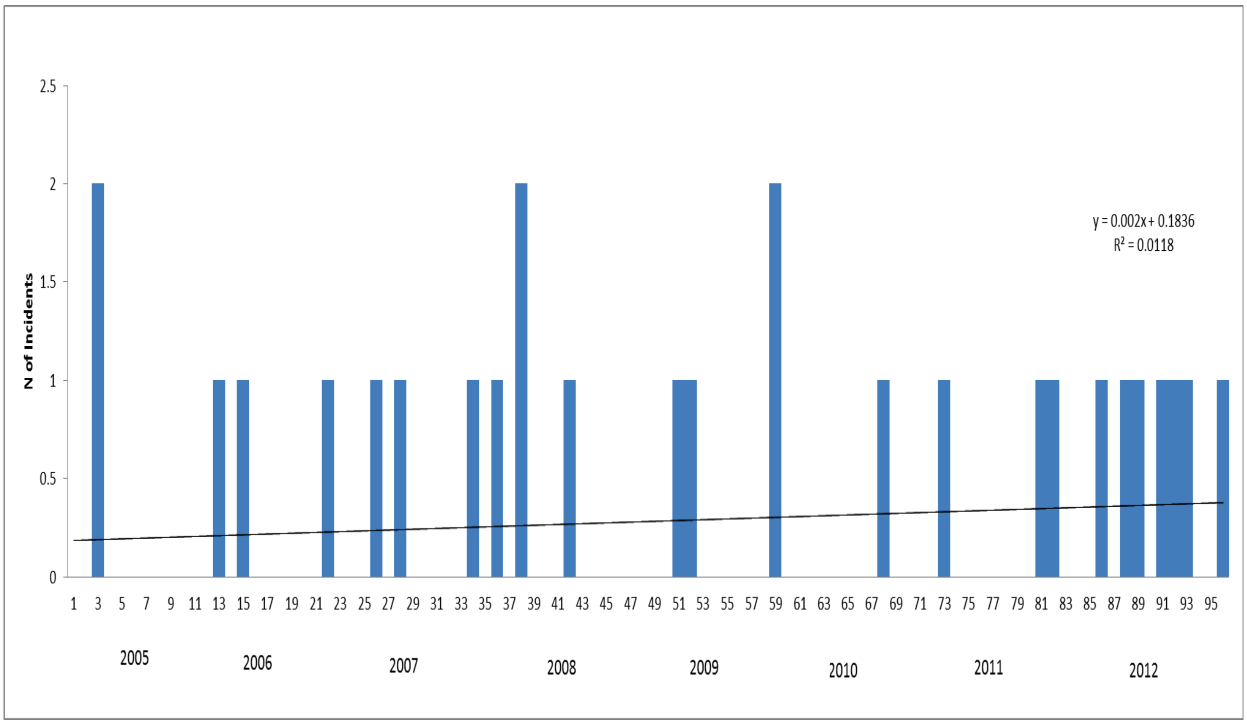

Figure 3: Number of Shooting Incidents per Month 2005-2012

Meanwhile, to clearly indicate whether public mass shootings are increasing, a comparison to overall homicide trends and offender/victim stranger homicides is necessary. Data for this specific analysis was pulled from the U.S. Department of Justice Bureau of Justice Statistics (1982-2012) in addition to Fox and Zawitz's U.S. Department of Justice (2007) work on homicide trends in the United States. Stranger homicide statistics were only available up until 2005, but a trend can still be established from the allowed time frame. Both total homicide rates and stranger homicide rates are plotted in Figure 4 and Figure 5 on the following pages. When analyzing the two trends, it clearly shows the peaks and valleys of homicides which were previously mentioned in the literature review section. Homicides in the U.S. appear to rapidly increase in the late 1980s and early 1990s while sharply declining through the 1990s to a more consistent level which it has been since around 2000.

Meanwhile, stranger homicides seem to have more abrupt changes in trends. As compared to general homicides, stranger homicides have pointy peaks indicating years where there was a sharp increase in stranger homicide. The three most pronounced peaks occur at years 1991, 1993, and 1995. After 1995, the amount of stranger homicides per year witnesses a steady decline similar to that of general homicide levels. When these trends are compared to Figure 4 and Figure 5, there do not appear many similarities. While public mass shootings did increase, on a small level, in rate during the late 1980s and early 1990s, there was no sudden increase or decrease as observed in general homicide statistics. Additionally, overall homicide levels remained moderately consistent during the 2000s. In contrast, public mass shootings have ensued at a more frequent rate with almost half of the total instances in the last 31 years occurring from 2005 to 2012. While this comparison does not prove that mass shootings are increasing, it does indicate that they are not occurring at a similar rate as general or stranger homicides. This finding is significant because it causes reasonable speculation that public mass shootings are independent of general homicide and therefore are not following the similar downward trend as observed in homicide rates since 1982.

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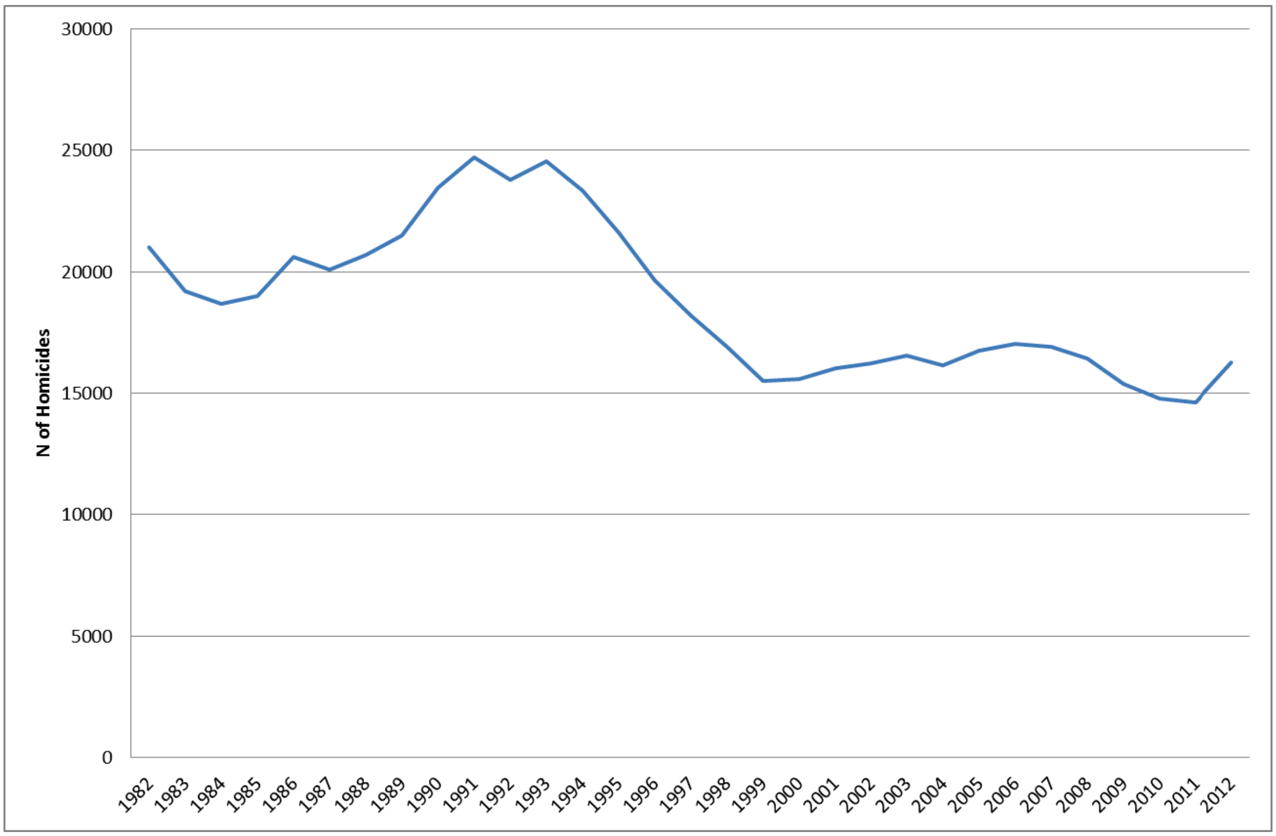

Figure 4: U.S. Homicides per Year 1982-2012 (U.S. Department of Justice Bureau of Justice Statistics 2012)

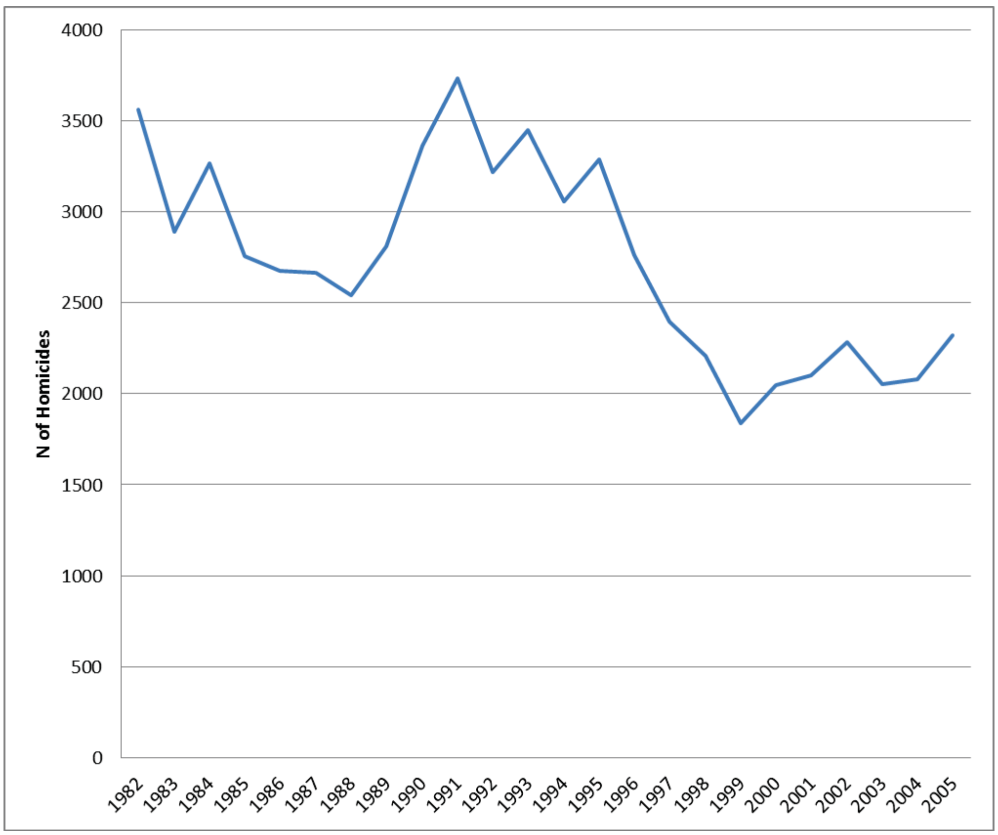

Figure 5: U.S. Stranger Homicides per Year 1982-2005 (U.S. Department of Justice 2007)

The final step in the analysis is to compare the recent trend of public mass shooting incidents used in this study to a different assessment of mass shootings. For the comparison, Schouten's USA Today 2013 investigation on mass shootings and Fox's (2013) assessment on mass murders have been used. Figure 6 shows the number of mass shooting incidents per year found in this investigation. It should be noted that USA Today defined mass shootings as events where four or more people are killed by firearm at one time. However, the criteria was not as selective as the present study's data as it includes all incidents regardless of location, public or private, and also includes the various classifications of murder including family murders. Almost half of the incidents involved the killing of family members. Overall, the investigation found a total of 146 mass shootings since 2006. On the other hand, the Mother Jones investigation found only 25 public mass shootings during the same time frame. In looking at the USA Today graph, mass shootings have been pretty consistent over the last seven years with an average of around 20 incidents per year. There are a couple of years with a rate slightly lower than the average as well as a couple of years with a slightly higher rate. Meanwhile, the last two years, 2011 and 2012, are right at the average indicating that mass shootings are not rapidly increasing. However, as mentioned above, this investigation included all shootings involving the deaths of four or more people. This comparison indicates that the trend in public mass shootings, as shown in the present study, does not follow the trend of mass shootings as defined by the USA Today study.

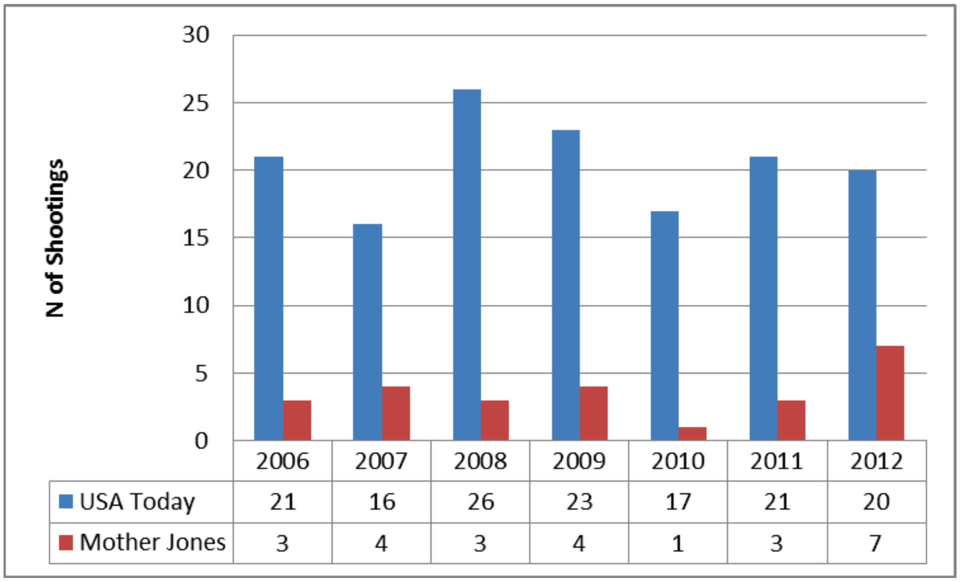

Figure 6: USA Today Mass Shootings 2006-2012 (Schouten 2013)

Additionally, Fox's (2013) assessment that mass shootings are not on the rise expanded the time frame to include 1980 to 2010. Similar to the USA Today analysis, Fox's (2013) investigation included all shootings where four or more victims had been killed while negating any other selective criteria such as the ones used in the present study's data. The graph representing the number of incidents, offenders, and victims for Fox's (2013) analysis is in Figure 6. Overall, the trend is relatively consistent indicating an average pace of about 20 mass shootings per year with a death toll of about 100. While casualty counts have fluctuated more wildly, the number of attacks has typically stayed level at fewer than 25 incidents per year. Like the USA Today analysis, Fox's (2013) data seems to indicate that mass shootings are not occurring at an increasing rate. Again, this fact leads more credence that public mass shootings are separate from other categories of mass shootings shown in these two comparisons as well as general homicide trends shown in the earlier comparison. Public mass shootings which do not involve family altercations, felony commission, or gang affiliation appear to follow a more unique trend that is on a slight rise of incidence.

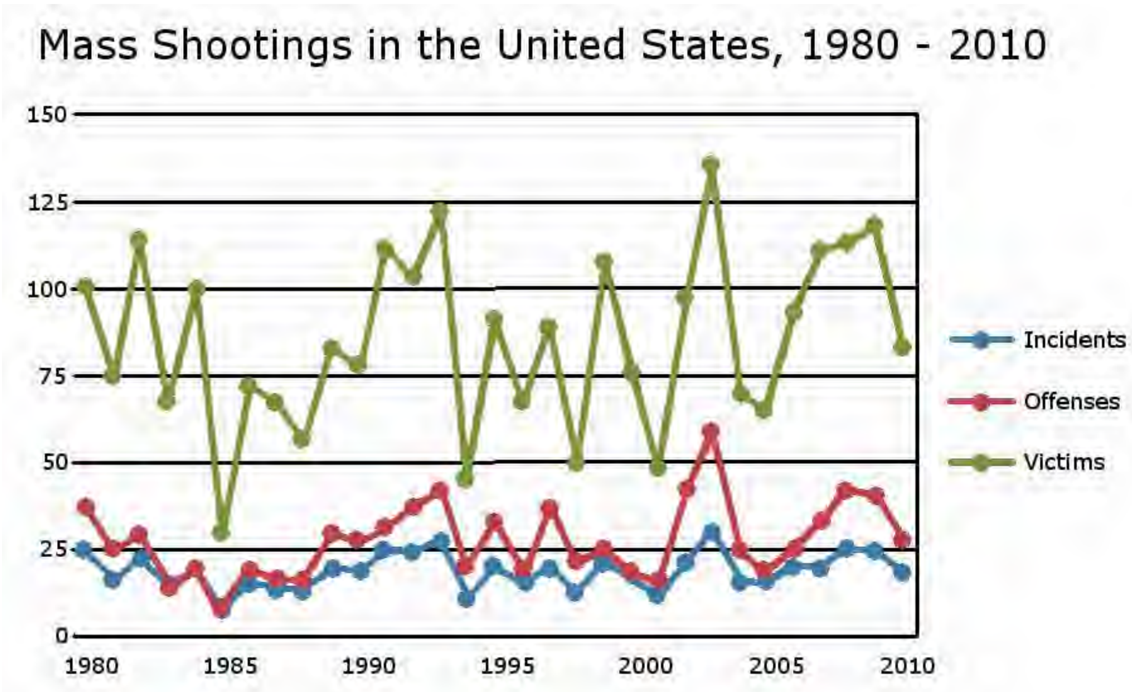

Figure 7: Mass Shootings 1980-2010 (Fox 2013)

Offender and Offense Characteristics

Demographics

Upon analyzing the descriptive statistics of the data, there was a wide variety of offenders who have committed public mass shootings over the last 31 years. As Table 3 shows, offenders' ages ranged from a minimum of 13 and a maximum of 66 with both a mean and median age of around 35-36 years old. Additionally, the overwhelming majority of offenders are male (98%) and white (67%). The remaining race identifiers are African American (14%), Asian (10%), Latino (5%), and Native American (2%). These statistics support the previous research that mass shooters do not have a strict age typology with offenders ranging from grade school and college ages all the way until late adult and elderly ages. However, the findings also support what previous research has indicated as the most common typology consisting of a lone adult white male.

Table 3. Offender Age Descriptive Statistics

	Mean	Median	SD	Min	Max
Age	35.27	36.50	12.195	13	66

N=62

Table 4 Offender Race

Race	Frequency	Percent
White	42	67.7%
African American	9	14.5%
Asian	6	9.7%
Latino	3	4.8%
Other/Unknown	2	3.2%

N=62

Table 5 breaks down offenders into the following age ranges: Grade School (13-18), College/Young Adult (19-29), Adult (30-44), Middle Age (45-55), and Elderly (56-66). The majority of incidents involve offenders who are in the young adult and adult ranges. Meanwhile, there are only a handful of offenders at both ends of the spectrum in the grade school range (N=5) and the elderly age range (N=3).

Table 5. Offender Age Range

Age Range	N of Shooting Incidents (Percentage of Total)
Grade School (13-18)	5 (8%)
College/Young Adult (19-29)	17 (27%)
Adult (30-44)	28 (45%)
Middle Age (45-55)	8 (13%)
Elderly (56+)	3 (5%)

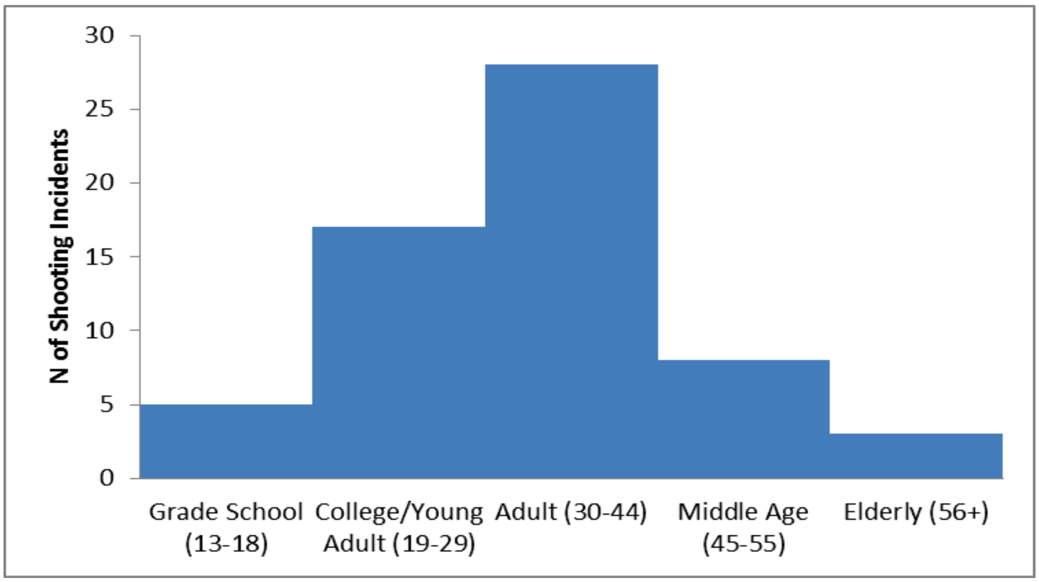

Figure 8: Offender Age Range over Time Periods

In comparison to general homicide offenders, trends in public mass shooters' demographics seem quite different. The comparison data comes from a Bureau of Justice Statistics 2007 report on the homicide trends from 1980-2008. Based from their analysis, African Americans were disproportionately represented as homicide offenders with the offending rate for blacks (34.4 per 100,000) as compared to whites (4.5 per 100,000) (U.S. Department of Justice 2011). Comparing this racial breakdown to mass shooters is the total opposite with almost 70% of the offenders being white as compared to only around 15% African American. Meanwhile, general homicide offenders tend to peak earlier in age as opposed to mass shooters which often involves adult offenders. For example, from 1980 to 2008, almost half of the offenders were under the age of 25 while over 60% of the mass shooters during a similar time frame were over 30 years old (U.S. Department of Justice 2011).

Additionally, it is important to note whether there have been general changes in the types of offenders over time. In order to accomplish this plan, the four time periods from an earlier analysis were compared with regards to age and race. Table 6 and Table 7 show the results of such analysis with Figure 9 and Figure 10 displaying a visual graphic of the tables. The most significant findings for this evaluation are that race and age of offenders typically have remained consistent over the last several decades with mean ages hovering around the adult range and at least 60% of the incidents involving a person of white race. However, there were some minor discrepancies. For example, the last 15 years have seen five mass shootings conducted by offenders in the grade school range while the previous 16 years did not have any such event. Also, the Asian race has observed a slight increase in frequency over the last several time frames as it surpassed African American as the second highest category.

While public mass shooters have remained relatively consistent from 1982 to 2012, the age patterns for general homicide offenders have fluctuated. In the 1980s, the offending rates for teens (14 to 17 years old) and young adults (18 to 24 years old) increased dramatically while the rates for older age groups declined (U.S. Department of Justice 2011). Meanwhile, from 1980 to 2008, young adults (18 to 24 years old) have consistently had the highest offending rate (U.S. Department of Justice 2011). The rate for this age group nearly doubled from 1985 to 1993, going from 22.1 offenders per 100,000 to 43.1 offenders per 100,000 (U.S. Department of Justice 2011). Since 1993, the offending rate for young adults has declined to 24.6 offenders per 100,000 in 2008 (U.S. Department of Justice 2011). The offending rates for adults age 35 and above have remained relatively stable since 2000 at a rate of under 5 offenders per 100,000 (U.S. Department of Justice 2011).

Table 6. Offender Age Range over Time Periods

Time Period	Age Range	Frequency	Percent of Cases for Time Period
2005-2012	Grade School	2	7%
	College/Young Adult	9	33%
	Adult (30-44)	13	48%
	Middle Age (45-55)	2	7%
	Age 56+	1	4%
1997-2004	Grade School	3	21%
	College/Young Adult	1	7%
	Adult (30-44)	7	50%
	Middle Age (45-55)	2	14%
	Age 56+	1	7%
1989-1996	College/Young Adult	7	47%
	Adult (30-44)	5	33%
	Middle Age (45-55)	3	20%
1982-1988	Adult (30-44)	4	67%
	Middle Age (45-55)	1	17%
	Age 56+	1	17%

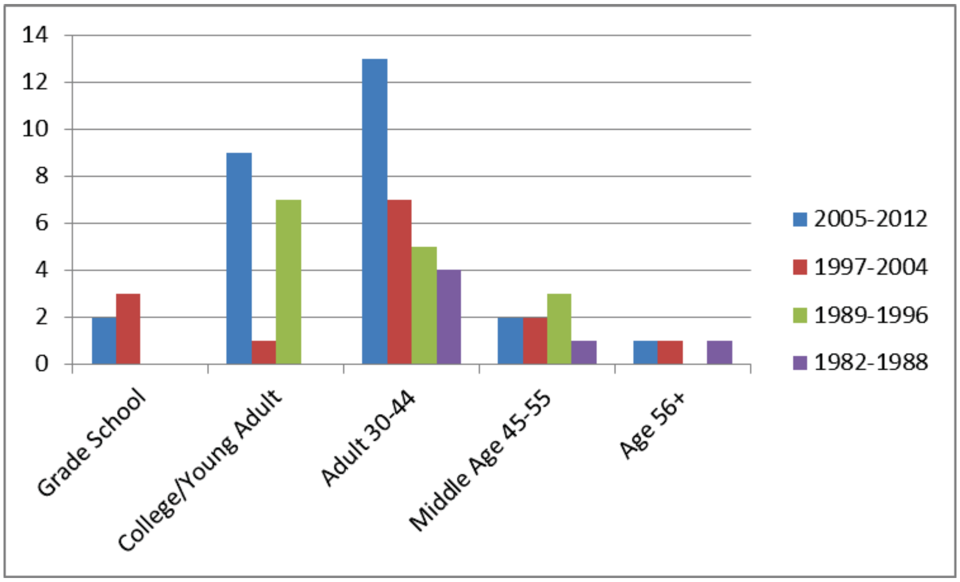

Figure 9: Offender Age Range over Time Periods

Table 7. Offender Race over Time Periods

Time Period	Race	Frequency	Percent of Time Period
2005-2012	White	18	67%
	African American	3	11%
	Asian	4	15%
	Latino	1	4%
1997-2004	White	9	64%
	African American	2	14%
	Asian	1	7%
	Latino	2	14%
1989-1996	White	9	60%
	African American	4	27%
	Asian	1	7%
1982-1988	White	6	100%

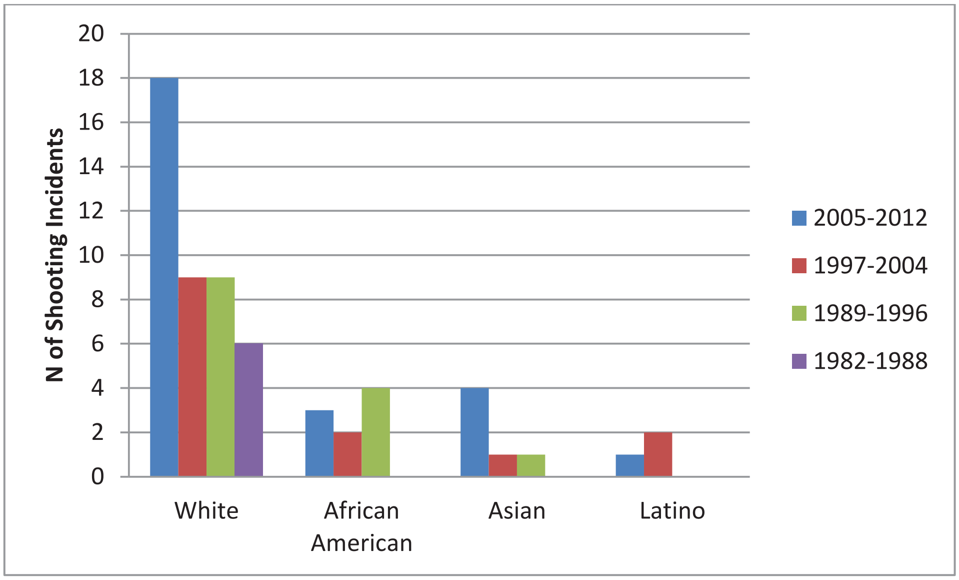

Figure 10: Offender Race over Time Periods

Locations/Venues

Over the last three decades, there have been public mass shootings in a variety of places. Since there has been a large diversity of locations, the present study divides shooting locations into five unique venue locations with a sixth category referencing all those cases which do not fit any particular mold. The venues are separated based on the following criteria: schools – any public or private learning facility; workplace – any corporate location or office building; religious facility –any structure which associates with a religious denomination; store/restaurant – any shopping or eatery establishment including the parking lot area; public attraction – any location where there is a public gathering to see the planned event including movies, concerts, speeches, etc. In total, there have been 12 school shootings, 23 workplace shootings, 3 religious facility shootings, 13 store/restaurant shootings, 2 public attraction shootings, and 9 other shootings. The significance of workplace locations witnessing the most public shootings is that it supports previous research involving the frustration-aggression hypothesis and a disgruntled male who transcends pent up frustrations into violent outbursts. Additionally, Table 8 tallies the number of shooting incidents at each venue category over the different time periods. These results indicate that school shootings have increased over time both in the sense of total incidents and percentage of incidents per time period. Another important factor is in reference to the decline of workplace shootings. While workplace shootings are still the most frequent overall, the last eight years have seen a drastic rise in store and restaurant shootings as well as the aforementioned school shootings. It is possible that school shootings have increased due to the growing occurrence of younger offenders. Meanwhile, there is nothing pertinent in this data as to why store and restaurant shootings have increased. This result is an element which needs to be studied in future research.

Table 8. Venues over Time Periods

Time Period	School	Workplace	Religious Facility	Store/Restaurant	Public Attraction	Other
2005-2012	6	5	2	8	1	5
1997-2004	3	9	1	0	0	1
1989-1996	3	7	0	2	0	3
1982-1988	0	2	0	3	1	0
Total	12	23	3	13	2	9

When analyzing which offenders are more likely to commit violence at certain locations as is shown in Table 9, almost all of the school shootings involve offenders who are currently in school or in the early stages of adulthood (83%). Similarly, the vast majority of workplace shootings, 16 of the total 23, involve adult offenders. A possible reason for both of these findings could be that the offender is targeting a place that is a large part of his or her daily life and, in other words, is seen as a cause or motivation for the action. This situation is true in the case of the Columbine Killers where Harris and Klebold targeted their high school and fellow classmates who were the cause of their frustrations. However, there are other situations like the school shooting at Sandy Hook Elementary where there is still no evidence of a plausible connection between Lanza and the school. In the workplace scenario, 20 of the 23 (87%) work location based shootings involved offenders who were either current employees or former employees of the businesses they attacked. The other 3 cases involved offenders who were not directly tied to the workplace, but had a prior altercation with the corporation or had transferred their frustrations externally onto the business. For example, in 1993, failed businessman Gian Luigi Ferri chose an office building for the target although he was not directly connected.

Table 9. Offender Age Range and Shooting Locations

Age Range	School	Workplace	Religious Facility	Store/Restaurant	Public Attraction	Other
Grade School (13-18)	4	0	0	1	0	0
College/Young Adult (19-29)	6	3	0	3	1	4
Adult (30-44)	2	16	2	6	1	2
Middle Age (45-55)	0	3	1	1	0	3
Elderly (56+)	0	1	0	2	0	0
Total	12	23	3	13	2	9

Mental Illness

A large part of the discussion involving offenders and possible motivations for their actions has involved mental illnesses and their overall mental capacities (Holmes and DeBurger 1988, Holmes and Holmes 1992, Fox and Levin 2012, Fox et al 2012). Although it should be noted that there has been no definitive causation provided between mental illnesses and violence (Fox and Levin 2012), it is still important to identify some of the reoccurring trends of public mass shootings. Negating the 7 cases where the offenders' mental capacities are unknown, investigations into 40 of the 55 cases (73%) have unveiled the possibility of a mental illness condition. As shown in Table 10 which breaks down each age range, every group had more instances of a possible mental condition as opposed to definitively having a full mental capacity. The largest discrepancy involved adult offenders where 21 of the 27 offenders (89%) were investigated to unveil some level of a mental deficit. While the present study cannot indicate the impact that an individual's mental condition could have on their future violent actions, these findings suggest that future studies further explore the link between mental illness and public displays of violence.

Table 10. Offender Age Range and Evidence of Mental Deficiency

Age Range	Evidence of Mental Condition - *N*	No Instance of Mental Deficiency - *N*
Grade School (13-18)	3	1
College/Young Adult (19-29)	8	5
Adult (30-44)	21	6
Middle Age (45-55)	6	2
Elderly (56+)	2	1

Similarly, an important element in analyzing the role of mental illness in mass shootings is to test whether there has been an increase in offenders lacking in full mental capacities. If there is an increase in offenders whose post-investigations reported a mental deficit, then it is feasible that mental illness might play a role in mass shootings when matched with a similar increase in shooting incidents over the same time frame. Table 11 indicates the statistics for offender's mental status over the same four time periods as used previously. The results show that the recorded incidents of offenders' mental deficits have increased over time, but the percentage of observations per time period only increased from 1989 to 2012. Meanwhile, for the time period of 1982 to 1988 where there was only 6 shooting incidents, all 5 of the offenders indicated some level of mental condition where a reasonable understanding of their mental capacities could be discovered through investigation. If mental illness were a strong indicator for an offender committing a mass shooting, there would have either been more recorded incidents from

1982 to 1988 or fewer instances of offenders with a mental condition to lower the valid percentage of observations per time period thus accounting for fewer shooting incidents. On the other hand, it should be noted that between 1982 and 1996, only 57% of all shooting incidents involved an offender with a mental condition. Therefore, there is a noticeable leap in instances involving mental illnesses when discussing the more recent years of 1997 to 2012.

Table 11. Offenders Presence of Mental Illnesses over Time Periods

Time Period	Evidence of Mental Condition - N	Valid Percentage of N During Time Period
2005-2012	18	78%
1997-2004	10	71%
1989-1996	7	47%
1982-1988	5	100%

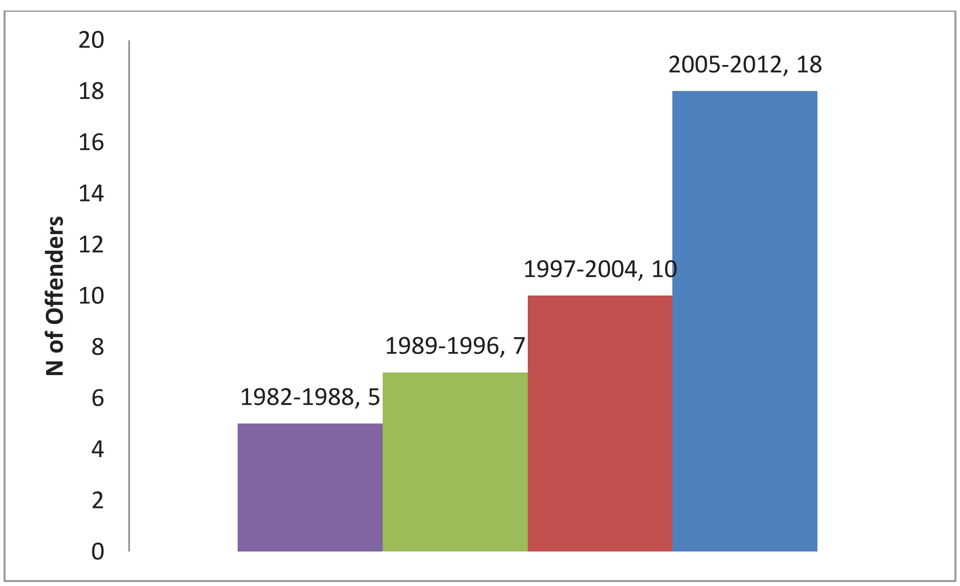

Figure 11: Offenders Presence of Mental Illnesses over Time Periods

Weapons

Method of Acquisition

In order to achieve a more complete understanding of the offenders behind public mass shootings, a descriptive analysis was conducted on their weapon choices and if the weapons were obtained legally. Overwhelmingly, the statistics propose that the majority of the weapons were legally obtained. Specifically, in 48 of the 60 cases (80%) where the weapon legality was known, the offender of that event had obtained their weapon legally. By looking at some of the results more closely, 5 of the 12 cases (42%) where a weapon was obtained illegally involved offenders 13 to 18 years old where it is often mandated by law that they cannot legally own a firearm. Therefore, the findings indicate that an individual who commits a public mass shooting typically already legally owns a firearm which supports prior research on typologies that mass murders have access to guns (Fox and Levin 2012, Holmes and Holmes 1992).

Weapon Type

When analyzing the types of weapons which each age group tends to use, there are small indications of trends. Shown in Table 12, by a very small margin of 3 cases to 2 cases, offenders 13 to 18 years old were more likely to use a combination of an assault weapon, semiautomatic handgun, and shotgun. Meanwhile, the slight majority of offenders 19 to 29 years old used an assault weapon (9 instances where an assault weapon was used as opposed to 8 cases where it was not). Additionally, 19 to 29 year old offenders will commonly use a semiautomatic handgun as was evidenced in 11 of the 17 instances (65%) involving this age group. In the past 31 years, adult offenders of mass shootings have not used an assault weapon often. Offenders in this age range used an assault weapon in only 9 of the total 29 instances (31%). The most commonly used weapon for offenders age 30 to 44 years old is the semiautomatic handgun (86% of the total events).

When comparing the use of assault weapons and large capacity magazines in general homicides with public mass shootings, there are some significant differences. Regarding general crime, assault weapons are used in a small percentage of gun crimes. Prior to the assault weapons ban of 1994, Koper (2004) indicated that assault weapons accounted for an average of 2% up to a high of 8% of all gun crimes. For large capacity magazines, Koper (2004) found that they were used in roughly 14% to 26% of gun crimes during the same time period. When following up after the ban expired in 2004, Koper (2004) determined that both use of assault weapons and large capacity magazines were remaining constant or actually declining in percentage to overall gun crime. Using these statistics to compare their applicability in mass shootings, assault weapons are used significantly more in public mass shootings. In total, assault weapons were involved in mass shootings almost 42% of the time as opposed to the high of 8% of general gun crimes. For large capacity magazines, the difference is even greater. Where all weapon characteristics were known (see discussion below), 86% of the mass shootings involved large capacity magazines as opposed to roughly one-quarter of all general gun crimes. Overall, these findings seem to indicate that assault weapons and large capacity magazines' characteristics lend more assistance to mass shooters as opposed to general offenders.

Age Range	Obtained Legally	Assault Weapon	Large Capacity Magazine	Semiautomatic Handgun	Shotgun	Revolver
Grade School Age (13-18)	0 (0%)	3 (60%)	3 (75%	3 (60%)	3 (60%)	2 (40%)
College/Young Adult (19-29)	14 (88%)	9 (53%)	8 (89%)	11 (65%)	5 (29%)	2 (12%)
Adult (30-44)	25 (89%)	9 (45%)	16 (94%)	25 (86%)	4 (14%)	8 (28%)
Middle Age (45-55)	6 (75%	3 (38%)	3 (60%)	6 (75%)	3 (38%)	3 (38%)
Elderly (56+)	3 (100%)	2 (67%)	1 (100%)	1 (33%)	2 (67%)	2 (67%)

Table 12. Offender Age Range and Weapons in Possession

N of Cases (Valid % Per Weapon Type). Offenders often possessed more than one type of weapon.

Another important analysis which can assist in figuring out a common trend involved in mass shooting incidents is to test the role of certain weapons being used in specific locations as well as which locations might be prone to more lethal shootings. First, Table 13 shows the breakdown of weapons used at the six different venue locations. The findings indicate that semiautomatic handguns are again the most frequently chosen weapon consistently across all of the venues. However, it is interesting to note that assault weapons are the second most frequently chosen weapon in every venue. In a mass shooting scenario, it is a typical occurrence that the shooter has more than one firearm in his or her possession with many of those cases involving some type of handgun for easier concealment and most likely a larger secondary firearm. These statistics appear to indicate that offenders have usually chosen some combination of semiautomatic handgun, assault weapon, and large capacity magazine as opposed to a revolver, basic shotgun combination, for example.

Table 13. Weapons Used at Different Venues

Venue	Assault Weapon	Large Capacity Magazine	Semiautomatic Handgun	Revolver	Shotgun
School	7 (58%)	7 (78%)	9 (75%)	2 (17%)	6 (50%)
Workplace	10 (43%)	11 (100%)	19 (83%)	8 (35%)	4 (17%)
Religious Facility	0 (0%)	2 (100%)	3 (100%)	0 (0%)	0 (0%)
Store/Restaurant	5 (38%)	6 (75%)	7 (54%)	5 (38%)	5 (38%)
Public Attraction	1 (50%)	2 (100%)	2 (100%)	0 (0%)	1 (50%)
Other	3 (33%)	3 (75%)	6 (67%)	2 (22%)	1 (11%)

Offenders often possessed more than one type of weapon.

Next, an analysis is necessary to determine if certain venues seem to be prone to more lethal shootings. The importance of this approach is it can serve to provide an indication as to what venues were most significantly affected, in terms of body counts, from mass shootings. Table 14 shows the results of this descriptive analysis. The first significant finding is that there is a lot of variability both between different venues as well as within the same venue in terms of fatalities, injured, and total victims. Out of all settings, school is overall the most lethal with around 10 fatalities and 24 total victims per incident. At a small sample of only two cases, public attractions are also considerably high in victim counts. Both schools and public attractions such as movie theaters might have particularly high fatalities and victim totals due to there being a large number of people in a common location with not a lot of protection or easy exit points away from the oncoming shooter. Meanwhile, workplace shootings are around the middle in fatality instances, but have the lowest overall numbered injured and victim totals. Typically, in workplace shootings the shooter has an objective of targeting specific people, making sure that the targets are killed while the rest are seen as collateral damage or left unharmed. This reasoning could be a factor as to why workplace fatalities are usually higher than the number of solely injured victims. Overall, the findings indicate that each case can be a different scenario as there have been school shootings with low body counts while a workplace shooting can have 30 injured and 43 total victims. There have been some general trends which have been noted, but as each venue has particularly wide range of victim counts, it signifies that there have been a vast variety of scenarios.

Table 14. Fatalities, Injured, and Victims by Venue

	School (N=12)	Workplace (N=23)	Religious Facility (N=3)	Store/Restaurant (N=13)	Public Attraction (N=2)	Other (N=9)
Fatalities						
Mean	10.83	7.30	7.33	8.69	9	6.89
Median	6	7	7	6	9	6
SD	9.722	2.738	0.577	6.537	4.243	2.848
Min/Max	4/33	4/15	7/8	4/24	6/12	5/14
Injured						
Mean	13.17	4.65	4.67	7.31	29.50	6.78
Median	10	3	4	4	29.50	3
SD	10.426	6.859	2.082	7.005	40.305	8.363
Min/Max	1/29	0/30	3/7	0/20	1/58	0/23
Victims						
Mean	24	11.96	12	16	38.50	13.67
Median	21	8	11	12	38.50	11
SD	14.635	8.472	2.646	12.610	44.548	8.185
Min/Max	7/56	5/43	10/15	5/44	7/70	5/28

Weapons – Assault Weapons and Large Capacity Magazines

One of the fundamental questions for this study involves the weaponry used in public mass shootings, specifically the role of assault weapons and large capacity magazines. An initial descriptive analysis was used to capture the general application of some of the weaponry. Table 15 displays descriptive statistics of the weapons which the offenders had in their possession during the public mass shootings of the last 31 years.

Table 15. Weapons in Possession Descriptive Statistics

	Frequency - *N*	Valid Percentage
Semiautomatic Handgun	46	74%
Revolver	17	27%

Shotgun	17	27%
Assault Weapon	26	42%
Large Capacity Magazine	31	*86%
	Mean	**Range**
Weapons in Possession	2.33	9 (Min 1, Max 10)

*Missing N=26

Overall, the majority of the incidents involved weapons which were obtained legally by the individual who performed the shooting. Specifically, 80% or 49 of the total 61 cases where legality is known involved weapons which were legally obtained. In the shooters' possession during the shooting, the total number of weapons ranged from 1 to 10 firearms with around 2 firearms as the average. However, in the most common situation (37%), the shooter only had 1 firearm in their possession. Only around 15% or 10 of the instances involved offenders who had more than 3 firearms in their possession at the time of the incident. In regards to the type of firearm involved, the most common choice was a semiautomatic handgun with it being in the shooters' possession during 46 of the 62 instances (74%). However, the next most common firearm was an assault weapon. Assault weapons were in the offenders' possession in 26 of the 62 situations (42%). A shotgun and a revolver were only involved 17% of the time each. These findings do not support results from previous research (Duwe 2000, 2007) which approximated the use of assault weapons to fewer than 5% of the total amount of incidents. An even more significant finding is that high-capacity magazines were involved in exactly 50% or 31 of the 62 total cases. When negating the cases where large capacity magazine possession was unknown, the percentage is 86% or 31 of 36 cases. In total, more than half of all mass shooters in the past 31 years possessed high-capacity magazines, assault weapons, or both.

The next step is to determine if the use of assault weapons or large capacity magazines in mass shootings has changed over time. Shown in Table 16, when the instances are divided into four periods of time, the use of assault weapons has remained relatively constant over time with an average of around one instance per year. In fact, when compared to the total number of mass shootings in each time period, the use of assault weapons has actually decreased over the last 7 years. From 2005 to 2012, an assault weapon has been involved in 7 mass shootings, but that number equates to only 26% of the total incidents in that time frame. With applying the same analysis in regard to the use of large capacity magazines, the results are opposite. Total incidents involving large capacity magazines have increased from a total of 3 cases during 1982 to 1988 and now to a total of 13 cases during 2005 to 2012. Generally, the analysis indicates about one of every two mass shooting incidents have involved large capacity magazines consistently over the last three decades. When compared to the number of total incidents where a determination was made on large capacity magazines during the separate time periods, the percentages are significantly higher, from 75 to 100%. Overall, when a determination could be made for the use of a large capacity magazine, it was present in the vast majority of incidents even across the different time periods.

Table 16. N of Shootings involving Assault Weapons and Large Capacity Magazines in Offender's Possession

Time Period	N of Assault Weapon Incidents	Percentage of AW incidents per Total N of Time Period	N of Large Capacity Magazines	Valid Percentage of LCM incidents per Total N of Time Period
1982-1988	3	50%	3	75%
1989-1996	9	60%	7	88%
1997-2004	7	50%	8	100%
2005-2012	7	26%	13	81%

With these findings indicating that throughout 31 years, assault weapons and large capacity magazines have been used in at least one out of every two public mass shootings, the lethality of this form of high powered weaponry needs to be addressed. In order to accomplish this task, a series of independent samples t-tests were conducted comparing the number of fatalities, injured, and total victims of each incident where an assault weapon or large capacity magazine was involved to those not involving such weaponry. Table 17 shows the results of this analysis. In the first t-test analysis comparing lethality rates for shootings involving assault weapons and those which do not, the number of fatalities are almost identical between the two groups. When an assault weapon is not in the possession of the offender, an average of 8.31 people are killed per incident while an average of 8.23 people are killed per incident when an assault weapon is in the possession of the shooter. As expected, the difference between the two groups is not statistically significant. When comparing the number of injured per shooting incident, the difference between an offender having an assault weapon and not having one is more pronounced. When an assault weapon is not in the possession of the shooter, an average of 5.75 people are injured per incident. On the other hand, when an assault weapon is in the possession of the shooter, an average of 11.04 people are injured per incident. This difference is significant at the $p < .05$ level. Meanwhile, the average number of victims per shooting incident when an assault weapon is involved is 19.27 people, whereby the average number of victims without an assault weapon is 14.06 people. While the difference in average number of victims is around 5 people per shooting incident, the t statistic is not statistically significant.

Table 17. Independent T-test of Fatalities, Injured, Total Victim Counts for Assault Weapons

	Assault Weapon in Offender's Possession?	N of Shooting Incidents	Mean per Shooting Incident	Standard Deviation	t statistic
Fatalities	No	36	8.31	5.686	0.051
	Yes	26	8.23	5.631	
Injured	No	36	5.75	7.666	-2.044*
	Yes	26	11.04	12.663	
Victims	No	36	14.06	11.897	-1.552
	Yes	26	19.27	14.509	

* Significant at $p<.05$

While the findings on the effects of assault weapons are mixed, the results for large capacity magazines are more indicative. In the t-test analysis comparing the number of fatalities, injured, and victims with whether large capacity magazines are a part of the shooter's arsenal, all three measures are higher in the incidents where a large capacity magazine is present. The results are shown in Table 18 which includes the incidents where possession of a large capacity magazine is unknown. For fatalities, the average number of people killed per incident involving a large capacity magazine is 10.19 people while the average killed per incident is 6.35 people without an extended magazine. In terms of injured, there is an average of only 3.55 people per shooting event without a high capacity magazine while an average of 12.39 people are injured per each shooting with the additional capacity magazine. Likewise, the difference between the two groups in average number of victims per incident is 12.68. All of the t-statistics for this analysis are statistically significant at the p<.01 level. Additionally, Table 19 includes only the cases where possession of a large capacity magazine is known. There are only slight differences between the two comparisons. When the unknowns are removed, the difference between average injured and total victims are both increased as compared to Table 18. Meanwhile, the mean difference as well as the t-statistic in fatalities between the two groups is decreased slightly while no longer being statistically significant.

Table 18. Independent T-test of Fatalities, Injured, Total Victim Counts for Large Capacity Magazines (Contains Unknowns)

	Large Capacity Magazine in Offender's Possession?	N of Shooting Incidents	Mean per Shooting Incident	Standard Deviation	t statistic
Fatalities	Unknown/No	31	6.35	2.199	-2.843*
	Yes	31	10.19	7.190	
Injured	Unknown/No	31	3.55	3.118	-3.711*
	Yes	31	12.39	12.891	
Victims	Unknown/No	31	9.90	4.182	-4.286*
	Yes	31	22.58	15.929	

* Significant at p<.01

Table 19. Independent T-test of Fatalities, Injured, Total Victim Counts for Large Capacity Magazines (Definitively Known)

	Large Capacity Magazine in Offender's Possession?	N of Shooting Incidents	Mean per Shooting Incident	Standard Deviation	t statistic
Fatalities	No	5	7.00	1.000	-0.980
	Yes	31	10.19	7.190	
Injured	No	5	2.80	1.095	-4.051*
	Yes	31	12.39	12.891	
Victims	No	5	9.80	1.643	-4.327*
	Yes	31	22.58	15.929	

* Significant at p<.01

Overall, assault weapons statistically appear to be more damaging with regards to widening the scope of a public mass shooting. While having an assault weapon in their possession does not provide a shooter with a higher number of fatalities, it offers them the chance to shoot and injure more people thus providing more victims. The close similarity in average number of fatalities with expanding number of injured is most likely due to the nature of the weapon. As discovered in an earlier analysis, the most common choice of weapon for mass shooters is a semiautomatic handgun. With a semiautomatic handgun, the shooter will be closer to the target because of the weapon's range. When at close range, the fatality rate of the weapon will be higher while the rate of injury will be lower since the larger percentage of those people shot will die from their injuries. This inference can be captured in the first t-test analysis where the incidents not involving an assault weapon had a slightly higher fatality average along with a significantly lower injured average. In terms of large capacity magazines, the increased ease and availability of excess ammunition could enable a shooter to rapidly discharge more ammunition in a smaller time frame thus multiplying all three measures of victims. Similarly, this perception is highlighted in the analysis as average fatalities, injured, and total victims are all significantly increased in the instances involving large capacity magazines. Table 20 shows the results when both an assault weapon and a large capacity magazine are in the offender's possession. The results remain the same as the other analyses with there being a significant difference in the number of injured and total victims when the combination of an assault weapon and large capacity magazine is involved as compared to the incidents involving neither.

Table 20. Independent T-test of Fatalities, Injured, and Total Victim Count for Assault Weapons and LCM

	AW and LCM in Offender's Possession?	N of Shooting Incidents	Mean per Shooting Incident	Standard Deviation	t statistic
Fatalities	Neither	5	7.00	1.000	-1.854
	Yes	12	11.00	7.311	
Injured	Neither	5	2.80	1.095	-2.632*
	Yes	12	15.50	16.627	
Victims	Neither	5	9.80	1.643	-3.141*
	Yes	12	26.50	18.243	

DISCUSSION

Summary of Findings

The main thrust of the study is to evaluate public mass shootings, a topic that has relatively been under-researched considering the effects of any single incident. Specifically, the study answered questions on the trends of mass shootings with reference to other data on mass shootings, general homicides, and stranger homicides. In addition, the current study also observed common characteristics of incidents and offenders with a special importance placed on weapons. Questions relating to the use of assault weapons and large capacity magazines as well as the subsequent ramifications of their use were also answered.

Based on the analyses performed in the present study, several significant findings were evident in the results. When analyzing the trends of public mass shootings, it was discovered that these incidents follow a unique trend as compared to homicide trends and other mass shooting data. Overall, public mass shootings have slowly increased in incidence from 1982 until 2012 while other homicide trends were steadily decreasing or following a consistent level. While this increase was statistically small, an OLS regression indicated a significant result. However, when the time frame was separated into quarter time periods, the increased rate was more pronounced. The rate accumulated to about an additional incident each year. This regression analysis also indicated a significant result, although just moderately significant at $p<0.10$. From 2005 to 2012, there was no obvious increase in number of incidents while both a chi-square analysis and regression analysis indicated that the recent years of 2009 to 2012 were not statistically different from 2005 to 2008. When assessing trends in offense characteristics, the significant findings were that offenders are becoming slightly younger, mental illness is becoming an increasing factor, and venues for mass shootings are moving away from the more common workplace shootings of the 1980s.

Another subset of the study focused on weapons with specific attention to the role of assault weapons and large capacity magazines in public mass shootings. Descriptive analyses indicated that overall, the majority of weapons involved in mass shootings are obtained legally. In addition, a low estimate where all weapon characteristics were identified specified that assault weapons or large capacity magazines were used in more than half of all cases. An independent samples t-test on assault weapons and large capacity magazines showed the impact that high powered weaponry has when involved in mass public shootings. Assault weapons were found to enable significant increases in the number of injured victims while incidents involving large capacity magazines accumulated significantly higher fatalities, injuries, and total victims. When both assault weapons and large capacity magazines were involved, there were statistically significant increases in fatalities, injuries, and total victims as opposed to when neither weapon was involved.

Theoretical and Policy Interpretations

The findings of this study have some interesting theoretical and practical implications. While trends for other violent crimes and mass murders have witnessed a constant or declining status, public mass shootings have slightly increased in following a unique trend. Previous research on mass shootings has been limited thus reducing the possible explanations for this unique experience. As discussed in the literature review, theories for general homicides have often been applied, but with differing results because mass shootings involve a variety of circumstances. Still, the present study has found a slight statistical increase in occurrence of public mass shootings indicating that something must be happening over time to cause such changes. The results almost appear to contrast the historical theories of explaining homicides and general crimes. To summarize what previous research has shown, homicides have historically been conducted by young African American males with violent incidents in their pasts. However, the findings illustrate a different picture for mass shooters. Public mass shooters are more often single, older white males who tend to have little to no criminal histories. Therefore, the findings raise questions as to why offenders for mass shootings tend to contrast previous research on other crimes and why are these events increasing while overall crime has decreased. Out of all findings discussed, maybe the most significant result is the realization that mass shootings are a completely different genre of crime where there is little criminological theory to account for its occurrences.

While many criminological theories do not apply (as noted above), there are still others which could explain some of the differences in offenders as well as the differing rates of occurrences. For example, the frustration-aggression hypothesis (Dollard et al 1939), life course theory (Sampson and Laub 1993), and the very similar school of control theories (Hirschi 1969) could be applied to the study's findings. With the majority of the offenders being single, older white males and their violent outbursts seemingly coming out of nowhere, there is a higher likelihood that a single event detached the individual from their normal status in life leading to frustrations and resulting aggressions. These individuals have had no previous violent activities because their lives had been connected to something of importance in a prior time. This connection could be a job, relationship, family, hobby, etc. In almost all of the workplace shootings, the offender had previously been reprimanded or fired by his former employer leading to a breakdown in their current status of everyday living. The emotional and sociological ramifications for losing something of value to a person such as their employment might have ultimately led to an inability to control their actions. Meanwhile, the lack of control is pressed further onto the youth generation which could be an explanation for an increase of school shootings involving more youthful offenders. In many of the young offender cases, however, there is not always a single event of frustration, but rather a period of frustration. These frustrations typically involve repeated bullying or prolonged feeling of loneliness from others in school. While it is not a single predisposed event, the theories still would presume that there is a lack of control in the individual's life. The lack of control stems from their inability to associate themselves with any other legitimate member of society or society itself. It comes to a point of frustration where it ultimately turns into an "us versus them" persona. This disconnection from any of society's standards leaves the individual with an easy choice to outwardly express their frustrations through violence since there is no obligation towards others.

Duwe (2007) proposed that the rate of mass murders were enhanced by the role of the media. On the basic level, the theory adds to Coleman's (2004) copycat effect where crimes that receive a lot of attention form clusters. It is the offender's desire for media attention and notoriety which serve as a strong motivating factor. This proposition might hold some value based on the results of the present study. Although the media was a factor in the 1980s and 1990s, the expansion of technology increased not only the wealth of information available to the public, but also the speed and accessibility of obtaining such information. Any serious event is no longer restrained to the locality in which it has occurred. However, along with the excess availability of global information, there is also an added filter where only the most sensational and newsworthy events receive the largest audience. This point is based solely on logic of human nature. For example, a person in Los Angeles might not be in tuned with the latest homicide that has occurred in Connecticut since general homicides are a more common event and without additional searching, only the local news will cover such a homicide. However, that same person in Los Angeles has undoubtedly been informed about the Sandy Hook Elementary School public shooting. It is this sensationalizing process that could be a possible explanation for the recent spike in public mass shootings.

Additionally, it could be an explanation for the recent trend of younger mass shooters and shifting away of venues from workplaces to more public atmospheres such as schools and shopping centers. The young generation has been raised on the latest technologies of the 21st century and with it has come the increased access to information. For example, James Holmes of the Aurora movie theater shooting might have received the motivation from a violent movie, but media covering of the original incident led to at least three men in three different parts of the county to threaten a copycat event. The most serious incident involved a Maine resident who was found to have an arsenal of weapons news clippings of the Aurora killings when he was stopped for speeding while on his way to shoot a former employer (Bay News 2012).

Media might also have an effect on the location of mass public shootings because the initial publicity surrounding the original event. "Going postal" was a common phrase in the 1980s and 1990s due to the series of incidents involving United States Postal Service workers shooting their fellow coworkers in the workplace. A clustering of similar shootings occurred frequently after the initial event. The same experience is evident in the results of the present study. School shootings were not a common occurrence prior to the late 1990s, but a clustering of similar events has happened since the initial instance. Likewise, store and restaurant shootings have witnessed an increase possibly due to well publicized cases such as the one involving Representative Giffords. While the spread of publicity involving mass public shootings is not the only explanation for copycat events, it is difficult to escape the reasoning that copycat killings are partly inspired by the publicity surrounding the original. The improvements made to the dispersion of media could have attributed to the increased trend. Forthcoming research needs to address more specifically how the media can impact the incident rate for public mass shootings.

Another angle displayed in the study's results involves the increase of mental illness as a factor in offenders. Over the last several decades, a growing percentage of mass shooters were identified to have mental deficiencies. It is still unclear exactly the role that mental illness plays in offenders' motivations or capacities to commit violent acts. Therefore, future research is necessary to address the relationship between mental illness and public mass shootings. Without research to guide in any explanations of the sort, all that can be mentioned are rationalizations. One possible explanation could be that mental illness separates an individual from society and the offender from any of their immediate actions. For example, there is a natural human inhibition against killing that can be reduced by adopting a persona or having a mental block to ignore any such belief. In the mental deficit cases, it is the idea of an alternate mental state which provides a vehicle through with the violent action is committed. This depersonalization of the individual can help account for uncharacteristically violent actions that are mass public shootings. While it is possible that many of the mass shooters have alternative motivations for their actions which must also be addressed, it is also possible that an individual's mental condition can serve as either a barrier or enabler towards violent activities. The present study indicates that mental illness cannot be ignored in the role of mass public shootings. It provides evidence for future research and the need for improvement of the current mental health system in America. If mental illnesses can be diagnosed accurately and care can be provided to those in need, it is possible that the rate of public shootings will be halted.

The Role of Weaponry in Public Mass Shootings and its Implications for Policy

Throughout the past three decades, the general homicide rate has generally experienced a downward trend. During the same time frame, public mass shootings have statistically occurred at a faster pace involving a greater use of advanced weaponry such as assault weapons and large capacity magazines. The findings shed light to the growing availability and ease of obtaining weapons in the U.S. as well as establishing statistical proof to the increased lethality of assault weapons and large capacity magazines. These two issues are at the forefront of the gun control debate.

Mass shootings typically invoke new debates on the use of gun control as an effective method in preventing future attacks. At the fundamental level, the discussion involves the components of criminal opportunity theories (Cohen and Felson 1979, Clarke and Felson 1993). The availability of more high powered weaponry provides motivated offenders with greater ease of committing acts of violence thus leading to increased mass shootings. Additionally, the expanded availability of weapons influences the routine activities and crime opportunity structure for social situations. By adding weapons into any situation, it increases the feasibility for a more violent action to occur. In the instance of the present study, the use of assault weapons and large capacity magazines ultimately increases the victim count for these homicides. If this same thought process is expanded to include other weapons, it is an obvious conclusion that firearms are more lethal than knives and knives are more lethal than bare hands, just as an example. Therefore, the availability of weapons in the U.S. ultimately increases the likelihood that would be single or double homicides if done by a knife now become mass murder if done by a firearm. Overall, weapons provide the offender with a greater ease to accomplish their goal and in the case of mass shooters the goal is typically to create the most amount of havoc possible. Based on the routine activity and rational choice perspective, it is only feasible that more mass shootings involve assault weapons and large capacity magazines since they provide the greatest opportunity to increase overall victim counts. In placing a motivated offender with numerous vulnerable victims in a public setting, the addition of a high powered weapon equates to more victims and therefore more public mass shootings.

The findings of the present study have indicated the increased damages caused by higher velocity weapons in addition to the fact that a majority of mass shootings have been committed with legal firearms. These two findings alone highlight the framework of any discussions on gun control. However, there are also additional circumstances and dilemmas surrounding the limitation of firearms. Throughout the past few decades, numerous legislative proposals have sought to reduce the availability of firearms in the hands of the public and research has additionally evaluated such proposals raising several questions. Are firearm restrictions permissible under the Constitution? Can gun control be an effective form of crime control? Can crime rates be significantly reduced by stricter regulation of firearms ownership or commerce? Would fewer disputes end up in lethal results if firearms were less accessible? Or would more restrictive gun control policies have an unintended effect of impairing citizens' right to self-defense?

The most recent legislation, the Assault Weapons Ban of 2013, has been tested in the current study in the sense that assault weapons and large capacity magazines were operationally defined through the proposed ban's definitions. Overall, the public mass shootings studied in this work involved a total of 20 assault weapons and 42 high capacity magazines. By ruling out those combinations which an assault weapon and high capacity magazine were involved together, a total of 48 out of the 143 weapons in the shooters' possessions would have been outlawed by the Assault Weapons Ban of 2013. Also, as discovered in the study, the vast majority of the weapons used in public mass shootings are obtained legally. The importance of those facts is that if the assault weapons and large capacity magazines were banned, the majority of would be shooters would not have them in their possession while performing their violent acts. Therefore, a large percentage of those 48 weapon combinations would not have been a factor in any mass shooting.

However, the question remains what is the benefit of eliminating or hardening the easy access of assault weapons and large capacity magazines from potential mass shooters? In fact, a low estimate of 95 of the 143 weapons would not be impacted at all by any proposed assault weapon ban which creates the belief that mass shootings would still occur with or without any further weapon legislations. This estimate includes the instances where the weapon type and presence of a large capacity magazine was unknown. Additionally, a similar ban had already been enacted and consequently ended after the ten year period had expired. Therefore, is there any belief that a new ban might be successful? In order to discuss the answer to this question, it is important to note the successes and failures of the preceding assault weapons ban.

Following a period of mass shootings in the early 1990s, federal legislature enacted the Violent Crime Control and Law Enforcement Act of 1994 which included provisions relating to assault weapons and large capacity magazines. The provisions imposed a ten year ban on the manufacture, transfer, and possession of semiautomatic firearms which had been classified as assault weapons. Rather than prohibiting the use of all semiautomatic firearms, it placed restrictions on semiautomatics having features regarded more for military or criminal usefulness such as pistol grips, silencer attachments, and the ability to accept large clips of ammunition magazines. A majority of these weapons had already been banned since 1989 so the more significant element of the ban was the two or more military style features test and the elimination of large capacity magazines which were defined as ammunition feeding devices capable of holding more than ten rounds of ammunition

While the ban was perceived to be at least a step in the right direction to preventing future mass shooting incidents, it included several exemptions that severely weakened its effectiveness. First, all assault weapons and large capacity magazines manufactured before the effective date of the ban were grandfathered in meaning that as long as they were purchased prior to the ban they were legal to own and transfer. Several surveys had attempted to estimate the number of privately owned assault weapons in the U.S. finding that there were an estimated one million around 1990 (American Medical Association Council on Scientific Affairs 1992), while domestic assault weapon makers produced about half a million assault weapons between 1989 through 1993 (Koper 2004). Therefore, it can be estimated that there were already more than 1.5 million assault weapons in circulation across the country by the 1994 ban. Meanwhile, it was estimated that U.S. gun owners possessed around 25 million guns equipped with large capacity magazines (Cook and Ludwig 1996). Additionally, as of 1995, the estimated number of large capacity magazines available was at least 25 million (Gun Tests 1995), and an extra

4.8 million were legally imported under the grandfathering exception from 1994 through 2000 (Koper 2004).

In the follow up evaluation of the assault weapon ban, Koper (2004) found some small indications that the assault weapon ban was at least minimally effective. Koper (2004) indicated that the use of assault weapons declined in crimes because of the ban by around one-third or more with the reduction due mostly to assault pistols and the fact that assault weapons were becoming increasingly rare. Meanwhile, there was no clear decline in the use of large capacity magazines due to the belief of having an immense stock of grandfathered large capacity magazines as well as those entering the country through importation (Koper 2004). Some of the positive impacts of reducing the availability of assault weaponry as defined by this litigation could have been offset by legal guns which have use of large capacity magazines. Additionally, there was no evidence of any decline in gun injuries or deaths due to the provisions of the ban (Koper 2004). The findings indicated that there might have been some positive effects of the ban, but that these effects occur gradually due to the grandfathering provisions in the law. Still, it leaves the possibility that a new ban might reduce shootings modestly while taking several years to achieve desired effects depending on its grandfathering provisions. It may not be a cure-all for gun crime, but it could prevent further spread of damaging weaponry and may assist in the reduction of more serious gun crimes.

Some of the same failures addressed in the evaluation of the previous ban will affect the most recently proposed legislation. The grandfathering provisions of both bans severely limit any successful indicators since there is already a vast supply of assault weapons and large capacity magazines on the market. Negating this provision, however, an assault weapons ban could impact the victim counts of deadly mass shootings where the offender's intent is to harm as many people as possible. The results of this study indicate that assault weapons significantly increase the amount of injured victims per each shooting. In addition, the involvement of large capacity magazines significantly increases the number of fatalities, injured, and total victims. Since the majority of weapons were obtained by mass shooters legally, it is possible that banning the future legal obtainment of high powered weaponry such as assault weapons and large capacity magazines would decrease their use in these crimes. Offenders who are motivated to commit a public mass shooting might choose a lesser weapon thus decreasing the quantity and rate of fire at which they are able to shoot ammunition at their targets. The present study has found that non assault weapon and large capacity magazine cases have reduced victim counts. Therefore, it is presumable that overall victim counts will also decrease for public mass shootings. None of the methods or results of this study have attempted to determine a perfect solution for mass shootings, but the findings do assist in uncovering that incidents have been increasing slightly in recent years and body counts are growing along with use of more high powered weaponry.

Study Weaknesses and Limitations

As with any study, there were multiple weaknesses that could be addressed in future endeavors. A majority of these limitations involve the data chosen for the study. With a lack of scientific research performed on mass murder in general, finding authentic secondary data was difficult. Typically, mass murder and public mass shootings are highly covered by media sources which increase the amount of general information on the topic while also decreasing the reliability of any data. The Mother Jones data set used in this study received all information from media sources and while multiple validations were performed to ensure the validity of the data, there is still the potential for errors. These errors could be found in a number of places especially when referring to the variables included in the study. For example, mental illness is a broad term with numerous applications. The separate investigation by Mother Jones operationally defined instances of mental illness based on media reports that indicated a shooter having some mental condition. Likewise, the investigation focused on media sources for weapons discovered in the offenders' possessions in order to classify them based on the proposed assault weapon ban's definitions. While the likelihood of error forming in the more publicized mass shooting incidents is considerably small considering the amount of information made public, the lesser known as well as the older shootings have larger potential for errors.

Another issue with the data involves the specific criteria of the included shooting incidents. In order for a shooting incident to be included in the data set, there were certain characteristics which needed to be present in the situation. The selectiveness of this data was advantageous for the present study's purpose of analyzing the more damaging public mass shootings, but eliminating countless other mass murder or serious shooting incidents limits the generalizations which can be drawn from the results. In essence, the study's findings might only apply to the shooting incidents included in the data while not applying to public mass shootings as a general classification. For example, when analyzing the weapons used in mass shootings, the analysis relies on cases that involved a lone shooter murdering four or more people in a short time window at a public place. In order to match all of those circumstances, high powered weaponry most likely was used in the shooting incident. Is it because high powered weapons are used frequently in public mass shootings or is it because high powered weapons were more likely to create such a result as opposed to the non-selected cases? Again, further research needs to be done to address this issue.

An additional problem deals with the nature of the study. The present study is explorative and therefore lacks some analytics. A majority of the results were found on descriptive analyses due to the nature of the data and should just be considered statistics, trends, and correlations. While the present study did not seek out to decipher any causal relationship between any of the variables, it is still an inherent weakness of the study. Also, the sample size is considerably small so any trends are equivalent in size to the sample. The occurrence of public mass shootings is rare in itself which exacerbates the problem of studying the number of cases necessary to conduct more thorough analyses. However, the study fills the gap of scientific research on public mass shootings and discovers findings which are not only helpful in creating future research, but also in establishing policies to diminish a growing problem.

Future Research of Public Mass Shootings

With a lack of scientific research on the topic, there is a great opportunity for more expansive research. Based on the findings of the present study, future research can touch a number of important issues. First, the results indicated a slight overall increase in the occurrence of public mass shootings over the last three decades with a more drastic increase occurring over the last eight years. Further research needs to be conducted to validate the increase, test possible causes for the increase, and discover if the trend is likely to continue in opposition to general homicide levels.

Second, the study found some differences in offender and offense characteristics over time. The variables within these characteristics need to be analyzed to determine causal relationships. For example, the study indicated a rise of younger offenders in the past 15 years while also finding an increase in school and store/restaurant shootings. It might be possible that there are variables connecting the trends together as well as some indicating reasons behind workplace shootings declining. With the present study highlighting changes over time, it creates numerous opportunities to analyze relationships in order to address the changes.

Additionally, there is an opportunity to study how the operationalization of mass murder and mass shootings can affect statistics of occurrence over time. For example, it is possible and very likely that the present study produced a different assessment of trends from other works because of the initial defining of mass shootings. There have been previous discussions on number of victims, locations, and time. However, no uniform definition has ever been consistently applied across studies. If it is possible to approach mass murders or mass shootings in the same manner, there will be more feasibility in the replication of studies and the field of mass homicide research will grow as a whole.

Also, one of the most significant findings for the study was the use of assault weapons and large capacity magazines in addition to the lethality of these dangerous weapons. In more than half of all instances, the offender had in their possession an assault weapon or large capacity magazine. Additionally, almost a third of all of the offenders' weapons would be ruled illegal with the recently proposed legislation. These statistics could be even larger since data could not be found on large capacity magazines in over 40% of the cases. Overall, the large presence of high powered weaponry in public mass shooting incidents is significantly measureable. However, the findings for lethality of these weapons might be more important for future research. Based on this study's findings, assault weapons impact shooting incidents by providing an offender a greater chance to shoot and injure more victims at the scene. Meanwhile, large capacity magazines provide an offender the possibility to shoot, injure, and kill more overall victims. Future research needs to analyze the lethality of these weapons in terms of general homicide and more simply the nature of the weapon. If it is discovered that these weapons truly create larger victim counts than a substitute weapon then the potential for increased legislation is exponential and the findings of this study could serve a purpose in preventing future harm.

APPENDIX A

Public Mass Shootings in U.S. (1982-2012)

Case	Location	Date
Welding shop shooting	Miami, Florida	8/20/1982
Dallas nightclub shooting	Dallas, Texas	6/29/1984
San Ysidro McDonald's massacre	San Ysidro, California	7/18/1984
United States Postal Service shooting	Edmond, Oklahoma	8/20/1986
Shopping centers spree killings	Palm Bay, Florida	4/23/1987
ESL shooting	Sunnyvale, California	2/16/1988
Stockton schoolyard shooting	Stockton, California	1/17/1989
Standard Gravure shooting	Louisville, Kentucky	9/14/1989
GMAC massacre	Jacksonville, Florida	6/18/1990
Luby's massacre	Killeen, Texas	10/16/1991
University of Iowa shooting	Iowa City, Iowa	11/1/1991
Royal Oak postal shootings	Royal Oak, Michigan	11/14/1991
Lindhurst High School shooting	Olivehurst, California	5/1/1992
Watkins Glen killings	Watkins Glen, New York	10/15/1992
101 California Street shootings	San Francisco, California	7/1/1993
Luigi's shooting	Fayetteville, North Carolina	8/6/1993
Long Island Rail Road massacre	Garden City, New York	12/7/1993
Chuck E. Cheese's killings	Aurora, Colorado	12/14/1993
Air Force base shooting	Fairchild Air Force Base, Washington	6/20/1994
Walter Rossler Company massacre	Corpus Christi, Texas	4/3/1995
Fort Lauderdale revenge shooting	Fort Lauderdale, Florida	2/9/1996
R.E. Phelon Company shooting	Aiken, South Carolina	9/15/1997
Caltrans maintenance yard shooting	Orange, California	12/18/1997
Connecticut Lottery shooting	Newington, Connecticut	3/6/1998
Westside Middle School killings	Jonesboro, Arkansas	3/24/1998
Thurston High School shooting	Springfield, Oregon	5/21/1998
Columbine High School massacre	Littleton, Colorado	4/20/1999
Atlanta day trading spree killings	Atlanta, Georgia	7/29/1999
Wedgwood Baptist Church shooting	Fort Worth, Texas	9/15/1999

Xerox killings	Honolulu, Hawaii	11/2/1999
Hotel shooting	Tampa, Florida	12/30/1999
Wakefield massacre	Wakefield, Massachusetts	12/26/2000
Navistar shooting	Melrose Park, Illinois	2/5/2001
Lockheed Martin shooting	Meridian, Mississippi	7/8/2003
Damageplan show shooting	Columbus, Ohio	12/8/2004
Living Church of God shooting	Brookfield, Wisconsin	3/12/2005
Red Lake massacre	Red Lake, Minnesota	3/21/2005
Goleta postal shootings	Goleta, California	1/30/2006
Capitol Hill massacre	Seattle, Washington	3/25/2006
Amish school shooting	Lancaster County, Pennsylvania	10/2/2006
Trolley Square shooting	Salt Lake City, Utah	2/12/2007
Virginia Tech massacre	Blacksburg, Virginia	4/16/2007
Crandon shooting	Crandon, Wisconsin	10/7/2007
Westroads Mall shooting	Omaha, Nebraska	12/5/2007
Kirkwood City Council shooting	Kirkwood, Missouri	2/7/2008
Northern Illinois University shooting	DeKalb, Illinois	2/14/2008
Atlantis Plastics shooting	Henderson, Kentucky	6/25/2008
Carthage nursing home shooting	Carthage, North Carolina	3/29/2009
Binghamton shootings	Binghamton, New York	4/3/2009
Fort Hood massacre	Fort Hood, Texas	11/5/2009
Coffee shop police killings	Parkland, Washington	11/29/2009
Hartford Beer Distributor shooting	Manchester, Connecticut	8/3/2010
Tucson shooting	Tucson, Arizona	1/8/2011
IHOP shooting	Carson City, Nevada	9/6/2011
Seal Beach shooting	Seal Beach, California	10/14/2011
Su Jung Health Sauna shooting	Norcross, Georgia	2/22/2012
Oikos University killings	Oakland, California	4/2/2012
Seattle cafe shooting	Seattle, Washington	5/20/2012
Aurora theater shooting	Aurora, Colorado	7/20/2012
Sikh temple shooting	Oak Creek, Wisconsin	8/5/2012
Accent Signage Systems shooting	Minneapolis, Minnesota	9/27/2012
Newtown school shooting	Newtown, Connecticut	12/14/2012

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