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A Descriptive Analysis of the Characteristics of School Shootings Across Five Decades

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Abstract
Research on understanding school shootings has traditionally focused on the individual level factors surrounding several highly publicized mass shooting events such as those in Parkland, Florida and Santa Fe, Texas. However, researchers have recently begun to examine characteristics among other types of shootings on K-12 school campuses, including non-mass and non-fatal shooting incidents. Correlates such the type of firearms used, the number of firearms, the age of the perpetrator, and school level, have been shown to differentially affect the severity of a school shooting incident. The current study provides a descriptive analysis of shooter, school, and incident level characteristics as they relate to the predicting casualties and fatalities in school shooting incidents from 1970–2020. Results suggest that school and incident characteristics are significantly related to school shooting severity. We discuss the importance of broadening the understanding of school shootings to include these other types of incidents.

Keywords School shootings · Firearms · School safety · School crime

Introduction

School shootings in primary and secondary schools are statistically rare events (Harding et al., 2002). Despite their rarity, highly publicized instances of mass school shootings, such as those at Columbine High School, Sandy Hook Elementary, and Marjory Stoneman Douglas High School have fueled uncertainty and fear among students, teachers, parents, and administrators. As a consequence of these shootings, an increased focus has been placed on safeguarding American schools

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in the past two decades (Simon, 2007). However, research suggests that there is still a lack of knowledge on the causes of school shootings and how to prevent them (Rocque, 2012). One of the contributing factors in the difficulty with safeguarding schools against school shootings is that there remains no standardized definition for what constitutes a school shooting (Elsass et al., 2016; Rocque, 2012). Although rampage shootings (also known as multiple-victim shootings or mass school shootings) have received the most attention in the media and the prior literature (Burns & Crawford, 1999; Holland et al., 2019; Newman et al., 2004; Rocque, 2012), they represent only a small percentage of overall gun associated school homicides (Holland et al, 2019). Other categories of gun associated school homicides, such as gang violence and student suicide, deserve evaluation. For example, according to the Indicators of School Crime and Safety 2019 edition, physical conflicts among students are a highly reported problem and gun violence connected to these situations should not be ignored in favor of attention to rare events. Emerging research suggests that the causes of gun violence in schools is often similar to that in communities (Shultz et al., 2013), and separate strategies for schools may ignore meaningful solutions. This is exacerbated by the fact that exaggerated attention on schools as potential places for rampage shootings has led to massive funding of policies that increase school security measures while underfunding the school personnel and/or appropriate programs that could play an active role in the prevention of violence escalation with students (Cornell, 2020).

Recently, researchers have sought to identify the characteristics among other types of shootings on K-12 school campuses, including non-mass shooting cases (Fridel, 2019; Livingston et al., 2019). Research that exclusively focuses on mass school shooting incidents or juvenile offenders paints an incomplete picture of the issue of gun associated school homicides. Therefore, the current study seeks to expand the recent research done by Livingston et al. (2019) by looking at the relationship between perpetrator, incident, and school characteristics and school shooting severity in a new, expanded sample of school shootings that occurred between 1970 and 2020. The following section outlines the previous literature on school shootings and what is currently known about the perpetrators of gun violence on primary and secondary school campuses, the weapons that are used, and the characteristics of schools that are most likely to be targeted.

Review of the Literature

Overview

Research suggests that the U.S. has the highest rate of firearm deaths, suicides, and homicides over any other developed nation (Shultz et al., 2013). According to the recent report by the Centers for Disease Control and Prevention, there were more than 38,000 firearm deaths in 2016 alone (CDC). However, despite these staggering statistics, homicides on school campuses are relatively rare, with some studies estimating that the risk of death from a school shooting is less than one in one million annually (Frederique, 2020). More recent data confirms this trend, noting that

the victimization rate for single-victim school-associated youth homicide was 0.03 per 100,000 students from July 1994 to June 2016 and 0.008 per 100,000 students for multiple-victim school-associated homicide between July 1994 and June 2017 (Holland et al., 2019). Despite the actual number of school associated deaths, gun violence on K-12 school campuses remains a salient issue for criminologists due to increased public scrutiny stemming from mass school shootings, which are often highly publicized and politicized.

Despite their relative rarity in comparison to other types of gun violence on K-12 school campuses, the prior literature on school shootings has disproportionately focused on analyzing the characteristics of perpetrators in rampage style school shootings (Agnich, 2015; Kleck, 2009; Langman, 2009; Lankford, 2016). Research has shown that these types of shootings are typically perpetrated by juveniles, particularly white males from middle-class to lower-middle-class families (Gerard et al., 2016; Rocque, 2012). Alternatively, single victim firearm deaths on K-12 school campuses are much more prevalent than rampage style shootings and they can take several forms, from gang shootings to suicides. Holland et al. (2019) found that the most common motive for a shooting on school campuses was gang-related activity, followed by interpersonal disputes. This suggests that understanding all types of school shootings is critical to avoiding misspecification of the problem of gun violence on K-12 school campuses. Viewing school shootings as a single category of violence rather than several separate categories has not only has created unnecessary fear but also possibly limited prevention efforts.

School Shooter Characteristics

Despite the statistical rarity of school shooting events in general, and rampage school shootings in particular (Paradice, 2017), prior literature on school shootings has disproportionately focused on analyzing the characteristics of perpetrators of highly publicized, rampage style school shootings (also known as multiple-victim shootings or mass school shootings) (Burns & Crawford, 1999; Holland et al., 2019; Langman, 2009; Lankford, 2016; Newman et al., 2004; Rocque, 2012). The most prominent findings for rampage school shooters are their gender and race: school shooters tend to be male and white (Agnich, 2015; de Apodaca et al., 2012; Gerard et al., 2016; Harding et al., 2002; Lankford, 2016). Additionally, studies have found that these rampage school shooters are commonly characterized as having a history of depression (Gerard et al., 2016; Langman, 2009; Newman et al., 2004; Verlinden et al., 2000), may have experienced rejection, whether by their peers or due to a romantic breakup, and have poor relationships with peers (Agnich, 2015; O'Toole, 1999; Vossekuil et al., 2004; Wike & Fraser, 2009).

It is important to discuss literature on the characteristics of school shooters in light of prior research on perpetrators of gun violence. Prior literature has shown that most gun crime offenders and victims tend to be young, black males (Blumstein, 2002; Moore et al., 2013) and that gun crimes are disproportionately concentrated in low-income neighborhoods (Cheatwood & Block, 1990). This finding appears in contrast to known characteristics of rampage school shooters, but it ignores many of

the school shooting incidents that are not rampage or mass shootings. Prior research on gun violence has also revealed that there is often an established relationship between the offender and the victim prior to the incident and that gun violence is often the result of an argument or disagreement between both parties (Pizarro et al., 2011). A recent study by the CDC, which examined 431 school-associated homicides, shows that among cases where motives are known, gang-related activity and interpersonal disputes were the most common motives (Holland et al., 2019). Therefore, it is important to analyze the characteristics of other types of school shooters, which may more closely resemble general gun crime offenders.

Firearm Characteristics

In addition to individual shooter characteristics, firearm characteristics are also important predictors of the severity of school shootings. There are several factors that should be addressed when determining the link between gun characteristics and the severity of a school shooting, including the type of gun that was used and the number of guns. Prior studies have shown that handguns are the most prominent type of firearm used in the commission of a homicide (Monuteaux et al., 2015) or other types of firearm-related violence, and that homicides in which teens and young adults were the victims were more likely to be committed with a gun than homicides of people in other age groups (Cooper & Smith, 2011; Reedy & Koper, 2003). However, homicide by other types of guns (such as rifles and shotguns) appear to be trending up since a low point from 1999 (Cooper & Smith, 2011).

Research specifically looking at school shootings on K-12 campuses seem to support these trends. Livingston et al. (2019) found that handguns were used in an overwhelming majority of school shootings that occurred either immediately before or after school from 1999–2018. Agnich (2015) found similar results among 282 incidents of mass school shootings in the United States and Europe. Long guns, such as rifles or shotguns, are typically the second most common type of weapon used in these events. Livingston et al. (2019) found that rifles were associated with both higher casualty and fatality rates. It is possible that handguns are used more because of the convenience of concealment rather than their lethality (Kleck, 2009). However, Kleck (2009) also notes that in the deadliest of school shootings, mass shootings such as those at Columbine High School, Sandy Hook Elementary School, or Marjory Stoneman Douglas High School, concealment was hardly a concern for perpetrators.

Another important detail related to firearms not to be overlooked is the accessibility to weapons. Studies have shown that despite the United States having fewer than 5% of the world's population, it is home to more than 40% of the world's guns (Wintemute, 2013). Despite high rates of gun ownership, gun-related deaths in the United States occur at a rate of roughly 3.3 homicides per 100,000 (Jena et al., 2014). In the context of school shootings, the number of guns a perpetrator has access to, and which are subsequently used in a school shooting event, can impact the likelihood and severity of a school shooting (Livingston et al, 2019; Newman et al., 2004). Livingston et al (2019) found that instances in which two or more guns were used were significantly more likely to end in a fatality and produce a higher

number of fatalities and overall casualties. Agnich (2015) similarly found that mass shootings and attempted mass shootings at a school involved, on average, more than one weapon. Both findings support Kleck's (2009) assertion that multiple firearms, despite their type, will likely produce a greater number of victims.

When considered in a school shooting context, where many of the perpetrators are under the age of being able to legally purchase firearms, accessibility to firearms becomes even more important. Previous research into targeted school violence has found that the majority of juvenile school shooters, and those who are planning plots against a school, obtain their firearms from friends and family (NTAC, 2019, 2021). This often included firearms that were otherwise thought to be stored securely, in locked gun cabinets (NTAC, 2019), although in several cases of identified school shooting plots, parents had allowed unlimited firearm access to potential perpetrators (NTAC, 2021). While firearm laws in most states are designed to actively limit adolescent access, friends and family can become inadvertent sources. This is important both from the perspective of educating the school community about risks and for policy discussions around ways to limit juvenile access.

School Characteristics

Lastly, there are school-level characteristics that relate to the severity of a school shooting. One factor that has been linked to an increase in the probability of a school shooting is the size of the school. For instance, Baird et al. (2017) found that schools where rampage shootings occurred had significantly higher enrollments than their state average. Higher enrollments lead to an increased possibility for opportunity, with the potential for more motivated students. In addition, the size of the study body could negatively affect the ability of the adults in the school to be alerted to threats or otherwise become aware of troubled students. Prior research has also made connections between the protective factors that schools with lower student–teacher ratios and the positive effects that healthy school climates can have in increasing social capital and reducing violence (Cheurprakobkit & Bartsch, 2005; Fridel, 2019; Lamoreaux & Sulkowski, 2020; Na & Gottfredson, 2013).

Livingston et al. (2019) also analyzed several school related factors of school shooting incidents and found that schools that were majority white and located in rural and suburban areas tended to have higher casualty rates. Additionally, they found that even though more shootings occur on high school campuses, fatalities were higher on elementary school campuses. Similar findings were presented by Agnich (2015) who found that mass shootings were more likely to occur in high schools, particularly those in rural areas, versus elementary or middle schools. Muschert (2007) notes that in some instances, school shooters choose their target because it represents the larger community in which the school is located. This is particularly the case in mass shootings. However, even single victim homicides that occur on K-12 school campuses tend to occur more at high schools. While not specifically limited to school shootings, Holland et al. (2019) also reported that the majority of school associated single victim homicides from 1994 to 2016 occurred on a high school or combined campus (N = 285) when compared to elementary or middle schools (N = 108).

This article will explore the relationship between several important factors of school shootings using data that spans fifty years. A descriptive analysis of the shooter, the incident, and school characteristics as they relate to the risk of non-perpetrator fatalities and causalities will be explored, using data that includes shootings outside of the more commonly used rampage and mass shooting definitions.

Methods

Data Source

Data from this study come from the Naval Postgraduate School's Center for Homeland Defense and Security (CHDS) *School Shooting Database* (SSDB) (Riedman & O'Neill, 2018). The database is an ongoing, comprehensive list of instances when a firearm was brandished or fired on a K-12 school property and related properties (i.e. school buses or athletic fields) in the United States from January 5, 1970 to November 11, 2020. Information on perpetrator characteristics (e.g. demographics, number of perpetrators), school characteristics (e.g. school type), and gun characteristic (e.g. weapon type, number of weapons) was collected and aggregated for each incident in the database. The database aggregates information from a variety of publicly available primary sources, including peer-reviewed studies, government reports, mainstream media reports, advocacy groups, and private sources. In order to be included in the SSDB, cases were cross-referenced and filtered such that each case, even if appearing in more than one original source, is only included once. More information about the database is available on the CHDS website (https://www.chds.us/ssdb/about/). The database is freely available to researchers.

For the purposes of the current study, a subsample of the SSDB population was analyzed. Incidents where a gun was fired that occurred during or immediately surrounding the school day (directly before or immediately after) were included. Shootings on nights and weekends or during the summer months (when school is not in session) are not included. Drive by shootings, accidental gunfire, and shootings using a BB gun and/or air rifle type firearms were excluded. We also exclude shootings on school buses, unless the bus was on school property at the time of the attack. In addition, suicides where the shooter was the only victim and there were no witnesses were excluded. This is consistent with previous studies on the correlates of school shootings (see Livingston et al., 2019). Those suicides that took place in public part of the school with witnesses, such as in the middle of a cafeteria or classroom, were included in the database, as were incidents where the perpetrator was killed in a "suicide by cop" situation (even if others were not injured). The reason these cases were included is because of the increased risk of injury to bystanders, compared to a situation where an individual commits suicide in a private part of the school without witnesses. The final sample includes 785 shooting incidents on a K-12 school campus, including athletic fields and parking lots, in the United States between January 5, 1970 and November 25, 2020. Table 1 presents summary statistics about the incidents and the following variables.

Table 1 Sample Descriptives (N = 785)

	%/Mean (SD)	Range
Non-Perpetrator Casualties	1.75 (3.21)	0–37
Non-Perpetrator Fatalities	.51 (1.42)	0–26
Highest School Level		
Up to 6th grade	8.42%	
7th—8th grade	13.99%	
Up to 12th grade	77.59%	
Inside School	48.28%	
Age of **oldest** shooter	19.69 (9.48)	6–66
2 + shooters	6.73%	
Shooter Suicided	14.36%	
ANY adult shooter	37.17%	
ANY white shooter	43.68%	
% with handgun	75.86%	
Post Columbine (2000 +)	42.69%	

Dependent Variables

Fatalities: Fatalities are measured by the number of non-shooter fatalities per incident. On average, there were 0.51 (sd = 1.46) fatalities per incident, with a range of 0 to 26 deaths per incident. There were victim fatalities in 36.21% of shooting incidents. When shooter fatalities are included, 46.63% of incidents resulted in a fatality.

Casualties: Casualties are operationalized as the total number of people killed or injured in the shooting incident. On average, there were 1.75 (SD = 3.21) casualties per incident, with a range of 0 to 37 injuries per incident. This is consistent with the casualty measurement in Livingston et al. (2019). In addition, all data are from the time of the incident and it is possible that over time, injuries can become fatalities. In this way, we are attempting to capture the true scope of the severity of incident to individuals and communities.

Shooter Variables

Adult Status: The perpetrator was coded as 1 = adult and 0 = minor. It is important to note that shooter ages were reported in two ways in the dataset. Where available, the exact age of the shooter was known (i.e. 19). When not available, several incidents identified the shooter as "adult" or "minor." In order to preserve as many cases as possible for data analysis, any shooter who was coded as "adult" or aged 18 or older were coded as 1. In incidents with multiple shooters, the presence of any adult shooter meant that the incident was coded as 1. Where exact age was reported (n = 634), the oldest shooter ranged from 6 to 66 years old, with an average age of 19.69 (SD = 9.48).

Shooter Race: The race of at least one of the shooters was available in only a small subset of the cases (n = 276; 35.2%). As a result, we conduct separate analyses with this subsample to control for shooter race. These results are

reported separately from the full models. The incident was coded as having a White shooter if *at least one* of the shooters was identified as white (white = 1); other cases were coded as Nonwhite (non-white = 0). Of those cases with information about shooter race, 43.8% (121) identified the perpetrator as White.

Multiple Shooters: Incidents with more than one identified shooter were coded as 1 = multiple shooters and 0 = 1 shooter. The majority of incidents (93.3%) had only one identified shooter. Of those cases with multiple shooters, the next most common number of shooters was 2 (5%); there was one incident each that reported 5, 6, and 8 shooters.

Suicide: In order to better control for potential shooter motivations, especially in terms of expectations of lethality, we control for whether any of the shooters committed suicide. The incidents included here only include suicides that were public (e.g. pulling out a gun in the middle of the cafeteria) and speak to the shooter's intent to call attention to themselves and the gun. This also includes those cases that were coded in the original data as "suicide by cop." Overall, 14.36% of all shooters committed suicide. Shooter suicide is coded as 1; all other cases are coded as 0.

School Level Variables

School Level: In keeping with previous attempts to find a way to separate grade level of schools (see Livingston, et al., 2019), we divide schools by grade levels. Schools were divided based on the highest grade level of students. Because grade level distributions are left up to local districts, there is a lack of consistency around the United States in which students are served by which kinds of schools. Elementary/primary schools were all of those serving students up to the 6th grade (approximately age 12). Middle schools/junior high schools were all school serving students up to the 8th grade (approximately age 14); this could include schools that served kindergarten through 8th graders together. High schools were those that served students through the twelfth grade (approximately age 18). This could also include schools that served students in the entire grade range (kindergarten through twelfth grade), although these were rare. The majority incidents in the dataset took place in high schools (77.59%).

Inside Building: To control for the location of the shooting, incidents that started inside the building were coded as 1 (48.28%); all others were coded as 0 (51.72%). Inside the building included any space beyond the school doors, such as hallways, classrooms, auditoriums, cafeterias, and bathrooms. Incidents that were outside the building included adjacent athletic fields, parking lots, and playgrounds.

Incident Variables

Handguns: Incidents where a handgun was used were coded as 1; others were coded as 0. The majority of incidents used at least one handgun (92.63%).

Long Guns: We also include whether or not a shotgun (4.45%) or rifles (7.37%) was used in the incident. In some cases, more than one kind of weapon was used. We include a measure of whether a long gun (13.4%) was used.

Multiple Weapons: Incidents where multiple weapons were identified were coded as 1; others were coded as 0. This could include more than one of the same types of firearm or multiple types of firearms. In most incidents (95.53%), only one firearm was identified.

Post Columbine: Scholars often point to the fact that the Columbine school shooting in 1999 fundamentally changed police responses to active shooter events in high schools (Addington, 2009; Morrow et al., 2016). In addition, the Columbine shooting was a pivotal point for awareness about school shooting events. Therefore, we include a variable to control for whether the incident happened before 2000. Shootings that happened in 1999 or earlier are coded as 0; incidents that happened in 2000 or later are coded as 1. Given the long-term nature of these data, the majority of incidents were recorded before 1999 (57.31%).

Analytic Strategy

In examining the distribution of the data, we can see that not every shooting incident ends in a casualty or a fatality. Even for those that do, the amount of variation in the dependent variable is great. Given the amount of overdispersion, we employ negative binomial regression to examine the predictors of casualties and fatalities in school shooting events. We chose this method due to the extreme positive skew of both dependent variables. In addition, all models were run using robust standard error terms in order to account for the potential grouping of multiple incidents within states and cities and, in a small number of cases, multiple incidents within one school over time.

In addition to the full models, we also present supplementary results from two subsets of cases: 1) the small subset of cases that include the race of the shooter; and, 2) all cases excluding the three K-12 cases with the highest fatalities numbers (Columbine High School, Sandy Hook Elementary School, and Marjory Stoneman Douglas High Scho0l). With the caveat that the subsample that includes race may not be representative of the population of school shootings, we think it is important to include this variable for the sake of comparison with similar types of studies. We recognize that there are potentially systematic reasons why race would be missing from open source shooting data, which we discuss in more detail in the limitations. In addition, we run analyses without outliers in an attempt to find the most representative population of school shootings in order to better comment on useful prevention implications. These models also employ negative binomial regression.

Table 2 Negative Binomial Regression for Non-Perpetrator Casualties and Fatalities (N = 600; without Race)

	Model 1: Casualties		Model 2: Fatalities	
	β	*SE*	*β*	*SE*
Middle/Jr High	-0.721	0.187***	-0.597	0.226***
High School	-0.331	0.158*	-0.455	0.182**
Adult Shooter	0.074	0.117	0.452	0.168**
Multiple Shooters	0.455	0.180*	-0.090	0.292
Shooter Suicide	-0.542	0.175**	0.004	0.214
Inside Building	0.212	0.115***	0.305	0.159
Handgun	1.851	0.307***	1.763	0.433***
Long Gun	2.521	0.258**	2.369	0.333***
Multiple Weapons	0.671	0.272	0.182	0.349
Post 2000	0.038	0.129	-0.181	0.173
_cons	-1.355	0.345	-2.539	0.408

***p < .05; **p < .01; *p < .05

Results

Without Race

Results are reported in Table 2. Model 1 reports the results of the negative binomial regression for predicting non-perpetrator casualties. School level was negatively related to the number of casualties, with incidents in junior high schools (β = -0.721; p < 0.001) and high schools (β = -0.332; p < 0.05) each leading to fewer casualties when compared to elementary schools. In addition, incidents where the shooter committed suicide also had fewer non-perpetrators casualties compared to those incidents where the shooter survived (β = -0.542; p < 0.01). Incidents where there were multiple shooters (β = 0.454; p < 0.05), multiple weapons (β = 0.671; p < 0.01); the shooter used a handgun (β = 1.851; p < 0.001); and, the shooter used a long gun (β = 2.521; p < 0.001) resulted in more casualties.

Model 2 reports the results of the negative binomial regression model for predicting non-perpetrator fatalities. School level was negatively related to the number of fatalities, with incidents in junior high schools (β = -0.597; p < 0.001) and high schools (β = -0.455; p < 0.01) each leading to fewer fatalities when compared to elementary schools. Incidents where at least one of the shooters was an adult (β = 0.452; p < 0.01) were more likely to lead to more fatalities, as were incidents where the shooter used a handgun (β = 1.763; p < 0.001) or a long gun (β = 2.369; p < 0.001).

Pre/Post Columbine

Given previous research on how responses to school shootings have changed after the Columbine incident, we conducted additional models specifically comparing the incidents before the year 2000 and after. Similar to the models reported here, negative

binomial regression was employed to examine the role of school, shooter, and incident characteristics on predicting casualties and fatalities. To test for differences between these two time periods, we ran the statistical tests recommended by Clogg et al. (1995) and advanced by Paternoster et al. (1998) to determine if there were any differences in the effects of our independent variables on causalities and fatalities by time frame. We omit the tables for the sake of space; however, results are available from the authors.

Overall, results were similar between the two time periods, but an examination of the comparisons shows that after the year 2000, incidents that took place *inside* the school building predicted more non-perpetrator casualties ($t = -2.095$; $p < 0.05$). Similarly, there is some evidence that predictors of non-perpetrator fatalities may change over time. Multiple shooters predicted higher fatalities before the year 2000, but not after ($t = 2.42$; $p < 0.01$). Additionally, shooting incidents that happened *inside* the school building predicted fatalities in the year 2000 and beyond, but not before ($t = -3.03$; $p < 0.05$). We discuss these results in more detail below, as the implications of the effects of outliers in these cases may be very important.

With Race

Due to the limitations of open source data, perpetrator race information was only available for a subset of the shooting incidents ($n = 235$). The results of the negative binomial regression models to predict non-perpetrator casualties and non-perpetrator fatalities are reported in Table 3. Model 3 presents the results for non-perpetrator casualties. Incidents with at least one white shooter resulted in more non-perpetrator casualties ($\beta = 0.342$; $p < 0.05$). School level was negatively related to the number of casualties, with incidents in junior high schools ($\beta = -0.806$; $p < 0.01$) leading to fewer casualties when compared to elementary schools. Incidents where there were multiple shooters ($\beta = 0.659$; $p < 0.001$); the shooter used a handgun ($\beta = 1.851$;

Table 3 Negative Binomial Regression for Non-Perpetrator Casualties and Fatalities (N = 235; with Race)

	Model 3: Casualties		Model 4: Fatalities	
	β	*SE*	*β*	*SE*
Middle/Jr High	-0.806	0.288**	-0.477	0.345
High School	-0.288	0.245	-0.301	0.317
Adult Shooter	0.108	0.170	0.295	0.232
White Shooter	0.342	0.173*	-0.036	0.199
Multiple Shooters	0.659	0.174***	-0.136	0.393
Shooter Suicide	-0.236	0.229	0.233	0.240
Inside Building	0.237	0.150	0.548	0.191***
Handgun	1.472	0.331***	1.291	0.447***
Long Gun	2.084	0.244***	2.048	0.324***
Multiple Weapons	0.213	0.328	-0.038	0.397
Post 2000	0.056	0.169	-0.140	0.205
_cons	-0.976	0.440	-1.964	0.556

*** p < .05; **p < .01; *p < .05

Table 4 Negative Binomial Regression for Non-Perpetrator Casualties and Fatalities (N = 597; without Outliers)

	Model 5: Casualties		Model 6: Fatalities	
	β	SE	β	SE
Middle/Jr High	-0.732	0.186***	-0.506	0.220*
High School	-0.371	0.158*	-0.419	0.173*
Adult Shooter	-0.024	0.099	0.236	0.132
Multiple Shooters	0.390	0.167*	-0.220	0.298
Shooter Suicide	-0.509	0.168**	0.027	0.206
Inside Building	0.117	0.107	0.141	0.128
Handgun	1.851	0.315***	1.687	0.454***
Long Gun	2.342	0.283***	1.936	0.430***
Multiple Weapons	0.826	0.259***	0.494	0.343
Post 2000	-0.043	0.119	-0.329	0.144*
_cons	-1.207	0.357	-2.270	0.539

***p < .05; **p < .01; *p < .05

p < 0.001); and, the shooter used a long gun (β = 2.521; p < 0.001) resulted in more casualties.

Model 4 presents the results for non-perpetrator fatalities. Incidents that took place inside the school building (β = 0.548; p < 0.001); where the shooter used a handgun (β = 1.291; p < 0.001); and, the shooter used a long gun (β = 2.048; p < 0.001) resulted in more casualties. There were no significant findings for race of the shooter.

Outlier Exclusions

In order to better get a picture of what predicts a "typical" school shooting incident, we also conduct analyses while excluding the three most high profile shootings in recent history: Columbine High School (1999); Sandy Hook Elementary School (2012); and, Marjory Stoneman Douglas High School (2018). Without these three cases, there were 0.60 (SD = 0.98) fatalities per incident, with a range of 0–10 deaths per incident. In addition, there were 1.83 (SD = 2.59) casualties per incident, with a range of 0 to 36[1] injuries per incident. Table 4 reports these results. In Model 5, the results of the negative binomial regression for predicting non-perpetrator casualties without outliers were very similar to the full model. School level was negatively related to the number of casualties, with incidents in junior high schools (β = -0.732; p < 0.001) and high schools (β = -0.371; p < 0.05) each leading to fewer casualties when compared to elementary schools. In addition, incidents where the

[1] This shooting happened on January 17, 1989 at Cleveland Elementary School in Stockton, California. There were 6 fatalities and 36 casualties (including the shooter). The perpetrator, Patrick Purdy, committed suicide at the scene. This was the K-12 school shooting with the highest number of fatalities/casualties until the Columbine High School shooting.

shooter committed suicide also had fewer non-perpetrators casualties compared to those incidents where the shooter survived ($\beta = -0.509$; $p < 0.05$). Incidents where there were multiple shooters ($\beta = 0.389$; $p < 0.05$), multiple weapons ($\beta = 0.826$; $p < 0.001$); the shooter used a handgun ($\beta = 1.851$; $p < 0.001$); and, the shooter used a long gun ($\beta = 2.342$; $p < 0.001$) resulted in more casualties.

Model 6 reports the results of the negative binomial regression model for predicting non-perpetrator fatalities while excluding outliers. School level was negatively related to the number of fatalities, with incidents in junior high schools ($\beta = -0.505$; $p < 0.05$) and high schools ($\beta = -0.419$; $p < 0.05$) each leading to fewer fatalities when compared to elementary schools. Incidents where the shooter used a handgun ($\beta = 1.763$; $p < 0.001$) or a long gun ($\beta = 2.369$; $p < 0.001$) resulted in more casualties. Incidents that occurred after the Columbine shooting (April 1999; $\beta = -0.328$; $p < 0.05$) resulted in fewer causalities. We discuss the implications below.

Discussion and Conclusions

Preventing school shooting incidents requires in-depth analysis not just of the sensational, but rare, rampage shooting events but also of the more common gun crimes that occur on school grounds. In this research, we used open source data examined the several potential correlates of school shooting incidents that took place over a fifty-year time span in the United States. We find that incidents in junior high schools and high schools are related to fewer non-perpetrator casualties and fatalities. In line with previous research (Livingston et al., 2019), incidents with multiple shooters and multiple weapons are correlated with higher causalities and fatalities. As is to be expected, handguns and long guns also results in more casualties and fatalities than did other firearms choices. In addition, there were some differences in correlates when incidents that happened before Columbine were compared to those that happened after, with shootings post-2000 that took place *inside* a school more likely to have higher non-perpetrator causalities and fatalities.

These results raise several important points of discussion. Our finding that elementary schools are correlated with higher non-perpetrator casualties and fatalities warrants further discussion, especially in light of the fact that this age group in particular is less likely to carry guns. While there have been a small number of high-profile school shootings in elementary schools over the years (e.g. Sandy Hook Elementary School and West Nickel Mines Elementary School), the majority of conversations are centered around schools that serve older students. However, elementary schools may be at particular risk for victimization given that most shooters in these incidents are adults. In the sample used here, 70.9% of the perpetrators of elementary school shooters were classified as adults (over 18), compared to 24% of perpetrators in junior high schools and 35.4% of shooters in high schools. Adult shooters who target an elementary school may have more insidious intentions or otherwise dangerous motives for maximum victimization. They may also be more experienced with firearms, or have access to more dangerous firearms, making them more skilled and more capable of inflicting damage (see Koper, 2020).

Given that elementary schools make up the small proportion of schools in the sample, the differences could be related to the fact that junior high schools and high schools just have more gun related incidents. But many of these incidents are still qualitatively different from each other, as indicated by the fact that this dataset includes shooting incidents that can be characterized as rampage shootings, others that are more appropriately considered single victim homicides, and still others that are suicides. A more nuanced differentiation between shooting typologies would help researchers better understand the correlations and important places where intervention strategies can be better implemented. As has been noted elsewhere in the literature, rampage shooters who committed suicide may have been more motivated to harm as many people as possible but those motivations may not translate to all shooting incident perpetrators, not even all of those who commit suicide. Improvements in data collection, as evidenced by the existence of these data and several other new school shooting incident databases (see Frederique, 2020) will help us parse out the answers to many of these questions going forward.

Despite the benefits of these data, there are still some limitations that should be addressed. Many of the coding decisions had to be made in light of potentially limited data available in the case files for each incident. High profile incidents, such as rampage shootings, will have more information about the perpetrators and other situational factors around the shooting compared to incidents without fatalities. While every attempt was made to include all relevant variables, our analysis was limited only to what was included in the K-12 SSDB. Therefore, several variables identified by the prior literature as predictors of school shootings, such as student enrollment, urbanicity, or student–teacher ratio could not be evaluated. In addition, we know that there are several variables that the literature suggests will be very important in better understanding school shooting fatalities that are simply not available in this dataset. For example, the number of fatalities will be dependent on factors such as the type of ammunition used, the time between shooting and medical attention, the capabilities of the nearest trauma center, and how close the victim is to the shooter. These variables are not available in the current dataset but future research is already moving in this direction (Frederique, 2020) and we hope that this analysis can lend some direction to subsequent studies. Similarly, data reporting practices may have changed over the fifty years of data collection; incidents that may not have received public attention in the 1970s, for example, may be more likely to be reported in the media in recent years due to the conversations surrounding school shooting incidents. Additionally, several incidents had more than one perpetrator, necessitating decisions about choosing which perpetrator details to include in the models. For instance, some incidents may have had both an adult and a juvenile shooter. In those incidents, the adult shooter would be included in the coding. Similarly, in incidents where shooters were of different genders, the male shooter would have been coded. These decisions were made based on previous research suggesting the importance of these correlates and do not reflect on whether one perpetrator may have had been a stronger driving factor in an incident than another.

The findings about the role of the race of the shooter must also be interpreted with caution, given the fact that we were only able to examine a small subsample of the shooting incidents due to limited data on this variable. Nonetheless, media

attention and previous research has pointed out that, at least in rampage killings, white males are most likely to be perpetrators (Agnich, 2015; de Apodaca et al., 2012; Gerard et al., 2016; Harding et al., 2002; Lankford, 2016), so we felt it important to add some discussion surrounding these incidents. In addition, suicide rates for white males are increasing (Curtain & Hedegaard, 2019) and over 14% of the incidents in these data are suicides. Future research should continue to examine the link between race and gun violence in youth, especially as there may be interactions between race and perpetrator status that cannot be teased out with the current data.

These findings also offer support for stronger school shooting prevention efforts. We point to two important areas for increased attention: the application of situational crime prevention (SCP) efforts and more attention to student mental health needs. SCP assumes a rational decision-maker in the context of an opportune situation, a situation with criminal opportunities. To reduce crime, examining the situation and environment of a crime can produce preventative effects. The nature of the circumstances surrounding a shooting incident offer many points of prevention, including the possibility of disrupting events during the planning stages, a better understanding of the appropriate use of school level security measures, and active shooter policies that could limit the devastation during a shooting incident. Madfis (2020) uses examples from several averted shootings in the northeastern United States to point how the appropriate use of threat assessments, combined with creating a culture where students feel supported to come forward with concerns (Connell et al., 2014; Madfis, 2014) can serve as a meaningful early warning system. In these data, a not insignificant number of perpetrators are adults, many of whom are not affiliated with the school. Access and entry requirements can be re-examined, as can school building design, to limit opportunities for non-school actors. Additionally, the use of a SCP techniques such as a metal detectors and random locker checks could help alter opportunities structures with student perpetrated shootings and suicides on campus.

While there are legitimate concerns about the use of security measures to create draconian institutions (Kupchik et al., 2015), there are ways to create spaces that are both welcoming and safe. With recent research suggesting that security measures may, for some students, lead to a feeling of safety (Connell, 2018), there is room for more innovation in this space. And changes in law enforcement techniques related to active shooter incidents after high profile incidents has also led to improvements in response tactics which has in turn appears to be related to fewer causalities (Martaindale & Blair, 2019). But not all perpetrators in these incidents come from outside of the school and this speaks to the need for more supports for students, especially with regards to mental health support. Not only do supportive school environments increase positive outcomes for youth but the number of shooting incidents in this dataset that were really students attempting or completing suicide shows the importance of the overlap between student safety and mental health priorities. This argument has been made elsewhere (Baird et al., 2017; Leary et al., 2003) but bears repeating here. Mental health supports for students have far reaching positive consequences and these approaches should not be ignored when it comes to reducing gun violence.

SCP techniques lead to another important avenue of inquiry, which is the ways in which perpetrators access firearms. The findings presented here show strong support for continuing to examine the roles that different types of firearms have in fatalities and casualties but beyond that, the conversation around who accesses firearms – in ways both legal and illegal – continues to be an important one. As pointed out above, many of the shooters in these incidents are unaffiliated adults, most of whom would presumably have legal access to firearms. Without a sense of the criminal history of these shooters, we cannot comment on whether newer legislation to regulate access would have been effective but future research needs to consider case studies that would better answer these questions. In addition, there needs to be more examination into how underage shooters are obtaining firearms. Anecdotally, we know that many steal guns from family, friends, and/or neighbors. Legal remedies may not be enough to deal with this problem and more examination is necessary. We need to both understand how underage shooters obtain firearms and, subsequently, how they manage to get them on school property, given the current pro-security culture around schools.

Firearms are the second leading cause of deaths among adolescents in the United States (Cunningham et al., 2018). While school shooting incidents remain exceptionally rare, they still present a public health and safety concern to students, teachers, administrators, and policy makers. The costs of school shootings, both in real dollars and emotional terms, demand that we continue to examine the ways in which these incidents can be averted and prevented.

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