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US Mass public shootings since Columbine: victims per incident by race and ethnicity of the perpetrator

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ABSTRACT

White individuals in the United States (US) have historically had disproportionate access to firearms. The real-life availability of firearms, including those most lethal, may still be greater among White populations, manifesting in the number of victims in shootings. We compared the severity of US mass public shootings since Columbine by race and/or ethnicity of the perpetrator using The Violence Project Database of Mass Shooters, assessing fatalities (minimum four), total victims, type, and legal status of guns used. We used data visualization and Quasi-Poisson regression of victims minus four – accounting for truncation at 4 fatalities – to assess fatality and total victim rates comparing Non-Hispanic (NH) White with NH Black shooters, using winsorization to account for outlier bias from the 2017 Las Vegas shooting. In 104 total mass public shootings until summer 2021, NH White shooters had higher median fatalities (6 [IQR 5–9] versus 5 [IQR 4–6]) and total victims (9 [IQR 6–19] versus 7 [IQR 5–12]) per incident. Confidence intervals of NH Black versus NH White fatalities rate ratios (RR) ranged from 0.17–1.15, and of total victim RRs from 0.15–1.04. White shooters were overrepresented in mass public shootings with the most victims, typically involving legally owned assault rifles. To better understand the consequences when firearms are readily available, including assault rifles, we need a database of all US gun violence. Our assessment of total victims beyond fatalities emphasizes the large number of US gun violence.

1. Introduction

Gun-related mortality in the United States (US) far exceeds rates in comparable countries (Grinshteyn and Hemenway, 2016). Mass public shootings represent only a small fraction of overall gun violence in the US; but for a country not at war, their frequency and number of victims have been without parallel for decades (Lankford, 2016). While guns have long been a part of US culture (Yamane, 2017), mass public shootings have dramatically increased in the past decades (Smart and Schell, 2021). Most recently, during the COVID-19 pandemic, gun sales

have soared (Miller et al., 2021) and gun violence has worsened (Cohen et al., 2021), including mass public shootings (Peña and Jena, 2021).

America is one of the few countries (including Mexico, Haiti, and Guatemala) where the right to bear arms is constitutionally protected; and the widespread availability of firearms contributes to the country's mass public shooting problem. Availability of firearms creates opportunity with important implications for gun violence outcomes: for example, having a firearm in the home is associated with greater odds of homicide and suicide (Anglemyer et al., 2014); and while there is no empirical evidence that access to firearms is associated with suicidal

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Abbreviations: NH, Non-Hispanic; TVP database, The Violence Project (TVP) database.

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ideation itself, it is associated with intention to use firearms among those with suicidal ideation (Betz et al., 2011).

Historically, gun policies have often been a means to uphold the racial order in the US. Black individuals were excluded from the right to bear arms in many state constitutions until the civil war, and after that, based on Black codes in many Southern states (Cramer, 1994). This legacy of restricting access to firearms for Black Americans continued during and after the Civil Rights era: (Anderson, 2021; O'Brien et al., 2013) for example, the 1967 Mulford Act, which forbade public carrying of loaded guns in California, was drafted largely to disarm members of the Black Panther movement who at the time were conducting armed patrols in response to police brutality (O'Brien et al., 2013). Black Americans exercising their Constitutional right to bear arms have been unduly punished, even killed, throughout American history (Anderson, 2021; Kendi, 2019; Graham, 2016). In 2016, Philando Castile informed an officer during a traffic stop that he had a permit to carry and had a gun, but the officer fatally shot him anyway. In 2020, police executing a no-knock search warrant killed Breonna Taylor when her boyfriend fired a shot from his licensed firearm. In February 2022, permitted gun-owner Amir Locke was killed in his own home by Minneapolis police in a similar incident. In all three cases, these individuals were not whom the police were seeking. After Amir Locke's death, Shannon Watts, founder of Moms Demand Action, wrote on Twitter, "The Second Amendment has always been a privilege for whites and too often a death sentence for Black Americans." (shannonrwatts, 2022)

The enforcement of gun rights and restrictions aside, there are also informal mechanisms that may limit the availability of firearms for Black Americans. These include: divergent attitudes towards guns and gun ownership by race (PRC, 2015); social identity - a sense of belonging to groups in which gun-carrying is common and has symbolic value (Stroud, 2016; Lacombe, 2019; Jouet, 2019; Filindra et al., 2021; Carlson, 2015); and differences in the affordability of firearms given wealth inequities by race and/or ethnicity in the US (Williams and Jackson, 2005). Disproportionate felony convictions among Black individuals because of mass incarceration can restrict legal access to guns (NAACP, 2022); gun marketing is often designed to appeal to White audiences (Hunter-Pazzara, 2020; Witkowski, 2020; Yamane et al., 2020); Black individuals applying for gun licenses are sometimes treated in a humiliating manner (Carlson, 2020); and gun sellers with potential racist biases may be more likely to sell firearms to White than Black buyers.

Consistent with racist US gun-law history, and with persistent racist biases, barriers, and narratives of Black criminality in the US (Swanson, 2020; Parham-Payne, 2014), firearms may still be more available to White individuals, including firearms that are most lethal such as highpowered assault weapons. These powerful weapons can kill multiple victims within seconds and have been frequently used in mass public shootings; and their lethality is the reason why they are banned in most countries. Thus, if the availability of firearms, especially those most lethal, were unequal by race, we would also expect this to be the case among potential mass shooters, and evident in the average lethality of mass public shootings by race of the perpetrator, regardless of the race of the victims. We used The Violence Project (TVP) database of mass public shootings (Peterson and Densley, 2022) to compare shootings by race and/or ethnicity of the perpetrator, hypothesizing that mass public shootings claim more victims if perpetrators are non-Hispanic (NH)

Table 1

Characteristics of mass public shootings in the US, Non-Hispanic White versus Non-Hispanic Black/African American perpetrators, N = 104, The Violence Project database, May 1999 - Summer 2021.

Race/Ethnicity of Perpetrator	Everyone (N = 104)		Non-Hispanic White (N = 49)		Non-Hispanic Black (N = 19)		Р*
Parameter	N	%	N	%	N	%	
Non-Hispanic White	49	49					
Non-Hispanic Black	19	19					
Latinx	12	12					
Asian	9	9					
Middle-Eastern	7	7					
Native American	3	3					
Other	1	1					
Unknown	4	4					
Age group							0.53
<20-29	48	46.2	23	46.9	9	47.4	
30–39	18	17.3	6	12.2	4	21.1	
40-49	26	25.0	15	30.6	3	15.8	
≥50	12	11.5	5	10.2	3	15.8	
_ Gender							0.23
Male	100	96.2	48	98.0	18	94.7	
Female	2	1.9	1	2.0			
Both	2	1.9			1	5.3	
Location type							0.16
Workplace	29	27.9	10	20.4	8	42.1	
Retail	21	20.2	11	22.5	2	10.5	
Restaurant / Bar	14	13.5	7	14.3	3	15.8	
House of worship	9	8.7	7	14.3	1	5.3	
Place of residence	9	8.7	6	12.2	1	5.3	
School / College / University	12	11.5	5	10.2	1	5.3	
Outdoors	5	4.8	3	6.1	1	5.3	
Government building	5	4.8			2	10.5	
Type and legal status of gun used**							0.0004
Legal hand/shotgun	54	33.3	33	40.7	8	29.6	
Illegal hand/shotgun	26	16.0	7	8.6	7	25.9	
Legal status unknown, hand/shotgun	30	18.5	7	8.6	9	33.3	
Legal rifle/high-powered assault rifle	29	17.9	23	28.4	1	3.7	
Illegal rifle/high-powered assault rifle	14	8.6	8	9.9	0	0	
Legal status unknown, Rifle/high-powered assault rifle	9	5.6	3	3.7	2	7.4	

* Chi-squared test; Non-Hispanic White versus Non-Hispanic Black.

** For each gun used; total does not add up to number of shootings because some perpetrators used more than one gun.

White versus NH Black.

2. Methods

2.1. Data source

The University of Minnesota Review Board deemed this study exempt because data from The Violence Project (TVP) were publicly available (protocol 00013422). The TVP, available at https://www.the violenceproject.org, was initially funded by the National Institute of Justice and is maintained by a nonprofit, nonpartisan research center, and was built using several sources, including first-person accounts, such as perpetrators' diaries, "manifestos", suicide notes, social media and blog posts, audio and video recordings, interview transcripts, and personal correspondence. Secondary sources, such as existing mass shooter databases, media coverage, documentaries, biographies, monographs and, academic journal articles, court transcripts, police records, medical records, school records, and autopsy reports, were also consulted. Each case and variable were coded four separate times by at least three independent coders to ensure reliability before being checked again by a designated database manager, who had final document control.

The database includes 179 perpetrators of mass public shootings in the United States from 1966 to 2021, coded on over 150 life history variables. It also tracks every firearm used in a mass public shooting and includes a database of every mass shooting victim. The TVP uses the mass shooting definition of the Congressional Research Service, according to which a mass public shooting is a single firearm attack in public spaces with at least four fatalities, excluding armed robberies, gang violence, or incidents with unidentified perpetrator(s) (Peterson and Densley, 2022). We restricted our analyses to post-Columbine shootings for the following reasons: 1) the post-Columbine period coincides with a documented shift in US gun culture (Yamane, 2017), and 2) Columbine marks a discontinuity in US mass public shootings that has since shaped gun violence, policies, and society's psychology in manifold ways. These include, but are not limited to the media-hype around Columbine as the internet was becoming widely available, inspiring copycat shootings to the present day (Raitanen and Oksanen, 2018; Peterson, 2019); continuously growing mass public shooting trends in the US since Columbine (Smart and Schell, 2021); and "generation Columbine" among whom mass public shootings, and fear thereof, are the new normal (Graf, 2018; Toppo, 2018).

2.2. Measures

The primary outcomes of interest of our analysis were fatalities and total victims per mass public shooting; the primary exposure of interest was race and/or ethnicity of the perpetrator (measured in the TVP database as White, Black, Latinx, Asian, Middle Eastern, Native American, or Other based on media and official [court/police etc.] reports). The TVP database documents all firearms in each perpetrator's possession, including an indicator whether a firearm was used in the shooting or not. We excluded firearms from our analyses that were not used in the respective shootings. Firearms are categorized as handguns, shotguns, rifles, or assault rifles/submachine guns (the latter category referred to as high-powered assault rifles in this manuscript), and for each firearm, the legal status is annotated (legal [federal firearms licensed dealer, unregulated private sale, legal but specific source unknown] versus illegal [system failure such as background check missed something or records were not reported, straw purchase, lying and buying, illegal



Fig. 1. Number fatalities and total victims^{*} per incident, by race and/or ethnicity of the perpetrator, N = 104, The Violence Project database May 1999-Summer 2021. NH = Non-Hispanic.

* Excluding the 2017 Las Vegas mass-shooting (Non-Hispanic White perpetrator, 58 fatalities, 945 total victims).

P.I. Jewett et al.

street sale, illegal but specific source unknown, legal purchase but illegal possession]).

2.3. Statistical analysis

We summarized all documented post-Columbine mass public shootings in univariate analyses and described type and legal status of guns used (handgun or shotgun only versus at least one rifle or highpowered assault rifle; legal versus illegal versus legal status unknown). We visualized victim-per-incident distributions as barplots and by depicting the full incident distribution, ordering incidents by total victims per shooting, color-coded by perpetrators' race and/or ethnicity. We used Quasi-Poisson regression with the outcomes: fatalities and total victims minus 4 (to account for truncation at minimum four fatalities in the database) to calculate rate ratios (RR) and confidence intervals (CI) of victims beyond four, adjusted for location (workplace, retail, restaurant/bar, house of worship, residential, school/college/university, government building, outdoors). In the adjusted analysis, we focused on shootings with NH White or NH Black perpetrators, because other race and/or ethnicity groups were too small for meaningful multivariate comparisons. As sensitivity analysis to mitigate the outlier effect of the Las Vegas shooting (58 fatalities and 945 total victims), we additionally ran 5 winsorized models for each outcome. Winsorization reduces outlier bias without deleting observations (Wicklin, 2022). In k iterations the 1st to k-largest and -smallest observed outcome values are replaced with the next smallest (largest) observation, shrinking the outcome range while keeping all events. All analyses were conducted using SAS 9.4 and R packages GGPLOT2 and GGSTANCE (SAS Institute Inc, 2021; Wickham, 2016; Henry et al., 2020); P-values <0.05 were considered significant.

3. Results

A total of 104 mass public shootings since Columbine through summer 2021 were included in our analyses. Of these, 49% were committed by NH White perpetrators, and 19% by NH Black perpetrators (Table 1). Most mass public shootings were carried out by male shooters (96%) aged <40 years (64%). Compared to NH White perpetrators, NH Black perpetrators tended to more often commit mass shooting in workplaces or government buildings (53% versus 20%) compared with all other types of locations which were more common among NH White shooters (not statistically significant, P = 0.16). We found differences by race and/or ethnicity of the perpetrator regarding type and legal possession of guns used (P = 0.0004): NH White perpetrators more often used rifles or high-powered assault rifles (either illegal or legal; 42% versus 11%) while NH Black perpetrators more often used illegal hand- or shotguns (33% versus 9%). Legal status was unknown for 21 of 108 guns used in these 2 perpetrator groups, with the legal status more frequently unknown (41% versus 12%) among NH Black than NH White perpetrators.

Fatalities, number of total victims per incident, and variance were higher if perpetrators were NH White, Fig. 1 (median fatalities, NH White perpetrators, 6 [IQR 5–9] versus NH Black perpetrators, 5 [IQR 4–6]; median total victims, NH White perpetrators, 9 [IQR 6–19] versus NH Black perpetrators, 7 [IQR 5–12]). Of all 812 fatal victims of US mass public shootings since Columbine, 437 (53.8%) were killed by NH White shooters versus 108 (13.3%) by NH Black shooters; and of all 2356 total victims, 1686 (71.6%) were victims of NH White versus 161 (6.8%) of NH Black shooters. When plotting all mass public shootings, ordered by total number of victims and color-coding each incident by race and/or ethnicity of the perpetrator, NH Black perpetrators were overrepresented among shootings with fewer total victims, whereas NH White shooters were increasingly overrepresented as the total number of victims per incident increased, Fig. 2.

Table 2 highlights the outsized role that high-powered assault rifles have played in the most notorious mass public shootings: until summer



Fig. 2. Number of total victims per shooting, by race/ethnicity of the perpetrator, N = 104, The Violence Project database May 1999-Summer 2021. Each row represents one mass shooting in ascending order by 1) number of total victims and 2) year; with color coding by race and/or ethnicity of the shooter (pink - Non-Hispanic White; dark blue – Non-Hispanic Black; turquoise – Other; white – unknown race and/or ethnicity). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

2021, there have been 14 mass public shootings since Columbine with more than 25 total victims each. Of these, 10 shootings involved high-powered assault rifles, and in 7 cases of those, the shooter legally owned the high-powered assault rifles(s) used, and 6 of those legal owners were NH White. None of these most notorious mass shootings were committed by a NH Black shooter.

Quasi-Poisson regression of victims beyond the minimum of four, restricted to mass public shootings with NH Black and NH White perpetrators (N = 68) and adjusted for location of the shooting, confirmed these findings (Supplemental Table 1): when including the 2017 Las Vegas shooting, NH Black shooters had on average fewer fatal and total victims than White mass shooters (NH Black versus NH White perpetrator: fatalities, RR 0.38, 95% CI 0.14–1.07; total victims, RR 0.16, 95% CI 0.03–0.79). The Las Vegas outlier may have biased the estimates. Running the same models using winsorization, replacing the k = 1 to 5 most extreme observations with the next smallest (largest) observations, the total victims' model no longer reached significance. However, the RRs and their confidence intervals remained stable across these iterations: fatalities RR ranged from 0.45–0.57, 95% CI 0.17–1.15; the total victims RR ranged from 0.40–0.49, 95% CI 0.15–1.04.

Table 2

Use of high-powered assault rifles in mass public shootings by number of total victims, N = 104, The Violence Project database, May 1999 - Summer 2021.

Race and/or ethnicity			Total	High-powered assault rifle(s)
of the perpetrator	Year	Fatalities	victims	used in shooting / legal status
Other	2001	4	4	No
Non-Hispanic White	2003	4	4	No
Unknown	2005	4	4	No
Non-Hispanic White	2008	4	4	No
Other	2009	4	4	Yes – legal status unknown
Non-Hispanic Black	2009	4	4	No
Non-Hispanic Black	2013	4	4	No
Non-Hispanic Black	2017	4	4	
Other	2017	4	4	No
Non-Hispanic Black	2018	4	4	No
Non-Hispanic White	1999	4	5	No
Non-Hispanic Black	2003	4	5	No
Non-Hispanic White	2010	5	5	No
Other	2014	4	5	No
Other	2016	5	5	No
Non-Hispanic White	2017	5	5	No
Non-Hispanic White	2018	4	5	Yes – legal status unknown
Other	2018	5	5	No
Non-Hispanic White	2019	5	5	No
Non-Hispanic Black	2020	5	5	
Other	2021	4	5	No
Non-Hispanic Black	2000	5	6	No
Non-Hispanic White	2000	5	6	No
Other	2000	6	6	No
Non-Hispanic White	2003	4	6	No
Non-Hispanic White	2004	5	6	No
Non-Hispanic Black	2000	5	6	No
Other	2008	3	6	No
Nan Hispania White	2010	4	6	No.
Non-Hispanic White	2012	3	0	NO N-
Other	2013	4	6	No
Other	2013	0	0	NO No
Other	2014	4	6	No
Non-Hispanic white	2015	0	0	NO
Unknown	2020	4	0	NO
Other	1999	/	/	NO
Other	2000	7	7	Yes - illegal
Non-Hispanic White	2001	4	7	No
Non-Hispanic White	2001	5	7	Yes - illegal
Unknown	2004	5	7	No
Non-Hispanic Black	2005	4	7	No
Non-Hispanic White	2006	7	7	No
Non-Hispanic Black	2008	6	7	No
Other	2010	4	7	No
Other	2015	5	7	Yes - legal
Non-Hispanic Black	2019	4	7	Yes – legal status unknown
Other	1999	5	8	No
Non-Hispanic Black	2001	4	8	Yes – legal status unknown
Other	2004	6	8	Yes – legal status unknown
Non-Hispanic White	2006	6	8	No
Non-Hispanic Black	2010	4	8	No
Non-Hispanic White	2011	7	8	No
Non-Hispanic White	2012	6	8	No
Other	2013	5	8	Yes - illegal
Non-Hispanic White	2016	6	8	No
Non-Hispanic White	2018	4	8	Yes - illegal
Other	2018	5	8	No
Unknown	2002	4	9	No
Other	2007	5	9	No
Non-Hispanic White	2007	4	9	Yes - legal
Non-Hispanic White	2011	8	9	
Non-Hispanic White	2012	6	9	No
Non-Hispanic White	2015	9	9	No
Non-Hispanic White	2021	8	9	No
Non-Hispanic White	2021	9	9	No
		1	1	1

Non-Hispanic White	2006	5	10	No
Other	2008	6	10	No
Non-Hispanic Black	2010	8	10	No
Other	2012	7	10	No
Non-Hispanic White	2005	7	11	No
Non-Hispanic White	2009	8	11	No
Other	2011	4	11	Yes - legal
Other	2021	10	11	Yes - legal
Non-Hispanic Black	2016	5	12	Yes - legal
Non-Hispanic Black	2019	5	12	No
Non-Hispanic White	2007	8	13	Yes - illegal
Non-Hispanic White	1999	7	14	No
Non-Hispanic White	2003	6	14	No
Non-Hispanic White	2021	8	15	Yes - legal
Other	2005	9	16	No
Non-Hispanic Black	2015	9	16	No
Non-Hispanic Black	2019	12	16	No
Other	2009	13	17	No
Non-Hispanic White	2017	5	17	Yes - illegal
Non-Hispanic White	2018	11	17	Yes – legal status unknown
Non-Hispanic White	2011	6	19	No
Non-Hispanic Black	2013	12	20	No
Other	2014	6	20	No
Non-Hispanic White	2008	5	21	No
Non-Hispanic White	2018	10	23	No
Non-Hispanic White	1999	12	25	No
Non-Hispanic White	2012	27	28	Yes - illegal
Non-Hispanic White	2019	7	30	Yes - legal
Non-Hispanic White	2018	12	33	No
Non-Hispanic White	2018	17	34	Yes - legal
Other	2015	14	36	Yes - illegal
Other	2009	13	45	No
Non-Hispanic White	2017	25	45	Yes - illegal
Non-Hispanic White	2019	9	46	Yes - legal
Other	2017	5	48	No
Non-Hispanic White	2019	23	49	Yes - legal
Other	2007	32	58	No
Non-Hispanic White	2012	12	82	Yes - legal
Other	2016	49	102	Yes - legal
Non-Hispanic White	2017	58	945	Yes - legal

Each row represents one mass shooting in ascending order by 1) number of total victims and 2) year. All shootings that involved high-powered assault rifles are highlighted according to the legal status of the firearm (illegal – light blue; legal status unknown – lilac; legal – pink).

4. Discussion

We found that fatality rates of Black mass shooters were 0.17–1.15 times as high as fatality rates of White mass shooters, while the total victim rates of Black mass shooters were 0.15–1.04 times as high as total victim rates of White shooters. Most mass public shootings with the highest victim numbers were committed with high-powered assault rifles, and most of these were in legal possession of the perpetrator.

Previous debates have suggested that US mass shooters are typically White and male (McArdle, 2021), but there is no evidence based on our or previous work that White individuals - relative to their proportion in the general population – commit a mass public shooting more often than persons of color (Peterson, 2020). However, the stable confidence intervals across our sensitivity analyses highlight the possibility that White shooters may harm a greater number of victims on average when they commit a mass shooting, likely mediated by a more frequent use of high-powered assault weapons, usually owned legally. Both the 1994–2004 Federal Assault Weapons Ban as well as large-capacity magazine bans have been associated with decreased incidence of mass shootings, gun deaths, and injuries (Post et al., 2021; Klarevas et al.,

2019). If White individuals disproportionately use more lethal firearms in mass public shootings, this has important implications for public safety, especially since many mass shootings are racist motivated (for example attacks on a Sikh temple in Oak Creek, Wisconsin [2012], the Tree of Life Synagogue in Pittsburgh [2018], and a grocery store in a predominantly Black neighborhood in Buffalo, New York [2022]). Furthermore, it would shift discussions from conflating race and/or ethnicity as a surrogate for character or culpability towards focusing on the means used, especially those that cause greatest harm. Other countries drew conclusions and banned assault weapons after single mass shootings without waiting for further evidence for the lethality of these guns from potential future shootings, for example the United Kingdom, New Zealand, and Australia (Chapman et al., 2016); but such commonsense laws, supported by a large majority of the American population (Pew Research Center, 2021), have not been passed in the US.

Understanding the distribution of firearms and greater oversight over and tracking to whom the deadliest guns are available, for example assault rifles, is a public health imperative. The authors cannot draw final conclusions about potential differences in access to or availability of firearms due to limitations in the data, specifically the truncation at four fatalities at a minimum which was an inclusion criterion in the TVP database. A comprehensive database of all gun violence incidents in the US, with demographic details on shooters and guns used, and including incidents with fewer victims would give us a better understanding of the real-life availability and distribution - as opposed to theoretical legal access which is likely less meaningful from a public health perspective of firearms in the US population (Capellan et al., 2019). A starting point may be the National Violent Death Reporting System (NVDRS) Restricted Access Database (RAD) by the Centers of Disease Control and Prevention (CDC), n.d, but these data are not easily accessible to the public. Shootings excluded from the current definition of mass public shootings may have claimed fewer victims because perpetrators did not have more lethal guns, for example high-powered assault rifles.

Our study further highlights the importance of acknowledging the total number of victims of mass public shootings. Fatalities are typically discussed in the media, but an exclusive focus on fatalities underestimates the true impact of mass shootings. Shooting survivors carry physical and emotional scars for the rest of their lives; and emotional wounds extend to those whose loved ones have been affected. According to Everytown for Gun Safety, a gun violence survivor is "anyone who has personally experienced gun violence - whether you have witnessed an act of gun violence, been threatened or wounded with a gun, or had someone you know and cared for wounded or killed." (Everytown for Gun Safety, 2022). In other health research fields - for example cancer the number of US survivors are monitored and reported on a regular basis (American Cancer Society, 2022); and cancer survivorship experiences have been the subject of federally funded research for many years, with a wide range of tailored care options and resources available for affected individuals (National Cancer Institute, 2021; American Society of Clinical Oncology, 2021). In contrast, there are no systematic estimates of how many people in the US have been affected by gun violence while surviving it; and few resources are available for gun violence survivors to help them cope with the trauma from their experience (O'Neill et al., 2020; Woodrow-Cox, 2021). In addition to affected adults, experts in the field estimate that millions of children in the US have been directly or indirectly affected by gun violence (NPR, 2021). Although funding for gun violence research has increased since 2019 after funding was virtually nonexistent for 20 years following the Dickey amendment, the newly available funding is still only a fraction compared with other health topics by the number of lives lost (Why America spends so little on research into gun violence, 2022). Recent pilot work suggests that gun survivor support initiatives, including peer support, are effective in overcoming the trauma of gun violence (Schildkraut et al., 2021). Not only do gun violence survivors deserve such help, but importantly, because gun violence is self-perpetuating (Green et al., 2017), survivor support likely prevents future violence. There is a growing interest in gun survivorship experiences among researchers (Schildkraut et al., 2021; Peterson and Densley, 2021), community initiatives (StarTribune, 2022), and gun advocacy groups (Everytown for Gun Safety, 2022). Future work should estimate the number of US gun violence survivors, including those indirectly affected; examine long-term impacts of gun violence on people's lives; develop supportive interventions; and estimate downstream beneficial outcomes of such interventions in terms of lives saved, and injuries and societal costs prevented.

A strength of this study is the inclusion of all known mass shootings since Columbine; the latter marking a shift in US gun violence which has been followed by uninterrupted increasing trends in US mass shootings. The incidents included in the TVP are consistent with incidents included in other, similar databases that use the same definition of a mass public shooting (Follman et al., 2022). Another strength was our extensive use of visualization techniques to depict all mass shootings in the TVP database in addition to applying quantitative statistical methods for analysis. Limitations, in addition to the aforementioned truncated outcome data at minimum four fatalities based on the Congressional

Research Service definition of a mass shooting used in the TVP, include reliance on open-source data: despite a rigorous review protocol before a shooting is included in the TVP database (each case and variable coded four separate times by at least three independent coders with a final check by a designated database manager), the TVP data are limited by the accuracy of the data sources used. Furthermore, any coding process is an interpretative process which may lead to some misclassification. The TVP principal investigators try to minimize sources of error by reconciling discrepancies between coders. Potential media and police report bias may have resulted in the omission of mass shootings that received little media attention, and distortions in when and how race and/or ethnicity of perpetrators were portrayed in the media descriptions of these incidents (Duxbury et al., 2018). Bias could especially have led to potentially greater police and media scrutiny of the legal status of the guns used in each incident if the perpetrators were persons of color.

4.1. Conclusion

Our findings suggest that NH White shooters with legal highpowered assault weapons have been disproportionately represented among the most notorious mass public shootings in the US. Comprehensive analyses of all forms of gun violence are needed to gain a better understanding of the real-life availability of firearms, especially those most lethal, in the population to identify risk groups, inform gun and public health policies, and to understand the entanglement of racism with gun violence. Further, substantially more funding is needed for firearm-related violence research in general, including more research on the long-term effects of gun violence on those who survive it to develop appropriate resources for survivors. Gun violence survivors are a growing US population whose size is likely underestimated and whose needs following their trauma have been neglected. Gun survivorship support may even reduce secondary future violence, an important opportunity to respond to the ever-growing gun violence epidemic in the United States.

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Author contributions

<u>Jewett:</u> Conceptualization; Formal analysis; Investigation/Interpretation; Methodology; Project administration; Resources; Software; Validation; Visualization; original draft; review & editing.

<u>Gangnon:</u> Conceptualization; Formal analysis; Investigation/Interpretation; Methodology; Software; Supervision; review & editing.

<u>Borowsky:</u> Conceptualization; Investigation/Interpretation; Methodology; Project administration; Resources; Supervision; Validation; review & editing.

<u>Peterson:</u> Conceptualization; Data curation; Funding acquisition; Investigation/Interpretation; Methodology; Project administration; Resources; Validation; review & editing.

<u>Areba:</u> Investigation/Interpretation; Contextualization of Findings/ Validation; review & editing.

<u>Kiragu:</u> Investigation/Interpretation; Contextualization of Findings/ Validation; review & editing.

<u>Densley:</u> Conceptualization; Data curation; Funding acquisition; Investigation/Interpretation; Methodology; Project administration; Resources; Supervision; Validation; review & editing.

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Declaration of Competing Interest

The authors have no conflict of interest to declare.

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