

# School shootings during 2013–2015 in the USA

Bindu Kalesan,<sup>1</sup> Kinan Lagast,<sup>2</sup> Marcos Villarreal,<sup>3</sup> Elizabeth Pino,<sup>4</sup> Jeffrey Fagan,<sup>2,6</sup> Sandro Galea<sup>5</sup>

► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/injuryprev-2016-042162>).

<sup>1</sup>Center for Translational Epidemiology and Comparative Effectiveness Research, Boston University, Boston, Massachusetts, USA

<sup>2</sup>Department of Epidemiology, Columbia University, New York, New York, USA

<sup>3</sup>University of Texas Southwestern School of Medicine, Dallas, Texas, USA

<sup>4</sup>Department of Medicine, Boston University, Boston, Massachusetts, USA

<sup>5</sup>School of Public Health, Boston University, Boston, Massachusetts, USA

<sup>6</sup>Columbia Law School, New York, New York, USA

## Correspondence to

Dr Bindu Kalesan, Center for Translational Epidemiology and Comparative Effectiveness Research, Boston University, 801 Massachusetts Ave Room 475, Boston, 02118 MA, USA; [kalesan@bu.edu](mailto:kalesan@bu.edu)

Received 17 July 2016

Revised 15 October 2016

Accepted 18 October 2016

## ABSTRACT

**Background** Data on the factors associated with school shootings in the USA are limited. The public conversation has often suggested several factors that may be linked to these events, however with little empirical support. Aiming to fill this gap, we describe the characteristics of school shooting incidents in the USA between 2013 and 2015 and explore whether four factors that represent domains of firearm policy, educational policy and epidemiological risk factors for intentional firearm injuries—background check (BC) policies, per capita mental health expenditures (MHE), K-12 education expenditure (KEE) and urbanicity—were associated with school shootings during this period.

**Methods** We searched LexisNexis, a newspaper and broadcast media databases for school shooting incidents from 1 January 2013 to 31 December 2015. Presence of BC laws was extracted from legal information in LexisNexis. State-level covariates of per capita MHE (2013), KEE (2013) and urbanicity (2010) rates were obtained from publicly available data sources. We used negative binomial regression models accounting for clustering by state to explore unadjusted associations between the BC laws, state-level covariates and school shootings to report IRR and 95% CI.

**Results** We documented 154 school shootings (35, 55 and 64 each year). In unadjusted models, BC for firearm purchase (IRR=0.55, 95% CI 0.39 to 0.76), ammunition purchase (IRR=0.11, 95% CI 0.05 to 0.27), log per capita MHE (IRR=0.58, 95% CI 0.37 to 0.90), log per-capita KEE (IRR=0.09, 9% CI 0.02 to 0.29) and urbanicity (IRR=0.97, 95% CI 0.96 to 0.99) were associated with school shooting.

**Conclusions** School shootings are less likely in states with BC laws, higher MHE and KEE, and with greater per cent urban population.

The high profile Sandy Hook Elementary school shooting on 14 December 2012 galvanised public attention around the issue of school shootings in the USA. In this horrific incident, 20 children and 6 adult staff members were shot dead by a lone gunman. However, while particularly horrific, the Sandy Hook shooting was only one of several such events in the USA in the past years. The USA has an extraordinarily high rate of school shootings by comparison with other countries.<sup>1</sup> By way of illustration, between 1966 and 2008, there were 44 school shootings in the USA, an average of one episode per year. During this time period there were seven in Canada and seven in all of Europe.<sup>1</sup> This high prevalence of school shootings has, appropriately enough, contributed to substantial and contentious public debates about how best to mitigate this epidemic.

Several factors have characterised the public discussion in this area. First, it has been concerned with the effects or non-effects of gun laws in limiting school shootings. The USA is currently characterised by a patchwork of gun policies across US states.<sup>2–3</sup> The lack of comprehensive federal gun control legislation has resulted in considerable variation in state-specific gun laws.<sup>2</sup> For example, during 2013, 14 out of the 50 states and District of Columbia had some form of background checks (BCs) for firearm purchase, out of which 5 states required BC for handgun purchases alone but not for long guns or assault weapons.

Second, much has been written around the role of mental illness of perpetrators of gun violence generally,<sup>4–5</sup> and in mass shootings in particular.<sup>6</sup> Other reactions to school shootings and mass shootings generally ask whether improvements in mental health screening and treatment systems might mitigate some proportion of school shootings or other mass shootings.<sup>7</sup> The perception that mental illness contributes to school shootings, true in the anecdotal particular, flies in contrast to population data showing that persons with mental illness are far more likely to be victims, rather than perpetrators, of violence, including gun violence.<sup>8–9</sup>

Third, public education systems aspire to produce informed, engaged, prosocial citizens.<sup>10</sup> Recently, both federal and state funding for children that focuses on children's education has declined.<sup>11</sup> Students in states with larger school-age populations receive lower per-student spending for public schools than those in states with smaller percentages of school-age children.<sup>11–12</sup> Conversely, victimisation rates of high school students by weapons in general have also increased.<sup>13</sup> Accordingly, disinvestment in education has been suggested as a potential driver of increasing violence.<sup>10</sup>

Fourth, children living in urban areas are at a greater risk of victimisation and exposure to violence.<sup>14–16</sup> The exposure to violence among pre-adolescent children varies by community income levels in both suburban and urban middle school children.<sup>14</sup> Trauma centre studies that serve metropolitan areas have indicated a high incidence of firearm-related injury among children and adolescents with increased morbidity, including permanent neurological deficits.<sup>15–16</sup> However, the relationship between state-level urbanicity and school shootings have not been assessed. A higher concentration of urban residents in a state might contribute to a concentration of spending on mental health and education in those areas, as well as on public safety resources including police that may mitigate firearm and non-firearm violence.

**To cite:** Kalesan B, Lagast K, Villarreal M, et al. *Inj Prev* Published Online First: [please include Day Month Year] doi:10.1136/injuryprev-2016-042162

Much of the public debate around school shootings in the USA is undoubtedly informed by strong sentiments about the interpretation of Second Amendment rights and the depth of culture and tradition around gun ownership in the country. There is a strong positive relationship between social gun culture and gun ownership.<sup>17</sup> The empirical work on school shootings has not incorporated those debates or factors. Nor has the research on school shootings examined features of public policy or demography that has informed research on other forms of interpersonal gun violence.

Empirical evidence that documents both fatal and non-fatal school shooting injuries and that explores the potential impact of both state-specific social structural attributes and gun policies stands to contribute meaningfully to the public discussion.<sup>18</sup> Therefore, we documented the characteristics of school shootings during 2013–2015 and explored the relationship between state-level BC laws for gun and ammunition purchases, per capita mental health expenditure (MHE), K-12 education expenditure (KEE), urbanicity, gun ownership and school shootings.

## METHODS

### Inclusion and exclusion criteria

We identified and recorded all school shooting incidents from 1 January 2013 to 31 December 2015. We defined an occurrence of school shooting as an incident when a firearm was discharged inside a school building or on school or campus grounds, as documented in publicly reported news. Detailed inclusion and exclusion criteria are described in online supplementary appendix 1.

### Data sources

#### Outcome

We collected information regarding state-specific school shootings by querying LexisNexis Academic, an interdisciplinary, full-text database of over 18 000 sources including newspapers, journals, wire services, newsletters, company reports, case law, government documents, transcripts of broadcasts and selected reference works. We queried for school shooting incidents between 1 January 2013 and 31 December 2015, using terms (('school' OR 'college' OR 'university') AND ('shooting' OR 'gun' OR 'shot')) using natural language search terms option. Duplicate options were set for 'On-high similarity'. There were 941 records available during this time period. We searched all these items to identify multiple reports for 154 incidents, which fit our inclusion/exclusion criteria. The details are presented in online supplementary appendix 2. Data on shooter characteristics, school characteristics and deaths and injuries related to each incident were extracted from these reports by one investigator (KL) and checked by another investigator (BK) for consistency.

#### Covariates

*Everytown USA* researchers used LexisNexis Academic and legal sources to extract legal information on BC laws for each state that were in effect between 2013 and 2015. The state-specific variation in passage and implementation of BC for firearm purchases and ammunition purchases are detailed in online supplementary appendix 3. In 2013, 14 out of the 50 states (California, Connecticut, Hawaii, Illinois, Iowa, Maryland, Massachusetts, Michigan, Nebraska, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island) and District of Columbia had BCs for firearm purchase. Among these 14 states Connecticut, Iowa, Michigan, Nebraska and North Carolina

required BCs for handgun purchases alone. In 2014, additionally Colorado and Delaware implemented BC for all types of firearm purchase. In 2015, Washington implemented BC for all types of firearm purchase. BC for ammunition purchase was required in Illinois, Massachusetts and New Jersey in 2013. In 2014, Connecticut also implemented BC for ammunition purchase.

We obtained MHE allocation in 2013 from the National Association of State Mental Health Program Directors Research Institute (NRI) (SMHA-Controlled Mental Health Expenditures by Age Group and State: FY' 2013 (in millions) (<http://www.nri-incdata.org/RevExp2013/T31.pdf>)).<sup>19</sup> Data compiled by National Association of State Mental Health Program Directors were used in various studies such as financial information gap in different mental health service delivery systems<sup>20</sup> and the assessment of the impact on public mental health policy of the Clinical Antipsychotic Trials of Intervention Effectiveness.<sup>21</sup> KEEs for 2013 were obtained from Annual Survey of School System Finances from (<https://www.census.gov/govs/school/>) the US Census Bureau.<sup>22</sup> The school expenditure data provided by the US Census Bureau was used by a study that assessed the impact of an ageing population on public education spending<sup>23</sup> and another to estimate input elasticity coefficients that allows for differences over time and across states.<sup>24</sup>

Urbanicity is the percentage of population living in urban areas in each state according to US census in 2010. Urbanicity 2010 data were obtained by querying the US census 2010 data through <http://www.socialexplorer.com>.<sup>25</sup> Gun ownership rates during 2013 were obtained from the social gun culture study.<sup>17</sup> Gun ownership rates varied across states from 5.2% in Delaware to 61.7% in Alaska.

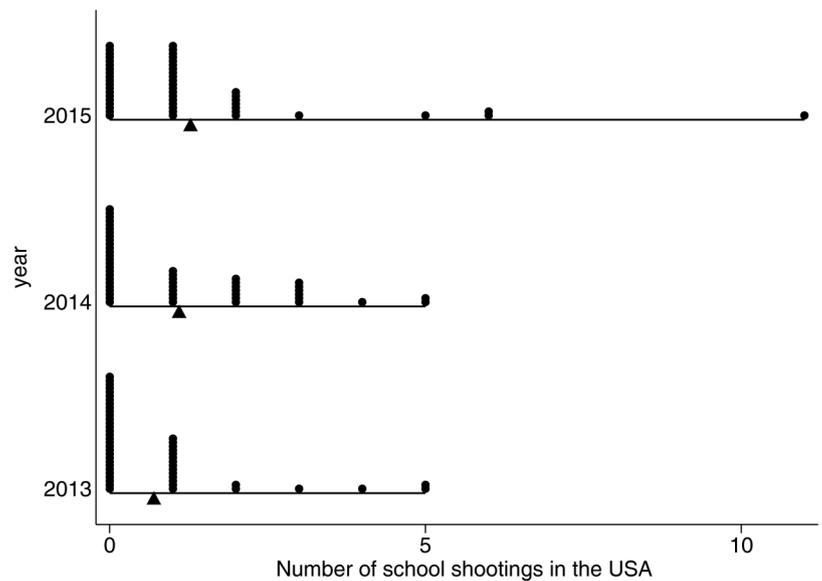
### Statistical analysis

The descriptive characteristics of school shooting incidents are presented as frequency and percentages, median (minimum and maximum) and mean and SD. The count data were arranged state-specific and by year, consisting of 154 records. In 2013, 2014 and 2015 respectively, 20, 25 and 31 out of 50 states had school shooting events and the variance was greater than the mean count of school shooting incidents. Therefore, we assessed the fit of negative binomial regression models (NBRM) and zero-inflated negative binomial model (ZINB).<sup>26</sup>

We performed crude or unadjusted regression between counts of school shooting incidents and BC firearm purchase law using both NBRM and ZINB. The fit of the model was assessed first visually after plotting the predicted residuals from both models by the count of school shooting events and then by head-to-head comparisons using Akaike's Information Criterion, Bayesian Information Criterion and Vuong test. The fit of the models was tested using McFadden's adjusted  $R^2$ , the maximum likelihood  $R^2$  and Cragg-Uhler (Nagelkerke)  $R^2$ .<sup>27 28</sup>

Both visual and comparison tests demonstrated a preference of NBRM over ZINB. Therefore, we used NBRM with log of the population as an offset and cluster by state to calculate IRRs and 95% CIs.<sup>29 30</sup> KEE and MHE were log transformed before entering into the model due to skewed distribution. STATA 14.1 (STATA, College Station, Texas, USA) was used to manage the data, to conduct the analyses and to calculate SEs, variances, and 95% CI for incidence rates and IRR. MHE and KEE were categorised into four categories based on quartiles to calculate estimates and 95% CI. A sensitivity analysis to assess association between BC laws, MHE, KEE, urbanicity, gun ownership rates and school shootings using incidents without dead victims (other than the shooter) was performed to assess a possible

**Figure 1** School shootings in each year between 2013 and 2015. Each dot represents one incident of school shooting. The fulcrum represents the median.



selection bias in reporting of fatal school shootings; the media may be more primed to report on incidents with dead victims.

## RESULTS

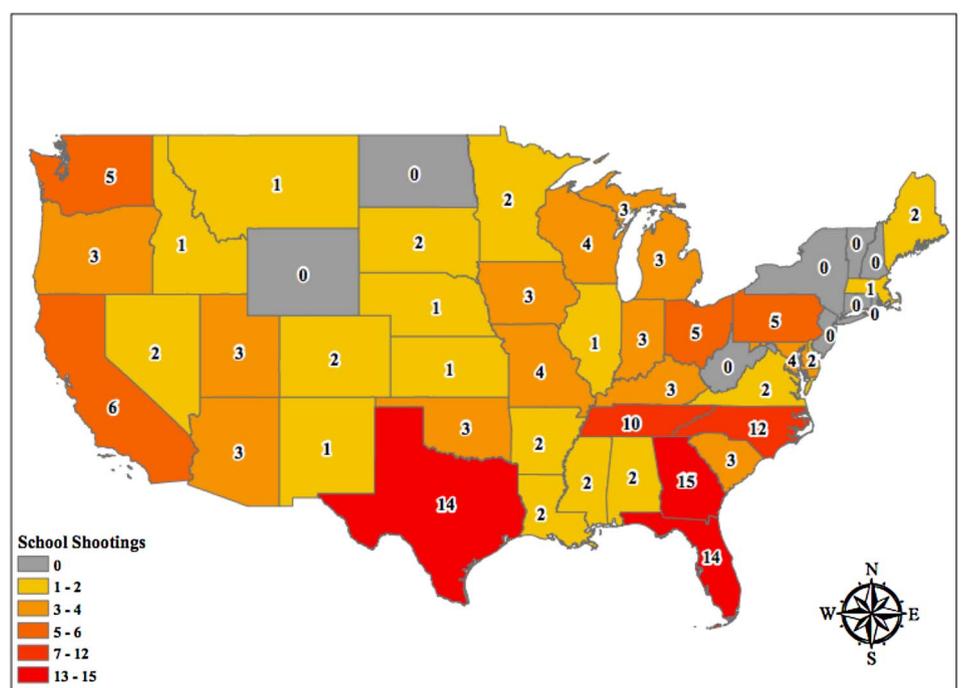
There were 154 incidents of school shootings during the 3-year study period. The events increased from 35 to 55 to 64 in 2013, 2014 and 2015, respectively (figure 1). School shootings in each state during the 3-year period are shown in figure 2. In each of these years, 20, 25 and 31 states experienced these school shootings. During the 3-year period, 39 states had at least one school shooting, while 11 states did not have any. The majority of states (34) had <10 incidents during this time period while Florida, Georgia, North Carolina, Tennessee and Texas had 14, 15, 12, 10 and 14 incidents, respectively. Alaska, Connecticut, Hawaii, New Hampshire, New Jersey, New York,

North Dakota, Rhode Island, Vermont, West Virginia and Wyoming did not have any school shootings.

School shootings in each state during the 3-year period are shown in figure 2. Out of the 154 incidents, a gun was discharged in all incidents while there were dead victims (excluding the shooter) in 45 incidents and non-fatal injuries in 109. Total numbers of school shooting incidents, shooters who were dead, victims who were killed and non-fatally injured victims by state are presented in table 1.

School, shooter and victim characteristics of the school shooting incidents during 2013–2015 are described in table 2. Most of the events (54.6%) occurred in K-12 schools and in metro areas (75.9%) and were intentional shootings (66.2%) perpetrated by boys (99.3%). Detailed information regarding the shooter could not be extracted from news articles in a large number of events; age of shooter was missing in 76 out of 154

**Figure 2** Incidents of school shootings between 2013 and 2015.



**Table 1** Incidents of school shootings from 1 January 2013 to 31 December 2015

State	Incidents	Dead, shooter	Dead victims	Non-fatally injured victims
Alabama	2	0	0	2
Alaska	0	0	0	0
Arizona	3	1	1	3
Arkansas	2	0	0	3
California	6	1	7	12
Colorado	2	2	1	2
Connecticut	0	0	0	0
Delaware	2	0	0	3
Florida	14	4	3	12
Georgia	15	0	3	8
Hawaii	0	0	0	0
Idaho	1	0	0	0
Illinois	1	0	1	0
Indiana	3	1	2	1
Iowa	3	1	0	2
Kansas	1	0	1	0
Kentucky	3	0	3	3
Louisiana	2	0	0	4
Maine	2	2	0	0
Maryland	4	0	0	3
Massachusetts	1	0	0	0
Michigan	3	1	1	7
Minnesota	2	2	0	0
Mississippi	2	1	2	2
Missouri	4	0	2	1
Montana	1	0	0	0
Nebraska	1	0	0	0
Nevada	2	1	1	0
New Hampshire	0	0	0	0
New Jersey	0	0	0	0
New Mexico	1	0	0	2
New York	0	0	0	0
North Carolina	12	0	2	9
North Dakota	0	0	0	0
Ohio	5	1	1	1
Oklahoma	3	1	0	0
Oregon	3	3	11	8
Pennsylvania	5	0	1	4
Rhode Island	0	0	0	0
South Carolina	3	1	2	0
South Dakota	2	1	0	1
Tennessee	10	0	2	9
Texas	14	3	3	9
Utah	3	0	0	9
Vermont	0	0	0	0
Virginia	2	0	2	3
Washington	5	1	5	6
West Virginia	0	0	0	0
Wisconsin	4	0	0	5
Wyoming	0	0	0	0

All values are counts. States not included in this list did not have any instances of school shootings as defined by a discharged firearm on a school campus during the years of 2013, 2014 and 2015. Those states without a school shooting are: Alaska, Connecticut, Hawaii, New Hampshire, New Jersey, New York, North Dakota, Rhode Island, Vermont, West Virginia and Wyoming.

events and whether the shooter was either a student, employee or not affiliated with school was missing in 44 events. The shooter was known to be a student in 35.7% of all events and

was reported to be dead among 28 (18.2%). Among the 57 who were fatally injured, 33 (59%) were students of the school and out of the 128 who were non-fatally injured, 88 were students wounded by a firearm.

The incidence rate of school shooting in each year from 2013 to 2015 was 1.11, 1.73 and 1.99 per 10 million populations. In an unadjusted analysis, state-level characteristics of BC for firearm purchase (IRR=0.55, 95% CI 0.39 to 0.76,  $p<0.0001$ ), BC for ammunition purchase (IRR=0.11, 95% CI 0.05 to 0.27,  $p<0.0001$ ), log per capita MHE (IRR=0.58, 95% CI 0.37 to 0.90,  $p=0.016$ ), KEE (IRR=0.09, 95% CI=0.02 to 0.29,  $p<0.0001$ ) and urbanicity (IRR=0.97, 95% CI=0.96 to 0.99,  $p=0.002$ ) were found to be significantly associated with school shooting (table 3). The association between categories of MHE and KEE and school shooting is in online supplementary table 3. After excluding school shooting incidents with no reported mortality, the estimates were similar but the strength of evidence was found to decrease in all covariates.

## DISCUSSION

We summarised characteristics of school shooting incidents from 2013 to 2015 in the USA using media reports. Three important findings emerge. First, we found an increasing incidence of school shooting episodes over time with more than half occurring in K-12 schools. Second, the majority of the school shootings were intentional shootings committed by male perpetrators. Third, we found that states with BC laws for firearm and ammunition purchase, higher capita MHE and KEE, and higher per cent urban population had lower school shooting incidence rates.

During the 3-year period there was on average one episode of school shooting per week. The increasing incidence of school shooting episodes we observe in our study builds on an earlier study that assessed school shooting incidents internationally and in the USA between 1966 and 2008, which found a robust trend towards an increasing number of episodes over time, about one episode every 10 years.<sup>1</sup> However, we documented an increase where there were 154 episodes in a 3-year span as compared with 44 incidents from 1966 to 2008 in the USA. This spike in school shooting may be explained by the theory of contagion; evidence has shown that mass killings involving firearms are motivated by similar events in the immediate past.<sup>31</sup> To our knowledge, there has been no formal documentation of the spatial or temporal spread of school shooting episodes after Sandy Hook Elementary shooting. We provide the most exhaustive description of the characteristics of episodes since that time from media reports. Additionally, we also found that more than half of these episodes occur in K-12 schools and most of them were intentional shooting.

The majority of the school shootings in our study were intentional shootings that were almost all committed by male perpetrators. Perpetrators were also male in such similar episodes in other parts of the world.<sup>1 32</sup> Similar mass shooting episodes in the USA also shared the similar gender of the perpetrators.<sup>33</sup> It is also important to note that such episodes nearly always led to multiple deaths and an even larger number of non-fatally injured victims. Many studies have elucidated the lasting consequences of such acute trauma to the students.<sup>34-36</sup> The traumatic and other mental health effects of these episodes extend to families of the students, school staff and the community as a whole, where the exact effects are very difficult to quantify.

We found a negative association between state-level, BC laws, MHE, KEE and urbanicity for firearm and ammunition purchase and school shooting incidence rates. Other studies have

**Table 2** Descriptive characteristics of school shooting incidents from 2013 to 2015 in the USA

Characteristics	n	Per cent
N	154	
Year of incident		
2013	35	22.7
2014	55	35.7
2015	64	41.6
School type		
K-12	84	54.6
College	70	45.4
School location		
Large central metro	49	31.8
Large fringe metro	28	18.2
Medium metro	40	25.9
Micropolitan (non-metro)	13	8.4
Non-core (non-metro)	4	2.6
Number of fatally injured persons, excluding shooter		
Total	57	
Median (min-max)	0	0-10
Mean (SD)	0.4	1.0
Number of fatally injured students, excluding shooter		
Total	33	
Median (min-max)	0	0-8
Mean (SD)	0.2	0.8
Number of non-fatally injured students by gun		
Total	88	
Median (min-max)	0	0-7
Mean (SD)	0.6	1.1
Number of non-fatally injured students by other means		
Total	7	
Median (min-max)	0	0-2
Mean (SD)	0.1	0.3
Number of non-fatally injured non-students by gun		
Total	28	
Median (min-max)	0	0-3
Mean (SD)	0.2	0.5
Number of non-fatally injured non-students by other means		
Total	5	
Median (min-max)	0	0-3
Mean (SD)	0.03	0.3
Intentional discharge of gun (excludes suicides, misfires, incidental discharges, or warning shots; includes shooting at others)		
No	52	33.8
Yes	102	66.2
Shooter and/or victims were inside a building when injured or firing		
No	101	65.6
Yes	53	34.4
Gender of shooter		
Male	149	99.3
Female	2	1.3
Male and female (two shooters)	1	1.3
Unknown	2	0.6
Age of shooter		
11-19 years	36	23.4
≥20 years	42	27.3
Missing information	76	49.4
Shooter status at school		
Student	55	35.7
Employee	5	3.3

Continued

**Table 2** Continued

Characteristics	n	Per cent
Other	55	35.7
Missing information	44	28.6
Shooter was reported to be dead after the shooting		
No	126	81.8
Yes	28	18.2

found BC laws negatively associated with firearm deaths. A recent meta-analysis and a cross-sectional study reported that restrictive firearm laws such as BC laws were associated with lower firearm mortality.<sup>2 37</sup> The negative association between per capita MHE and incidence of school shooting may suggest that state expenditures on mental health are associated with screening that anticipates potential firearm-related harm to self and others. Additionally, there are no reliable contemporary data on expenditures for screening of mental health versus expenditures for treatment. However, this finding contrasts suggestion by many authors<sup>38</sup> that mental health is, at best, a limited driver of firearm-related injury and as such needs to be interpreted cautiously in light of our study's limitations, noted below, and seen as preliminary.

The reduced risk in school shooting associated with KEE is in line with the studies that have found that increased education spending associated with reduced crime and violence.<sup>13 39</sup> The likelihood of lower school shootings in states with higher per cent urban population may relate to the higher density of gun availability in rural areas compared with urban areas<sup>40</sup> as well as recent data showing that a gun culture, predominant in rural areas, increases access to guns for younger age Americans than does the comparable culture in urban areas.<sup>40 41</sup> The negative association between school shootings and MHE and KEE could be a function of state-level differences in political funding priorities and/or budgets, reflecting larger political, cultural and socioeconomic factors.

Within the limitations of these data, especially the scarcity and infrequency of school shooting events,<sup>42</sup> as well as the challenges in assessing the state-level factors<sup>17</sup> and multiple policies implemented differentially in different states,<sup>2</sup> we explored unadjusted associations between state-level social factors and BC for firearm and ammunition purchase. There are five main limitations of this work. First, we used exclusively media reports to collect data on school shootings, due to non-availability of a surveillance system. Although the dramatic nature of school shootings suggests more accurate reporting of school shootings than might be true for other events, we also found that details listed in media reports vary greatly. We found that media reporting often is incomplete or inconsistent, particularly when these incidents do not result in dead victims. Second we had no capacity to identify mental health status of perpetrators in the school shootings considered, allowing us no opportunity for individual level inference beyond the ecological analyses conducted. Third, all modelling exercises must be interpreted with caution, especially considering low event rates, subject to well established limitations<sup>29 30</sup> both of model form and of variable inclusion. Fourth, it is also likely that shooting incidents where no fatalities or injuries occurred may be more likely to go unreported by news agencies, resulting in underestimation of the prevalence and the estimates. Fifth, to our knowledge there are no studies that have validated the mental health and education data used in

**Table 3** Association between state gun laws, state mental health expenditure and school shooting incidents

		Crude IRR (95% CI)	p Value
Incidence rates by year, n (per 10 million population)			
2013	35 (1.11)		
2014	55 (1.73)		
2015	64 (1.99)		
Background checks for firearm purchase		0.55 (0.39 to 0.76)	<0.0001
Background checks for ammunition purchase		0.11 (0.05 to 0.27)	<0.0001
Urbanicity (% of population in urban areas), 2010		0.97 (0.96 to 0.99)	0.002
Log of mental health per capita expenditure in \$, 2013		0.58 (0.37 to 0.90)	0.016
Log of per capita expenditure on K-12 education, 2013		0.09 (0.02 to 0.29)	<0.0001
Gun ownership rates, 2013		1.02 (1.00 to 1.05)	0.051

Crude IRRs and 95% CIs for each covariate were derived from separate negative binomial regression models with log of population as an offset, cluster on state, and adjusted for year as a linear term. Background check for firearm purchase and ammunition purchase was obtained for 2013, 2014 and 2014.

our study. In the absence of more comprehensive national firearm data sets, this analysis is anchored in the best available data, but the small sample size of these events do not allow estimation of independent effects and as such, should be interpreted with caution.

In conclusion, our results indicate increasing school shooting events from 2013 to 2015. These incidents resulted in death and injuries to students and may be associated with existing gun laws and other state-level factors. A national surveillance registry of mass shootings and school shootings with retrospective and prospective information should be a priority to better inform studies that consider the drivers and consequences of school shootings.

#### What is already known on the subject?

- ▶ School shooting incidents in the USA are a major public health concern.
- ▶ High incidence of school shooting contributes to the burden of firearm-related injury.

#### What this study adds?

- ▶ There is an increasing incidence of school shooting episodes over the 3 years.
- ▶ The majority of the school shootings were intentional shootings committed by male perpetrators.
- ▶ States with background check laws for firearm and ammunition purchase, more capita mental health expenditure and K-12 education expenditure, and higher per cent urban population had lower school shooting incidence rates.

**Twitter** Follow Bindu Kalesan at @MadisonsIntent

**Acknowledgements** The authors thank Ted Alcorn, Research Director and Courtney Zale of Everytown (<https://everytownresearch.org/>) for providing the data on gun laws.

**Contributors** MV, BK and SG conceived the study. Data were obtained by MV and KL. Data analysis was performed by BK and EP. All authors wrote and finalised the manuscript.

**Competing interests** None declared.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data sharing statement** All data are available publicly as aggregate estimates.

#### REFERENCES

- 1 Preti A. School shooting as a culturally enforced way of expressing suicidal hostile intentions. *J Am Acad Psychiatry Law* 2008;36:544–50.
- 2 Kalesan B, Mobily ME, Keiser O, et al. Firearm legislation and firearm mortality in the USA: a cross-sectional, state-level study. *Lancet* 2016;387:1847–55.
- 3 Brent DA, Miller MJ, Loeber R, et al. Ending the silence on gun violence. *J Am Acad Child Adolesc Psychiatry* 2013;52:333–8.
- 4 Price JH, Mrdjenovich AJ, Dake JA. Prevalence of state firearm mortality and mental health care resources. *J Community Health* 2009;34:383–91.
- 5 Stuart H. Violence and mental illness: an overview. *World Psychiatry* 2003;2:121–4.
- 6 Lowe SR, Galea S. The mental health consequences of mass shootings. *Trauma Violence Abuse* 2015. p1–21
- 7 Dutton DG, White KR, Fogarty D. Paranoid thinking in mass shooters. *Aggress Violent Behav* 2013;18:548–53.
- 8 Hiroeh U, Appleby L, Mortensen PB, et al. Death by homicide, suicide, and other unnatural causes in people with mental illness: a population-based study. *Lancet* 2001;358:2110–12.
- 9 Hughes K, Bellis MA, Jones L, et al. Prevalence and risk of violence against adults with disabilities: a systematic review and meta-analysis of observational studies. *Lancet* 2012;379:1621–9.
- 10 Springer M. *Performance incentives: their growing impact on American K-12 education*. Washington DC: Brookings Institution Press, 2015.
- 11 Kyle S. *Children's budget 2015*. Washington DC: First Focus, 2015. <https://firstfocus.org/resources/report/childrens-budget-2015/> (accessed 22 May 2016).
- 12 Poterba JM. *Demographic structure and the political economy of public education*. Cambridge, MA: National Bureau of Economic Research, 1996.
- 13 DeVoe JF, Katharin P, Kaufman P, et al. *Indicators of School Crime and Safety: 2004 (NCES 2005-002/NCJ 205290)*. U.S. Departments of Education and Justice. Washington DC: U.S. Government Printing Office, U.S. Department of Justice, Office of Justice Programs, 2004. <http://nces.ed.gov/> or <http://www.ojp.usdoj.gov/bjs> (accessed 22 May 2016).
- 14 Campbell C, Schwarz DF. Prevalence and impact of exposure to interpersonal violence among suburban and urban middle school students. *Pediatrics* 1996;98:396–402.
- 15 Perkins C, Scannell B, Brighton B, et al. Orthopaedic firearm injuries in children and adolescents: An eight-year experience at a major urban trauma center. *Injury* 2016;47:173–7.
- 16 Bushman BJ, Newman K, Calvert SL, et al. Youth violence: what we know and what we need to know. *Am Psychol* 2016;71:17–39.
- 17 Kalesan B, Villarreal MD, Keyes KM, et al. Gun ownership and social gun culture. *Inj Prev* 2016;22:216–20.
- 18 Barry CL, McGinty EE, Vernick JS, et al. Two years after Newtown—public opinion on gun policy revisited. *Prev Med* 2015;79:55–8.
- 19 *State Mental Health Agency Revenues and Expenditures: 2013*. Falls Church, VA: National Association of State Mental Health Program Directors (NRI). <http://www.nri-incdata.org/RevExp2013/T13.pdf> (accessed 4 Apr 2016).
- 20 Lutterman TC, Mazade NA, Wurster CR, et al. Expenditures and revenues of state mental health agencies, 1981–1985. *Hosp Community Psychiatry* 1988;39:758–62.
- 21 Parks JJ, Radke AQ, Tandon R. Impact of the CATIE findings on state mental health policy. *Psychiatr Serv* 2008;59:534–6.
- 22 *Annual Survey of School System Finances: Table 1. Summary of Public Elementary-Secondary School System Finances by State: Fiscal Year 2013*. U.S.

- Census Bureau, Economic Reimbursable Surveys Division, 2013. <https://www.census.gov/govs/school/> (accessed 4 Apr 2016).
- 23 Harris AR, Evans WN, Schwab RM. Education spending in an aging America. *J Public Econ* 2001;81:449–72.
- 24 Garcia-Milà T, McGuire TJ. The contribution of publicly provided inputs to states' economies. *Reg Sci Urban Econ* 1992;22:229–41.
- 25 U.S. Census Bureau. Population Density, 2010. Prepared by Social Explorer.
- 26 Long JS, Freese J. *Countfit: command to choose models when modeling a count variable*. UCLA: Statistical Consulting Group, 2013.
- 27 Long JS. *Regression models for categorical and limited dependent variables*. SAGE Publications, 1997.
- 28 Long JS, Freese J. *Regression models for categorical dependent variables using Stata*. 3rd edn. College Station, TX: Stata Press, 2014.
- 29 Long JS, Freese J. *Regression models for categorical dependent variables using Stata*. 2nd edn. College Station, TX: Stata Press, 2006.
- 30 Cameron AC, Trivedi PK. *Microeconometrics using Stata*. College Station, TX: Stata Press, 1998.
- 31 Towers S, Gomez-Lievano A, Khan M, et al. Contagion in mass killings and school shootings. *PLoS ONE* 2015;10:e0117259.
- 32 Verlinden S, Hersen M, Thomas J. Risk factors in school shootings. *Clin Psychol Rev* 2000;20:3–56.
- 33 Oliffe JL, Han CS, Drummond M, et al. Men, masculinities, and murder-suicide. *Am J Mens Health* 2015;9:473–85.
- 34 Turunen T, Haravuori H, Pihlajamäki JJ, et al. Framework of the outreach after a school shooting and the students perceptions of the provided support. *Eur J Psychotraumatol* 2014;5. p16–469
- 35 Schwarz ED, Kowalski JM. Personality characteristics and posttraumatic stress symptoms after a school shooting. *J Nerv Ment Dis* 1992;180:735–7.
- 36 Schwarz ED, Kowalski JM. Malignant memories: PTSD in children and adults after a school shooting. *J Am Acad Child Adolesc Psychiatry* 1991;30:936–44.
- 37 Santaella-Tenorio J, Cerdá M, Villaveces A, et al. What do we know about the association between firearm legislation and firearm-related injuries? *Epidemiol Rev* 2016;38:140–57.
- 38 Glied S, Frank RG. Mental illness and violence: lessons from the evidence. *Am J Public Health* 2014;104:e5–6.
- 39 Lochner L. *Non-production benefits of education: crime, health, and good citizenship*. National Bureau of Economic Research, 2011.
- 40 Kim N, Mickelson JB, Brenner BE, et al. Altitude, gun ownership, rural areas and suicide. *Am J Psychiatry* 2011;168:48–54.
- 41 Singh GK, Siahpush M. Increasing rural-urban gradients in US suicide mortality, 1970–1997. *Am J Public Health* 2002;92:1161–7.
- 42 Harding DJ, Fox C, Mehta JD. Studying rare events through qualitative case studies: lessons from a study of rampage school shootings. *Sociol Methods Res* 2002;31:174–217.



## School shootings during 2013–2015 in the USA

Bindu Kalesan, Kinan Lagast, Marcos Villarreal, Elizabeth Pino, Jeffrey Fagan and Sandro Galea

*Inj Prev* published online December 6, 2016

---

Updated information and services can be found at:

<http://injuryprevention.bmj.com/content/early/2016/11/11/injuryprev-2016-042162>

---

*These include:*

### Supplementary Material

Supplementary material can be found at:

<http://injuryprevention.bmj.com/content/suppl/2016/12/06/injuryprev-2016-042162.DC1>

### References

This article cites 28 articles, 3 of which you can access for free at:

<http://injuryprevention.bmj.com/content/early/2016/11/11/injuryprev-2016-042162#BIBL>

### Email alerting service

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

---

### Topic Collections

Articles on similar topics can be found in the following collections

[Press releases](#) (38)

---

### Notes

---

To request permissions go to:

<http://group.bmj.com/group/rights-licensing/permissions>

To order reprints go to:

<http://journals.bmj.com/cgi/reprintform>

To subscribe to BMJ go to:

<http://group.bmj.com/subscribe/>