



ELSEVIER

 JOURNAL OF
 ADOLESCENT
 HEALTH

www.jahonline.org

Adolescent health brief

A Descriptive Analysis of School and School Shooter Characteristics and the Severity of School Shootings in the United States, 1999–2018

Melvin D. Livingston, Ph.D.^{a,*}, Matthew E. Rossheim, Ph.D.^b, and Kelli Stidham Hall, Ph.D.^a^a Department of Behavioral Sciences and Health Education, Rollins School of Public Health, Emory University, Atlanta, Georgia^b Department of Global and Community Health, College of Health and Human Services, George Mason University, Fairfax, Virginia

Article history: Received September 26, 2018; Accepted December 4, 2018

Keywords: School shootings; Violence; Firearms

 See Related Editorial on p. 683

A B S T R A C T

Purpose: The aim of the study was to determine whether characteristics related to the school, shooter, and guns used are associated with school shooting severity (casualty rates, fatality rates, and likelihood of fatality).

Methods: We analyzed associations between individual-, school-, gun-level factors and school shooting severity in the United States from April 1999 through May 2018.

Results: Handguns were used in most school shootings (81%); however, substantially, more fatalities occurred when rifles (relative risk [RR] = 14.74, 95% confidence interval [CI] [5.00, 43.41]) or shotguns (RR = 8.84, 95% CI [2.20, 35.54]) were used. Fatal shootings were more likely to happen in schools that were majority white, taught younger students, and were rural or suburban. When shooters were aged ≥ 20 years, shootings were more likely to be fatal (RR = 2.44, 95% CI [1.18, 5.07]), have more casualties (RR = 5.15, 95% CI [2.06, 12.90]), and more deaths (RR = 20.13, 95% CI [4.86, 83.28]). No significant differences were observed based on the presence of resource officers.

Conclusions: More severe shootings were associated with shooters who were older and therefore unlikely to be students, whereas the presence of a school resource officer was unassociated with any reduction in school shooting severity. Importantly, the type of gun used was strongly associated with casualties and fatalities. Study findings suggest a need for prevention efforts beyond those commonly used in schools, as well as the need for improved laws.

© 2018 Society for Adolescent Health and Medicine. All rights reserved.

IMPLICATIONS AND CONTRIBUTION

An analysis of the association between school-, shooter-, and gun-level characteristics and the severity of school shootings using recently released data from the Washington Post demonstrates the need for further research to establish evidence-based solutions to the ongoing school shooting crisis.

Firearm fatality is a major public health problem in the United States. According to the Centers for Disease Control and Prevention, in the United States, there were more than 38,000 deaths from firearms in 2016 [1]. Shootings in school settings

have brought substantial media and public attention to this urgent issue. Although school shootings have been characterized as “extremely rare” [2], increased frequency in recent years is resulting in both injuries and fatalities [3,4] as well as trauma [5,6] among U.S. children and adolescents. Research has yet to examine associations between characteristics of schools, shooters, or guns used in these school shootings and injury and fatality outcomes. A better understanding of the epidemiology of school shootings is needed to inform multilevel prevention

Conflicts of interest: The authors have no conflicts of interest to disclose.

* Address correspondence to: Melvin D. Livingston, Ph.D., Department of Behavioral Sciences and Health Education, Rollins School of Public Health, Emory University, 1518 Clifton Road NE, Grace Crum Rollins Building, Room 556, Atlanta, GA 30322.

E-mail address: melvin.livingston@emory.edu (M.D. Livingston).

efforts aimed at reducing the severity of school shooting–related morbidity and mortality in the United States.

Methods

To estimate the association between school/shooters/gun characteristics and school shooting severity, we used recently published data from the Washington Post (WP) [7]. Unlike other sources of school shooting data, the WP's database contains shootings that occurred during or immediately before or after the school day when children were at risk. Shootings were classified based on a review of news articles, police reports, and calls to schools and police departments [7]. We restricted our sample to 179 shootings intended to injure or kill others. We defined three measures of shooting severity: presence of a fatality, the casualty rate (injury or fatality), and the fatality rate. Available shooter characteristics included age and number of shooters. Gun characteristics included the types and number of guns used. School characteristics included urbanicity, presence of a resource officer, grades taught, percent eligible for free or reduced-price lunch, and percent white. We categorized age of the shooter as “under age 15 years,” “ages 15–19 years,” and “ages 20 years and over” to differentiate non–school-age shooters and older school-age shooters from younger shooters. Type of gun was recoded as handgun, rifle, or shotgun. This study was deemed exempt from institutional review board review by Emory University.

Using Poisson regression with robust standard errors, we estimated unadjusted risk ratios between whether a fatality occurred and the school, shooter, and gun characteristics. Using negative binomial regression with logged school enrollment as the offset, we estimated unadjusted rate ratios between the rate of casualties and fatalities with school, shooter, and gun characteristics. All models were estimated using PROC GENMOD in SAS v9.4 (SAS Institute Inc., Cary, NC).

Results

Of targeted or indiscriminate school shooting incidents between April 1999 and May 2018 ($n = 179$), there were on average .7 deaths per shooting (range 0–26). Total casualties averaged two per incident (range 0–34; Table 1).

Fatalities were less likely to occur at middle (relative risk [RR] = .49, 95% confidence interval [CI] [.26, .91]) and high school (RR = .40, 95% CI [.25, .65]) shootings. Fatalities were more likely to occur at schools that were majority white (RR = 1.85, 95% CI [1.19, 2.88]). Shootings with higher casualty rates tended to occur at rural (RR = 3.74, 95% CI [1.82, 7.67]) and suburban (RR = 2.70, 95% CI [1.57, 4.63]) schools and schools that were majority white (RR = 3.07, 95% CI [2.83, 5.15]). Lower casualty rates were observed at high schools (RR = .27, 95% CI [.11, .67]) and schools where most students were eligible for free or reduced-price lunch (RR = .42, 95% CI [.25, .70]). Similar patterns were observed for the rate of fatalities. No differences were seen in the severity of school shootings—by any measure—based on the presence of a resource officer. When the shooter was older than 20 years, shootings were more likely to be fatal (RR = 2.44, 95% CI [1.18, 5.07]), have a higher rate of casualties (RR = 5.15, 95% CI [2.06, 12.90]), and a higher rate of deaths (RR = 20.13, 95% CI [4.86, 83.28]). A similar pattern was seen when the use of more than one firearm was reported. The type of gun was unassociated with the likelihood of a fatality

Table 1

School shooting analysis sample summary statistics

Characteristic	Total shootings (N = 179) ^{a,b}
Number of casualties, mean (SD)	1.99 (4.6)
Number of fatalities, mean (SD)	.7 (2.6)
Fatal shootings, n (%)	54 (30.2)
Urbanicity, n (%)	
Rural	22 (12.4)
Suburb	51 (28.7)
Town	21 (11.8)
City	84 (47.19)
Resource officer, N (%)	66 (36.9)
Highest grade at school, N (%)	
Up to 5th grade	12 (6.8)
6th to 8th grade	34 (19.2)
9th to 12th grade	131 (74.0)
Majority of students are eligible for free or reduced-price lunch, n (%)	86 (48.0)
Majority of students are white, n (%)	69 (38.6)
Age of the shooter (y), n (%)	
≤15	31 (21.4)
15–19	85 (58.6)
≥20	29 (20.0)
Two or more involved shooters, n (%)	5 (3.5)
Handgun used, n (%)	120 (81.1)
Rifle used, n (%)	21 (14.2)
Shotgun used, n (%)	18 (12.2)

SD = standard deviation.

^a Discrepancies in Ns are due to missing data. In particular, the age and number of shooters was missing for 34 of the shootings, and the type of gun used was missing for 31 of the shootings.

^b Sample does not include accidental shootings ($n = 26$), suicide and suicide attempts ($n = 7$), and those that could not be clearly classified ($n = 7$).

occurring. Rifles were associated with both higher casualty (RR = 9.73, 95% CI [4.68, 20.21]) and fatality rates (RR = 14.74, 95% CI [5.00, 43.41]). Similar patterns were seen for shotguns. There were no differences in the severity of school shootings based on the number of shooters present (Table 2).

Discussion

To our knowledge, these findings represent the first description of the association between school-, shooter-, and gun-level factors and the severity of school shootings. Although overall firearm homicide risk is concentrated in urban areas and predominantly impacts black men [8], we found that the most severe school shootings occurred in rural and suburban schools, schools that were majority white, and schools with comparably low poverty. Hiring school resource officers has been a primary response to school shootings by a large number of schools despite the large financial cost and limited evidence of effectiveness [9]. We found no evidence that the presence of resource officers in schools lessened the severity of school shooting incidents. Measures beyond the employment of school resource officers are likely needed for mitigating mass casualty shootings. We also found that the most severe school shootings occurred when the shooters were aged 20 years or older. These shooters are unlikely to be students, indicating that school-based initiatives targeted toward students may not be sufficient to prevent the highest casualty school shootings. Although rifles or shotguns were used in <15% of shootings, their use was strongly associated with increased casualty and fatality rates. This finding suggests that these types of firearms may facilitate shooters' ability to cause more casualties during a single event. However, our data

Table 2

Association of school, shooter, and gun characteristics with the severity of school shootings

	Did a fatality occur?	Number of casualties	Number of fatalities
	RR (95% CI)	RR (95% CI)	RR (95% CI)
Urbanicity			
Rural versus city	1.56 (.93, 2.64)	3.74 (1.82, 7.67)	5.72 (1.72, 18.97)
Suburb versus city	1.20 (.55, 2.61)	2.70 (1.57, 4.63)	5.88 (2.43, 14.21)
Town versus city	1.53 (.78, 2.99)	1.57 (.73, 3.34)	2.09 (.60, 7.26)
Resource officer			
Yes versus no	1.18 (.75, 1.85)	.75 (.44, 1.26)	.51 (.21, 1.22)
Highest grade at school			
6th to 8th grade versus up to 5th grade	.49 (.26, .91)	.73 (.24, 2.18)	.36 (.07, 1.97)
9th to 12th grade versus up to 5th grade	.40 (.25, .65)	.27 (.11, .67)	.08 (.02, .31)
Majority eligible for free or reduced-price lunch			
Yes versus no	.69 (.43, 1.09)	.42 (.25, .70)	.23 (.10, .55)
Majority white school			
Yes versus no	1.85 (1.19, 2.88)	3.07 (2.83, 5.15)	6.05 (2.60, 14.05)
Age of the shooter (y)			
15–19 versus <15	1.25 (.60, 2.61)	1.36 (.66, 2.81)	2.21 (.66, 7.39)
20 or older versus <15	2.44 (1.18, 5.07)	5.15 (2.06, 12.90)	20.13 (4.86, 83.28)
Number of shooters			
Two or more versus one	1.91 (.90, 4.07)	1.50 (.38, 5.89)	1.50 (.16, 14.38)
Was a handgun used during the shooting?			
Yes versus no	1.43 (.72, 2.84)	.51 (.26, 1.02)	.40 (.15, 1.13)
Was a rifle used during the shooting?			
Yes versus no	1.51 (.90, 2.53)	9.73 (4.68, 20.21)	14.74 (5.00, 43.41)
Was a shotgun used during the shooting?			
Yes versus no	.98 (.49, 1.98)	5.90 (2.38, 14.62)	8.84 (2.20, 35.54)
Number of firearms used			
Two or more versus one	2.52 (1.67, 3.82)	12.76 (4.98, 32.71)	18.34 (4.23, 79.63)

CI = confidence interval; RR = relative risk.

on gun type lacks important detail (e.g., magazine size, action type, and stock) needed to make policy recommendations. We urge caution in the interpretation of this finding and stress the need for detailed, accurate, and standardized data collection with regards to firearm use.

The two main study limitations are both based on the data used. First, it is unclear from the WP's documentation whether shooting incidents were coded by multiple raters, which would help in assessing the reliability of coding. Second, our analysis was limited to exploring factors associated with school shooting severity. As a result, our findings do not offer insight regarding the policies and interventions that may prevent school shootings altogether.

Our exploratory findings suggest that a multilevel approach is likely needed to prevent and reduce the burden of school shootings. More research is needed to identify risk factors and evaluate the efficacy of school shooting prevention and harm reduction approaches.

References

- [1] Xu J, Murphy SL, Kochanek KD, et al. Deaths: Final data for 2016. *Natl Vital Stat Rep* 2018;67:1–76.
- [2] Shultz JM, Cohen AM, Muschert GW, et al. Fatal school shootings and the epidemiological context of firearm mortality in the United States. *Disaster Health* 2013;1:84–101.
- [3] Gius M. The effects of state and Federal gun control laws on school shootings. *Appl Econ Lett* 2018;25:317–20.
- [4] Kalesan B, Lagast K, Villarreal M, et al. School shootings during 2013–2015 in the USA. *Inj Prev* 2017;23:321–7.
- [5] Travers Á, McDonagh T, Elklit A. Youth responses to school shootings: A review. *Curr Psychiatry Rep* 2018;20:47.
- [6] Lowe SR, Galea S. The mental health consequences of mass shootings. *Trauma Violence Abuse* 2017;18:62–82.
- [7] Data-school-shootings. Github. Available at: <https://github.com/washingtonpost/data-school-shootings>. Accessed July 23, 2018.
- [8] Wintemute GJ. The epidemiology of firearm violence in the twenty-first century United States. *Annu Rev Public Health* 2015;36:5–19.
- [9] Jonson CL. Preventing school shootings: The effectiveness of safety measures. *Vict Offenders* 2017;12:956–73.