State Gun Law Grades and Impact on Mass Shooting Event Incidence: An 8-Year Analysis

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BACKGROUND: Gun violence, particularly in the form of mass shooting events (MSE), is a growing, significant public health crisis in the US. Whether stricter gun laws decrease MSE is not known. We hypothesized that stronger state gun laws would be associated with lower MSE incidence.

STUDY DESIGN: Mass shooting events, defined as at least 4 people injured in a single event, and state gun law grade data for years 2014 through 2021 were obtained from the Gun Violence Archive and Giffords Law Center, respectively. An A grade indicated strictest gun control laws, and F indicated the weakest. US 2020 Census data were used to estimate MSE per million per state. The number of MSE per million was examined for association with gun law grades.

RESULTS: From 2014 through 2020, there were a total of 2,736 recorded MSE, with at least a 2-fold increase in incidence from 272 in 2014 to 626 in 2020. Concomitantly, the number of F grade states decreased from 27 to 21 (22%). The MSE mean (SD) per F state increased from 4.0 (5.1) in 2014 to 9.7 (10.3) in 2020 ($p = 0.03$). No differences were found in unadjusted number of MSE per year by gun law grade for any study year examined ($p = 0.67$). After adjusting for population, this finding of no difference persisted.

CONCLUSIONS: Strength of state gun law grades does not affect MSE incidence, even after correction for population size. This suggests that legislation by itself is not an effective prevention measure and other broader and meaningful primary gun violence interventions are needed. (J Am Coll Surg 2022;234:645–651. © 2022 by the American College of Surgeons. Published by Wolters Kluwer Health, Inc. All rights reserved.)

Gun violence, particularly mass shooting events (MSE), are a public health problem nearly unique to the US. Despite the abundance of public attention drawn to these events and the common use of the term "mass shooting," there is no consensus or standard definition for what constitutes such an event, and the definition varies across different data sources.[1] The FBI definition of a mass murder, which is defined as at least 4 people killed in a single event, has been adopted by many as the bar for deeming an event a mass shooting.[2] Media organizations, such as the Associated Press and USA Today, also use this definition. Other data sources, such as Mother Jones and The Violence Project's Mass Shooter Database, include only incidents that occurred in a public location and exclude motivations such as crimes of armed robbery, gang violence, and domestic violence.[1] Further distinctions are often made between MSE that occur at public versus private locations.

Mass public shootings of seemingly random victims, such as those in Newtown, CT, and Las Vegas, NV, often evoke vast media coverage and galvanize the attention of the collective public and policy makers. A single, mass public shooting typically results in a 15% increase in firearm legislation introduced in a state in the year after the event.[3] This increase is directly proportional to the number of fatalities, such that a higher number of fatally wounded victims results in a larger increase in the introduction of new gun bills, as well as to the extent of media coverage.[3] The impact of resulting legislation on the incidence of MSE remains unclear. Using the widely used definition of mass public shootings to examine prevalence of MSE or the impact of gun legislation on MSE is problematic because it includes

Disclosure Information: Nothing to disclose.

Support: Dr Taghavi receives research funding from the CDC, Center Grant U01 CE003384-01; the Tulane Physician Scientist Pipeline Program; and the Louisiana Clinical and Translational Science Center Grant U54 GM104940.

Presented at the Southern Surgical Association 133rd Annual Meeting, Hot Springs, VA, December 2021.

Received December 11, 2021; Accepted December 13, 2021.

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https://doi.org/10.1097/XCS.0000000000000118
ISSN 1879-1190/22

Abbreviations and Acronyms
GVA = Gun Violence Archive
MSE = mass shooting events

only a specific type of mass shooting, and one which is a rare form of gun violence.[3,4] In contrast to other gun violence data sources, the Gun Violence Archive (GVA) does not have a casualty threshold and defines an MSE as an event in which 4 people were fatally or nonfatally injured, excluding the shooter.[5] We sought to determine the incidence of mass shooting events across a 7-year study period using the definition used by the GVA. We then sought to compare the strength of gun laws in each state to determine whether stronger gun laws demonstrated a reduction in MSE over this period. We hypothesized that states with stronger firearm legislation would have lower incidence of MSE.

METHODS

Mass shooting events were defined as at least 4 people injured or killed in a single event according to the GVA. The incidence of MSE over a 7-year period (2014–2020) was determined using the definition used by the GVA. State gun law grade data for an 8-year period (2014–2021) were obtained from the Giffords Law Center to Prevent Gun Violence. The GVA, established in 2013, is an independent research and data collection organization which aims to provide comprehensive data regarding gun violence.[5] The GVA uses both automated queries and manual research to collect and validate gun violence and crime incidents from 7,500 sources daily. Each incident is verified by researchers and secondary validation processes. No subcategories of shootings or victims are excluded, which allows a counting of both victims injured and victims killed. The GVA definition of mass shooting is "four or more shot and/or killed in a single event [incident], at the same general time and location not including the shooter." Their methodology and other definitions can be found online at www.gunviolencearchive.org/methodology.[5]

State gun law grades were obtained from the Annual Gun Law Scorecard compiled by the legal team at Giffords Law Center, which is headquartered in San Francisco, CA. Gun legislation in all 50 states is tracked, and laws and policies are assigned point values based on their respective strengths or weaknesses which are then compared to the most recent gun death rates in data maintained by the Center for Disease Control and Prevention (CDC; https://giffords.org/lawcenter/resources/scorecard/#rankings, accessed 11/8/2021).[6] An A grade indicated strongest gun control laws, whereas F indicated the weakest. Grades were assigned point values in accordance with the traditional 4-point grading scale as follows: A grade = 4 points; B grade = 3 points, C grade = 2 points, D grade = 1 point, and F grade = 0 points. The states of Hawaii, New Hampshire, and North Dakota were excluded from analysis because there were no data recorded in the GVA regarding number of mass shooting events. Similarly, MSE over the study period recorded in the District of Colombia (DC) were excluded from the count because DC did not have a gun law grade assigned by the Giffords Law Center.

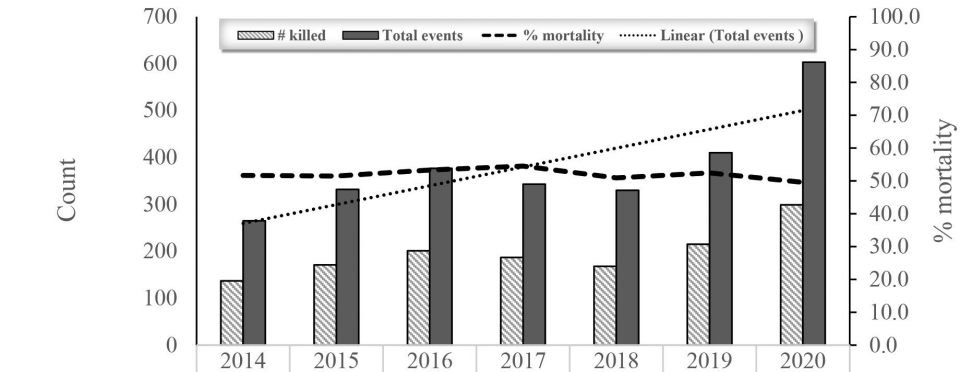
To account for population differences among the states, US 2020 Census data was used to estimate MSE per million per state (https://www.census.gov/programs-surveys/decennial-census/decade/2020/2020-census-results.html, Accessed 11/8/2021). Numbers of MSE per million were reported as medians and were examined by the Kruskal-Wallis test for association with gun law grades. The level of significance was set at $p < 0.05$, and all statistical analyses were performed using SPSS v27 (IBM; Armonk, NY).

RESULTS

A total of 2,736 mass shooting events were recorded between 2014 and 2020. After exclusion of those that occurred in the District of Columbia, 2,660 remained for analysis. The overall number of MSE trended steadily up over the study years, with a 2.3-fold higher incidence in 2020 when compared with 2014 (Figure 1). A total of 1,376 individuals injured in an MSE died, resulting in an overall mortality rate of 51.8%. The mortality rate across years ranged from 49.6% to 54.5% but did not differ significantly ($p = 0.31$). Figure 2 shows total MSE per state over study period and grouped by 2020 gun law grade. California and Illinois are the states with the highest number of MSE and are both a grade of A.

A subset analysis was performed to examine those incidents that would be categorized as MSE using the definition of at least 4 people killed. Of the 2,660 MSE, 186 (7.0%) met this definition. Incidence rates of these MSE decreased from roughly 8% for years 2014 through 2019 to 3.8% in 2020 ($p = 0.04$). Figure 3 shows trends of state gun law scorecard grades across total number of MSE per year. Number of MSE in grade F states appear to have decreased from 2017 to 2021, whereas MSE in grade C states appear to have increased over the same time period. Number of MSE in grade A and B states appears to have remained relatively unchanged over the study period.

As shown in Figure 4, there was no difference in MSE per state law grade after adjusting for population. Grade A states had the highest MSE per million people



	2014	2015	2016	2017	2018	2019	2020
# killed	137	171	201	187	168	215	299
Total events	265	332	377	343	330	410	603
% mortality	51.7	51.5	53.3	54.5	50.9	52.4	49.6

Figure 1. Counts of mass shooting events and percent mortality per year.

population with 9.35 MSE per million followed by Grade F states with 8.68 MSE per million. Grade C had the lowest with 5.67 MSE per million population. The overall mortality rate of A grade states was 48.5%, which was significantly lower than the 56.8% overall mortality rate of F grade states ($p < 0.01$). Despite a higher MSE per million people population, the mortality rates increased as grade level decreased (A to F) and ranged from 4.6% in the A grade group to 8.8% in the F grade group ($p < 0.01$).

DISCUSSION

Gun violence in the US has reached epidemic proportions.[7] Factors leading to gun violence in our country are multifactorial, with many socioeconomic issues in play.[8-10] Whether legislation can decrease gun violence in the US is unknown. From our analysis we determined that strong gun law grades, as measured by the Giffords Law Center, did not decrease the incidence of MSE. However, we did find that in states with strong gun law grades there was a decrease in mortality when MSE did occur when compared with lower grade states.

Formulation of potential solutions to combat the increasing incidence of MSE will require both a multifaceted and multidisciplinary approach with collaboration among federal and state government, policy makers, school boards, media agencies, healthcare professionals, and the National Rifle Association (NRA). Addressing MSE begins with policy makers. It is essential for policy makers to push for a standard definition of what truly is an MSE. Because of the plurality of definitions for MSE, it is difficult to examine the true incidence, risk factors, and impact of policy changes on MSE. Based on the different definitions from the FBI Supplementary Homicide Reports, Associated Press, USA Today, Mother Jones, Mass Shooter Database kept by The Violence Project, Gun Violence Archive, Mass Shooting in America Database, and Mass Shooting Tracker, there were between 2 and 696 mass shootings in the US in 2020; that amounts to a range of incident rates from approximately 0.01 to 2.11 per 1 million people in the US (Table 1). Because of lack of consistencies between databases, meaningful examinations which attempt to understand incidence, trends, motives, and relationship to gun violence can become very complicated and their results are misleading. For our analysis we chose the GVA over all other databases. The GVA definition of mass shooting was consistent with "four or more shot and/or killed in a single event [incident], at the same general time and location not including the shooter." This data source was chosen over the FBI Supplementary Homicide Reports, which is the most comprehensive data source for homicide in the US because participation in the Supplementary Homicide Reports program is voluntary for law enforcement agencies and thus does not include all homicides that occur. Further, it does not account for victims who were wounded but survived.[4] We encourage policy makers to standardize the definition of a MSE to that consistent with the GVA definition. Furthermore, policy makers should ask that state and federal agencies adopt the universal definition of MSE to improve documentation of MSE nationwide.

Whether stricter gun laws decrease MSE is extremely controversial. MSE often lead to significant media coverage and heated national debate.[11] Our study found that gun violence laws do not decrease the number of MSE when adjusting for population. This finding differs from numerous other studies that have shown that more permissive gun laws led to more mass shootings.[8,12-16] Previous studies also have determined that universal background check

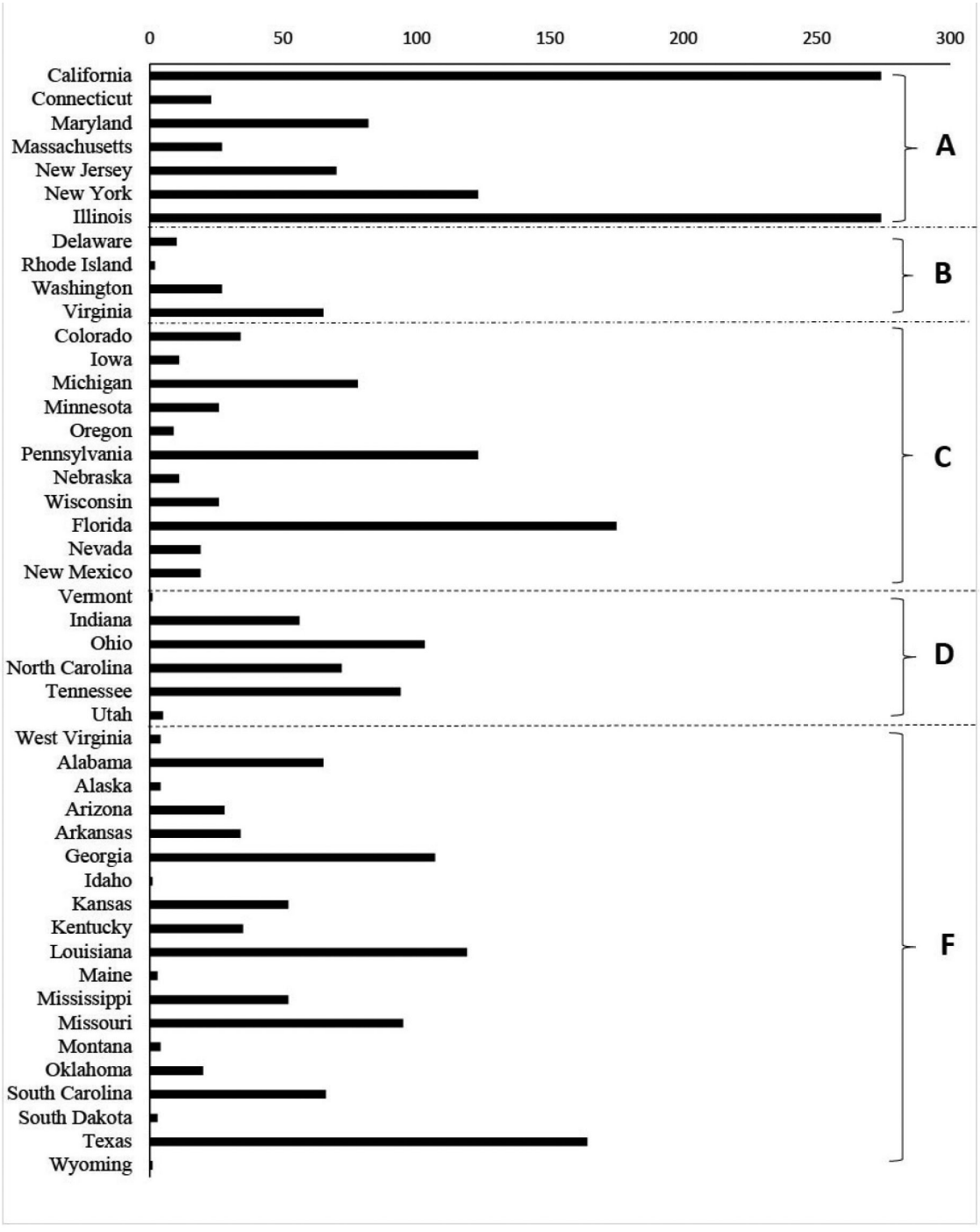


Figure 2. Total mass shooting events per state over study period. States are grouped by 2020 gun law grade.

laws do not decrease the incidence of MSE.[17,18] Arguably, target specific legislation may have a greater impact on the incidence of MSE compared with the total number of gun control laws. Further studies are needed to examine the relationship between stricter gun legislation and true incidence of MSE.

Importantly, although number of MSE were not decreased in higher graded states, states with higher gun grades did have lower mortality in MSE. This is consistent with existing research. Previous work has shown that gun laws banning large capacity magazines lead to decreased fatalities when mass shootings occur.[19] DiMaggio and

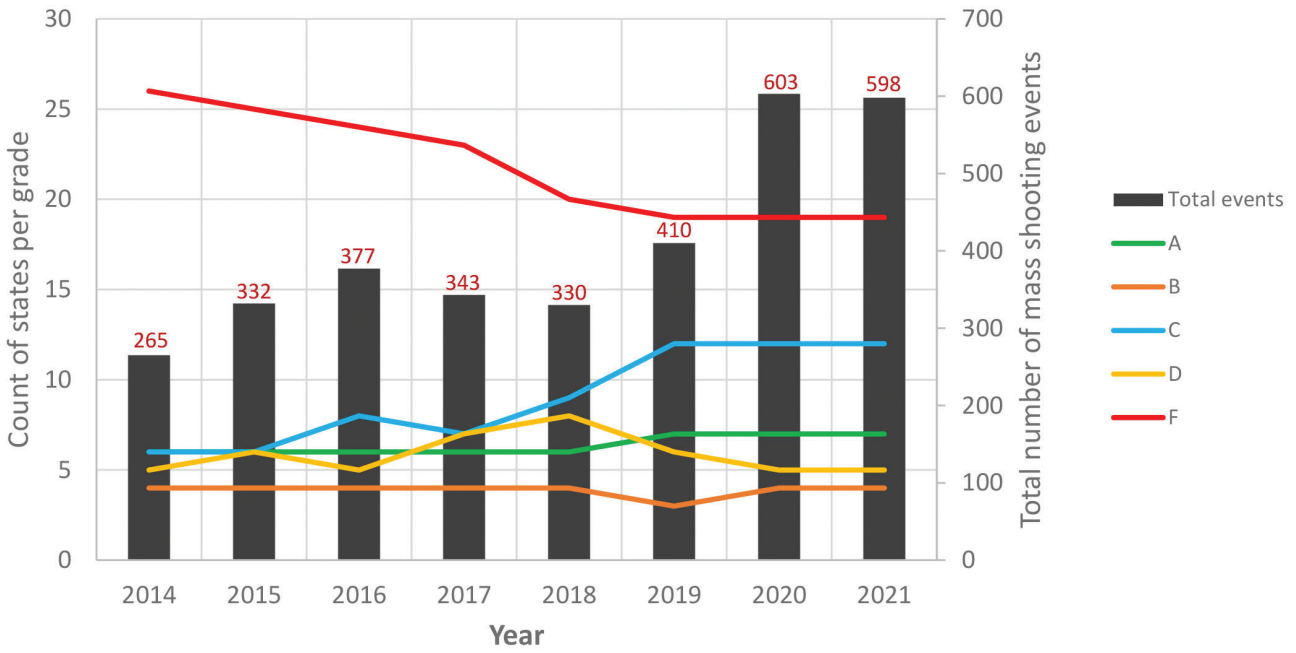


Figure 3. Trends of state gun law scorecard grades across total number of mass shooting events per year.

colleagues[20] found that during the federal assault weapons ban in the US from 1994 to 2004, there were less fatalities from MSE. Although legislation may not decrease number of events, it may save lives when these MSE occur.

Given that gun control legislation may not correlate to a lower incidence of MSE, it is reasonable to consider targeting other risk factors implicated in mass shootings. Recent studies have demonstrated that socioeconomic factors may pose a greater risk for MSE compared with lack of gun control policies. In a 2019 review of socioeconomic data from the US Bureau of the Census and mass shooting data amassed from the Mass Shootings in America, Mother Jones, and USA today, Kwon and colleagues[21] determined that counties with income inequality are more

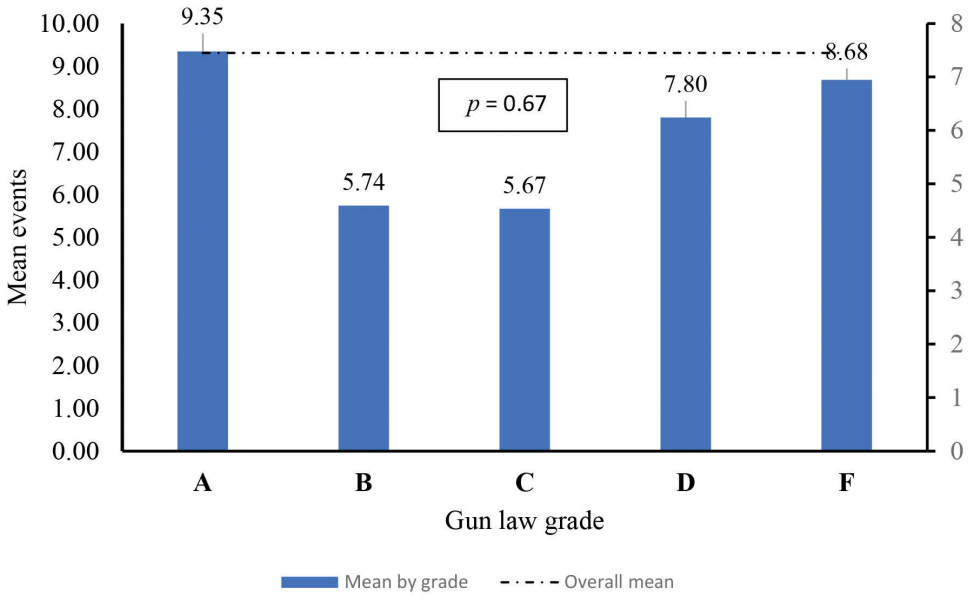


Figure 4. Mean number of mass shooting events per million people by gun law grade.

Table 1. Variation in How Mass Shootings Are Defined and Counted

Data source	Casualty threshold	Incident location	Shooter motivation	No. of US shootings in 2020	No. of mass shooting fatalities in 2020	No. of mass shooting injuries in 2020
Mother Jones	3 people* fatally injured; excludes shooter	Public	Indiscriminate†	2	9	0
Gun Violence Archive	4 people fatally or non-fatally injured; excludes shooter	Any	Any	611	513	2543
Mass Shooter Database (The Violence Project)	4 people fatally injured; excludes shooter	Public	Indiscriminate†	6‡	60‡	NA
AP/USA TODAY/ Northeastern University Mass Killings Database	4 people fatally injured; excludes shooter	Public	Any	33	174‡	NA
Everytown for Gun Safety Support Fund	4 people fatally injured; excludes shooter	Any	Any	17	79	10
Mass Shooting Tracker	4 people fatal or non-fatally injured; excludes shooter	Any	Any	696	661	2750

*Before January 2013, the casualty threshold for *Mother Jones* was 4 people fatally injured, excluding the shooter.
†Excludes crimes of armed robbery, gang violence, or domestic violence.
‡Represents data reported from 2019 because these data were not publicly available.
AP, Associated Press; NA, not applicable.

likely to experience mass shootings. Unemployment also increased the risk of mass shootings, but poverty rate and policy strategies were not significantly associated with mass shootings. A subsequent study reproduced similar findings and reported robust increases in MSE in counties where both income inequality and income were high.[22] The authors posit a link between income inequality and mass shootings, in which mass shootings occur when community members fail to achieve culturally defined levels of economic success, which fosters an environment of anger, frustration, and violence. In the future, MSE prevention strategies should target socioeconomic factors that are potential drivers of mass shootings, such as income inequality and unemployment (Fig. 5) Current isolated

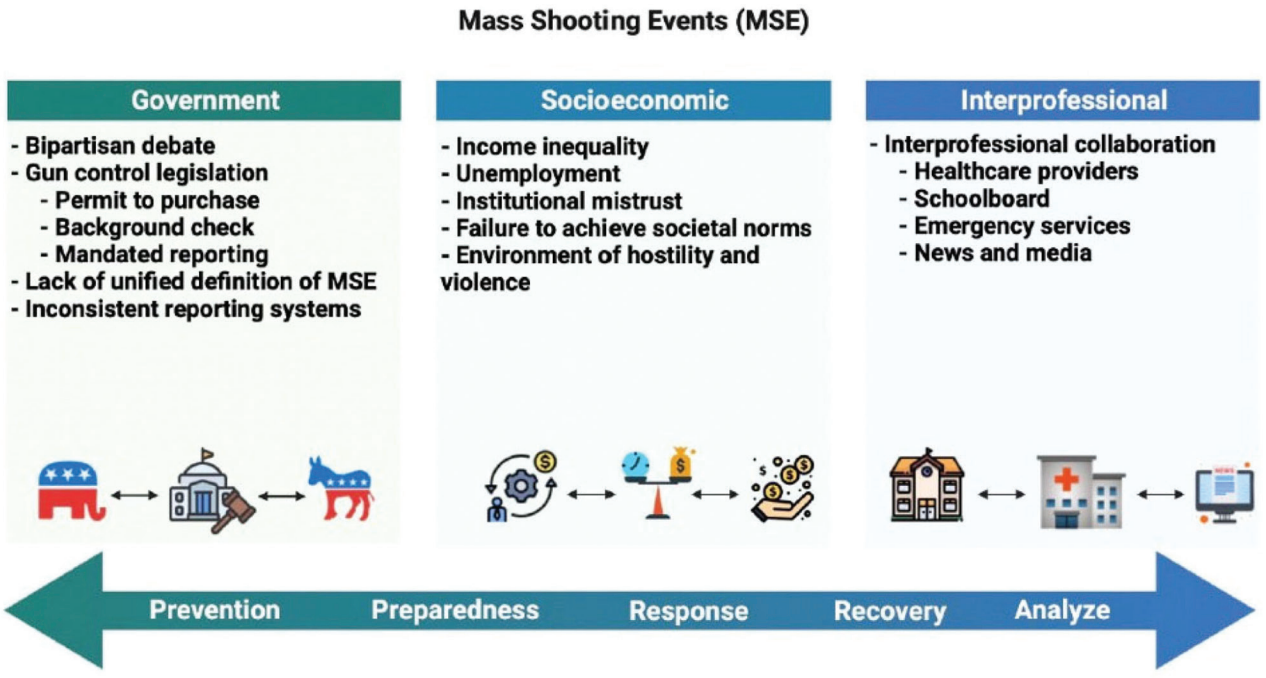


Figure 5. A national all-inclusive approach to mitigate mass shooting events (MSE).

efforts that aim to decrease the means to firearms through federal and state legislation may not be effective.

Study limitations

The authors relied on the Giffords Law Center to assess state gun law grades and did not independently examine the validity of this database, which is a potential source of bias. Similarly, the authors relied on the GVA database for data regarding mass shooting events. These data, as noted by the GVA, attempt to maintain real-time information but may not be 100% accurate and may not account for all MSE. Population size was obtained using the most recent data from the 2020 US Census, which may not reflect accurate population estimates in the early years of the study period. However, using the previous 2010 US Census data would have presented a similar issue, but with data that were less recent and more likely to be an inaccurate representation of population levels.

CONCLUSIONS

In conclusion, state laws do not decrease the number of MSE. However, when these MSE do occur, stronger state gun laws may lead to decreased fatalities. Further studies with standardization of definitions for MSE are needed to further characterize the relationship of stricter gun laws and MSE. Interventions to prevent MSE should also consider socioeconomic factors, such as income inequality and unemployment.

Author Contributions

Study conception and design: Duchesne, Taghavi, Toraih, Simpson, Tatum
Acquisition of data: Duchesne, Taghavi, Toraih, Simpson, Tatum
Analysis and interpretation of data: Duchesne, Taghavi, Toraih, Simpson, Tatum
Drafting of manuscript: Duchesne, Taghavi, Toraih, Simpson, Tatum
Critical revision: Duchesne, Taghavi, Toraih, Simpson, Tatum

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