

# UC Irvine

## UC Irvine Previously Published Works

### Title

Firearm Violence Surrounding the COVID-19 Pandemic: A Reopening Phenomenon

### Permalink

<https://escholarship.org/uc/item/0r25276n>

### Authors

Donnelly, Megan  
Kuza, Catherine  
Sargent, Brynn  
et al.

### Publication Date

2023-05-01

### DOI

10.1016/j.jss.2022.12.017

Peer reviewed



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

ScienceDirect

journal homepage: [www.JournalofSurgicalResearch.com](http://www.JournalofSurgicalResearch.com)

## Firearm Violence Surrounding the COVID-19 Pandemic: A Reopening Phenomenon



Megan Donnelly, BS,<sup>a</sup> Catherine Kuza, MD,<sup>b</sup> Brynn Sargent, BS,<sup>a</sup>  
 Lourdes Swentek, MD,<sup>a</sup> Christian de Virgilio, MD,<sup>c</sup> Areg Grigorian, MD,<sup>d</sup>  
 Sebastian Schubl, MD,<sup>a</sup> and Jeffry Nahmias, MD MHPE<sup>a,\*</sup>

<sup>a</sup> Division of Trauma, Department of Surgery, University of California, Irvine, Burns and Surgical Critical Care, Orange, California

<sup>b</sup> Department of Anesthesiology, University of Southern California, Los Angeles, California

<sup>c</sup> Department of Surgery, Harbor-UCLA Medical Center, Torrance, California

<sup>d</sup> Department of Surgery, University of Southern California, Los Angeles, California

### ARTICLE INFO

#### Article history:

Received 28 March 2022

Received in revised form

15 October 2022

Accepted 24 December 2022

Available online 3 January 2023

#### Keywords:

Community reopening

COVID-19

Firearm violence

Pandemic

### ABSTRACT

**Introduction:** Past research has demonstrated a “reopening phenomenon” of increased firearm violence associated with the initial lifting of coronavirus disease 2019 (COVID-19) pandemic-related restrictions after the first wave. Now, with widespread societal re-emergence from stay-at-home measures, we hypothesize another spike in firearm violence in the United States (US). Thus, the purpose of this study was to evaluate the trends in firearm violence before and after extensive community reopenings during the COVID-19 pandemic.

**Methods:** The Gun Violence Archive was utilized to collect data on daily firearm violence incidents, injuries, and deaths as well as on types of firearm violence. Mann–Whitney U-tests were performed for trends and types of firearm violence “before” (12/14/20–4/9/21) versus “after” (4/10/21–7/31/21) widespread societal reopening in the US. Additional analyses also sought to compare the after reopening time-period to historical data (2017–2020) of similar calendar dates, to better control for possible annual/seasonal variation.

**Results:** Median daily firearm violence incidents (153 versus 176,  $P < 0.001$ ), injuries (89 versus 121,  $P < 0.001$ ) and deaths (54 versus 58,  $P < 0.001$ ) increased from before versus after reopening. Compared to all historical years, in the after reopening time-period there were consistent increases in total as well as mass shooting incidents/injuries/deaths (all  $P < 0.05$ ).

**Conclusions:** Firearm violence incidents, injuries, and deaths increased after societal re-emergence from the COVID-19 pandemic. In addition, there has been an increase in mass shootings despite a relative lull initially brought on by the pandemic. This suggests the “reopening phenomenon” has worsened an already substantial national firearm epidemic.

© 2022 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

\* Corresponding author. Division of Trauma, Department of Surgery, University of California, Irvine, Burns and Surgical Critical Care, 333 City Blvd West, Suite 1600, Orange, CA 92868.

E-mail address: [jnahmias@hs.uci.edu](mailto:jnahmias@hs.uci.edu) (J. Nahmias).

0022-4804/\$ – see front matter © 2022 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

<https://doi.org/10.1016/j.jss.2022.12.017>

---

## Introduction

The fears and uncertainty surrounding the emergence of the coronavirus disease 2019 (COVID-19) were associated with a significant spike in firearm sales in the United States (US).<sup>1-3</sup> In the setting of ongoing socioeconomic upheaval brought on by the pandemic, many firearm purchasers obtained a weapon with the intention to protect themselves and their families.<sup>4,5</sup> Among these purchasers, a large proportion were first-time gun owners,<sup>6</sup> and approximately 40% of individuals admitted to storing a firearm unlocked.<sup>4</sup> In addition, pandemic-related stressors coupled with the use of alcohol<sup>7</sup> and/or drugs<sup>8</sup> were associated with increased firearm violence in the US in the wake of COVID-19.<sup>1,9-11</sup>

In a previous study published by our study group, a phenomenon of increased firearm violence associated with phased reopening was noted in California, Ohio, and the US as a whole.<sup>12</sup> Other studies have evidenced increased firearm violence incidents,<sup>6</sup> injuries, and deaths involving not only adults<sup>12</sup> but also children<sup>13</sup> associated with the COVID-19 pandemic. Although the intent of firearm purchase was for self-defense, the early COVID-19 era unfortunately saw an increase in accidental shooting deaths, with an increase in fatal and nonfatal child involved shootings as well as children killed by an adult with a firearm.<sup>13</sup> Conversely, there has been a decrease in defensive use, drug-involved, and home invasion shooting incidents.<sup>12</sup>

However, there remains a paucity of literature regarding trends in firearm violence after the widespread societal reopening that occurred in 2021.<sup>14</sup> Understanding trends during this time-period is vital to the overall understanding of firearm violence-related trends before, during and after the pandemic. This information will hopefully help target future local interventions and/or legislation. In particular, the lifting of pandemic-related restrictions lends more opportunity to mass shootings and this is an area with a paucity of research in relation to the pandemic. Thus, the purpose of this study was to evaluate the trends in firearm violence before and after extensive community reopenings during the COVID-19 pandemic as well as compared to historical data for the years 2017 to 2020 to control for annual/seasonal variation. As a result of the increased number of Americans who now own a firearm paired with heightened emotions and potentially increased aggression related to traumatic pandemic experiences,<sup>15</sup> we hypothesize an increase in firearm violence following societal reemergence after COVID-19.

---

## Materials and Methods

This study was deemed exempt by the University of California, Irvine Institutional Review Board. The manuscript was prepared using the guidelines outlined in the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.

Retrospective firearm violence data (12/14/2020 to 7/31/2021) were obtained from the Gun Violence Archive (GVA). The GVA is an independent organization that seeks to publish accessible, comprehensive, national data on firearm violence

and includes deidentified data only, and thus consent was not required for this study. This organization employs automated Internet queries to search and collect data from over 7500 sources, including police reports, media outlets, and more.<sup>16</sup> Data on total incidents, deaths, and injuries related to firearm violence, as well as on specific types of firearm violence, such as child involved shootings, home invasions, defensive use shootings, mass shootings, and officer involved shootings, were collected. Child involved shootings included children killed or injured by a child as well as children killed or injured by an adult regardless of accidental or intentional actions. Mass shootings were defined by the GVA and the Federal Bureau of Investigation as  $\geq 4$  persons shot or killed in a single incident, not including the shooter. Officer involved shootings were defined as any firearm violence during which a police officer was present.<sup>16</sup>

To evaluate trends in firearm violence after societal reemergence following COVID-19, “before community reopening” was defined as 12/14/2020 to 4/9/2021 (117 d) and “after community reopening” was 4/10/2021 to 7/31/2021 (113 d). The date April 9, 2021 was selected as the cutoff for these time periods because according to the Centers for Disease Control and Prevention’s COVID Data Tracker, this is the date when the US reached its daily vaccination peak with almost 4.5 million vaccines administered.<sup>17</sup> This date also closely coincided with many cities and states announcing plans to reopen given the decreasing COVID-19 burden.<sup>18-21</sup> The start date of 12/14/2020 was selected as this was the first date entered into the COVID Data Tracker, marking the beginning of vaccination rollout.<sup>17</sup> However, community reopening did not immediately follow these vaccination efforts given that COVID-19 cases in the winter months were surging.<sup>22</sup> Furthermore, to control for possible seasonal variation, GVA data for the dates 4/10 to 7/31 from the years 2017, 2018, 2019 and 2020 were compared to the “after community reopening” time-period.

The Mann–Whitney *U*-test was performed to compare median daily firearm violence incidents, deaths, and injuries as well as types of firearm violence (i.e., child involved shootings, home invasions, defensive use shootings, mass shootings, and officer involved shootings) before versus after widespread community reopenings in the US. Similar statistics were run to compare the after reopening time-period with historical control data. A scatterplot was created to demonstrate the trends in firearm violence incidents and deaths from 12/14/2020 to 7/31/2021. Statistics were performed on IBM SPSS Statistics, Version 26 (IBM Corp., Armonk, NY). Statistical significance was set as  $P < 0.05$ .

---

## Results

### *Before (12/14/2020 to 4/9/2021) versus after (4/10/2021 to 7/31/2021) widespread community reopening*

The median daily total firearm violence incidents (before: 153 incidents versus after: 176 incidents,  $P < 0.001$ ), injuries (before: 89 injuries versus after: 121 injuries,  $P < 0.001$ ) and deaths (before: 54 deaths versus after: 58 deaths,  $P < 0.001$ ) all increased from before versus after reopening. This

corresponded with an increase in total number of firearm violence incidents (before: 18,003 incidents versus after: 20,055 incidents), injuries (before: 10,884 injuries versus after: 14,503 injuries), and deaths (before: 6252 deaths versus after: 6685 deaths) during this time. Within the scatterplot, which includes data from these time periods, a clear increase in firearm violence incidents and deaths after widespread community reopening are noted (Fig.).

Similarly, median daily child involved shooting incidents (before: two incidents versus after: three incidents,  $P < 0.001$ ) and median daily child involved shooting injuries (before: two injuries versus after: three injuries,  $P < 0.001$ ) increased after widespread community reopenings. With regards to trends in totals, there were increased total child-involved shooting incidents (before: 284 incidents versus after: 376 incidents) and child involved shooting injuries (before: 291 injuries versus after: 472 injuries) after reopening.

Contrarily, median daily home invasion incidents (before: three incidents versus after: two incidents,  $P = 0.020$ ) and deaths (before: one death versus after: 0 deaths,  $P = 0.037$ ) decreased after reopening compared to before reopening. Similarly, total home invasion incidents (before: 369 incidents versus after: 292 incidents) and home invasion deaths (before: 149 deaths versus after: 104 deaths) decreased after societal reopening.

The period after community reopening also had an increase in median daily mass shooting incidents (before: one incident versus after: two incidents,  $P < 0.001$ ), mass shooting injuries (before: four versus after: 9,  $P < 0.001$ ), and mass shooting deaths (before: 0 deaths versus two deaths,  $P = 0.003$ ). Moreover, total mass shooting incidents (before: 146 incidents versus after: 268 incidents), mass shooting injuries (before: 564 injuries versus after: 1150 injuries), and mass shooting deaths (before: 186 deaths versus after: 265 deaths) increased after reopening.

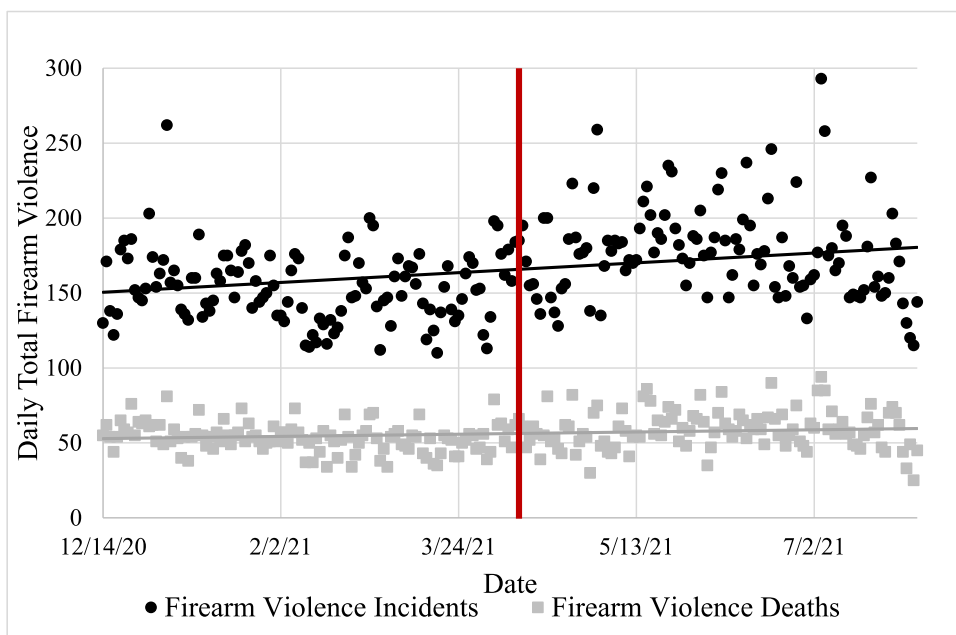
There were no changes in median daily defensive use and officer involved shooting incidents, injuries, and deaths before versus after widespread community reopening (all  $P > 0.05$ ) (Table 1).

**After widespread community reopening compared to historical data (2017 versus 2021)**

The median daily total firearm violence incidents (2017 historical: 166 incidents versus after: 176 incidents,  $P = 0.012$ ), injuries (2017 historical: 87 injuries versus after: 121 injuries,  $P < 0.001$ ) and deaths (2017 historical: 43 deaths versus after: 58 deaths,  $P < 0.001$ ) all increased from 4/10/2017-7/31/2017 to 4/10/2021-7/31/2021. Similarly, child-involved as well as mass shooting incidents, injuries, and deaths all increased after community reopening compared to 2017 (all  $P < 0.05$ ). On the other hand, home invasion and defensive use incidents, injuries, and deaths decreased after community reopening (all  $P < 0.05$ ) compared to 2017 (Table 2).

**After widespread community reopening compared to historical data (2018 versus 2021)**

The median daily total firearm violence incidents (2018 historical: 153 incidents versus after: 176 incidents,  $P < 0.001$ ), injuries (2018 historical: 82 injuries versus after: 121 injuries,  $P < 0.001$ ) and deaths (2018 historical: 41 deaths versus after: 58 deaths,  $P < 0.001$ ) all increased from 4/10/2018-7/31/2018 to 4/10/2021-7/31/2021. Child involved shooting incidents and injuries as well as mass shooting incidents/injuries/deaths all increased after community reopening compared to 2018 (all  $P < 0.05$ ) (Table 3).



**Fig. – Trends in Firearm Violence Before (12/14/20-4/9/21) versus After Reopening (4/10/21-7/31/21). The red line represents the cutoff for “before” versus “after” widespread community reopening.**

**Table 1 – Median Daily Firearm Violence Incidents, Deaths and Injuries Before (12/14/20-4/9/21) versus After Reopening (4/10/21-7/31/21).**

Firearm violence	Before reopening, daily median (min, max)	After reopening, daily median (min, max)	P
Total incidents	153.0 (110, 262)	176.0 (115, 293)	<b>&lt; 0.001</b>
Total deaths	54.0 (34, 81)	58.0 (25, 94)	<b>&lt; 0.001</b>
Total injuries	89.0 (52, 178)	121.0 (67, 281)	<b>&lt; 0.001</b>
Child involved incidents	2.0 (0, 7)	3.0 (0, 11)	<b>&lt; 0.001</b>
Child involved deaths	1.0 (0, 9)	1.0 (0, 7)	0.416
Child involved injuries	2.0 (0, 10)	3.0 (0, 23)	<b>&lt; 0.001</b>
Home invasion incidents	3.0 (0, 8)	2.0 (0, 8)	<b>0.020</b>
Home invasion deaths	1.0 (0, 7)	0 (0, 4)	<b>0.037</b>
Home invasion injured	1.0 (0, 5)	1.0 (0, 6)	0.766
Defensive use incidents	3.0 (0, 9)	3.0 (0, 10)	0.578
Defensive use deaths	1.0 (0, 8)	1.0 (0, 7)	0.997
Defensive use injured	2.0 (0, 9)	2.0 (0, 22)	0.490
Mass shooting incidents	1.0 (0, 6)	2.0 (0, 11)	<b>&lt; 0.001</b>
Mass shooting deaths	0 (0, 12)	2.0 (0, 11)	<b>0.003</b>
Mass shooting injured	4.0 (0, 29)	9.0 (0, 51)	<b>&lt; 0.001</b>
Officer involved incidents	13.0 (5, 22)	13.0 (5, 22)	0.576
Officer involved deaths	5.0 (1, 12)	5.0 (0, 13)	0.536
Officer involved injured	4.0 (0, 12)	4.0 (0, 11)	0.193

Bold values indicate statistically significant values ( $P < 0.05$ ).

#### After widespread community reopening compared to historical data (2019 versus 2021)

The median daily total firearm violence incidents (2019 historical: 153 incidents versus after: 176 incidents,  $P < 0.001$ ),

injuries (2019 historical: 87 injuries versus after: 121 injuries,  $P < 0.001$ ) and deaths (2019 historical: 43 deaths versus after: 58 deaths,  $P < 0.001$ ) all increased from 4/10/2019-7/31/2019 to 4/10/2021-7/31/2021. Child-involved and mass shooting incidents/injuries/deaths all increased after community

**Table 2 – Firearm Violence Before (2017 Historical) versus After Reopening (4/10/21-7/31/21).**

Firearm violence	Before 2017 historical, daily median (min, max)	After reopening, daily median (min, max)	P
Total incidents	166.0 (108, 234)	176.0 (115, 293)	<b>0.012</b>
Total deaths	43.0 (23, 74)	58.0 (25, 94)	<b>&lt; 0.001</b>
Total injuries	87.0 (44, 151)	121.0 (67, 281)	<b>&lt; 0.001</b>
Child involved incidents	2.0 (0, 7)	3.0 (0, 11)	<b>&lt; 0.001</b>
Child involved deaths	0 (0, 9)	1.0 (0, 7)	<b>0.006</b>
Child involved injuries	2.0 (0, 13)	3.0 (0, 23)	<b>&lt; 0.001</b>
Home invasion incidents	7.0 (2, 15)	2.0 (0, 8)	<b>&lt; 0.001</b>
Home invasion deaths	1.0 (0, 7)	0 (0, 4)	<b>0.001</b>
Home invasion injured	3.0 (0, 15)	1.0 (0, 6)	<b>&lt; 0.001</b>
Defensive use incidents	6.0 (1, 12)	3.0 (0, 10)	<b>&lt; 0.001</b>
Defensive use deaths	2.0 (0, 8)	1.0 (0, 7)	0.453
Defensive use injured	3.0 (0, 11)	2.0 (0, 22)	<b>0.015</b>
Mass shooting incidents	1.0 (0, 6)	2.0 (0, 11)	<b>&lt; 0.001</b>
Mass shooting deaths	0.0 (0, 9)	2.0 (0, 11)	<b>&lt; 0.001</b>
Mass shooting injured	3.0 (0, 35)	9.0 (0, 51)	<b>&lt; 0.001</b>
Officer involved incidents	12.0 (4, 22)	13.0 (5, 22)	<b>0.020</b>
Officer involved deaths	4.0 (0, 12)	5.0 (0, 13)	0.102
Officer involved injured	4.0 (0, 14)	4.0 (0, 11)	0.286

Bold values indicate statistically significant values ( $P < 0.05$ ).

**Table 3 – Firearm Violence Before (2018 Historical) versus After Reopening (4/10/21-7/31/21).**

Firearm violence	Before 2018 historical, daily median (min, max)	After reopening, daily median (min, max)	P
Total incidents	153.0 (127, 248)	176.0 (115, 293)	< 0.001
Total deaths	41.0 (21, 66)	58.0 (25, 94)	< 0.001
Total injuries	82.0 (47, 161)	121.0 (67, 281)	< 0.001
Child involved incidents	2.0 (0, 7)	3.0 (0, 11)	< 0.001
Child involved deaths	1.0 (0, 6)	1.0 (0, 7)	0.081
Child involved injuries	2.0 (0, 13)	3.0 (0, 23)	< 0.001
Home invasion incidents	5.0 (1, 13)	2.0 (0, 8)	< 0.001
Home invasion deaths	1.0 (0, 4)	0 (0, 4)	0.131
Home invasion injured	2.0 (0, 8)	1.0 (0, 6)	0.001
Defensive use incidents	5.0 (1, 14)	3.0 (0, 10)	< 0.001
Defensive use deaths	2.0 (0, 9)	1.0 (0, 7)	0.937
Defensive use injured	3.0 (0, 10)	2.0 (0, 22)	0.238
Mass shooting incidents	1.0 (0, 6)	2.0 (0, 11)	< 0.001
Mass shooting deaths	0 (0, 10)	2.0 (0, 11)	< 0.001
Mass shooting injured	4.0 (0, 30)	9.0 (0, 51)	< 0.001
Officer involved incidents	12.0 (5, 22)	13.0 (5, 22)	0.044
Officer involved deaths	4.0 (0, 13)	5.0 (0, 13)	0.014
Officer involved injured	4.0 (0, 24)	4.0 (0, 11)	0.369

Bold values indicate statistically significant values ( $P < 0.05$ ).

reopening compared to 2019 historical trends (all  $P < 0.05$ ). Officer involved incidents (2019 historical: 10 incidents versus after: 13 incidents,  $P < 0.001$ ) and deaths (2019 historical: 4 deaths versus after: 5 deaths,  $P = 0.016$ ) also increased during this time (Table 4).

*After widespread community reopening compared to pandemic time-period historical data (2020 versus 2021)*

Median daily total firearm violence deaths (2020 historical: 55 deaths versus after: 58,  $P = 0.033$ ) increased significantly after

**Table 4 – Firearm Violence Before (2019 Historical) versus After Reopening (4/10/21-7/31/21).**

Firearm violence	Before 2019 historical, daily median (min, max)	After reopening, daily median (min, max)	P
Total incidents	153.0 (120, 250)	176.0 (115, 293)	< 0.001
Total deaths	43.0 (21, 76)	58.0 (25, 94)	< 0.001
Total injuries	87.0 (59, 179)	121.0 (67, 281)	< 0.001
Child involved incidents	2.0 (0, 7)	3.0 (0, 11)	< 0.001
Child involved deaths	0.0 (0, 11)	1.0 (0, 7)	0.018
Child involved injuries	1.0 (0, 20)	3.0 (0, 23)	< 0.001
Home invasion incidents	5.0 (0, 13)	2.0 (0, 8)	< 0.001
Home invasion deaths	1.0 (0, 5)	0 (0, 4)	0.040
Home invasion injured	2.0 (0, 10)	1.0 (0, 6)	0.001
Defensive use incidents	5.0 (0, 10)	3.0 (0, 10)	< 0.001
Defensive use deaths	2.0 (0, 7)	1.0 (0, 7)	0.526
Defensive use injured	3.0 (0, 9)	2.0 (0, 22)	0.125
Mass shooting incidents	1.0 (0, 7)	2.0 (0, 11)	< 0.001
Mass shooting deaths	0.0 (0, 14)	2.0 (0, 11)	< 0.001
Mass shooting injured	4.0 (0, 32)	9.0 (0, 51)	< 0.001
Officer involved incidents	10.0 (5, 20)	13.0 (5, 22)	< 0.001
Officer involved deaths	4.0 (0, 17)	5.0 (0, 13)	0.016
Officer involved injured	4.0 (0, 22)	4.0 (0, 11)	0.023

Bold values indicate statistically significant values ( $P < 0.05$ ).



**Table 5 – Firearm Violence Before (2020 Historical) versus After Reopening (4/10/21-7/31/21).**

Firearm violence	Before 2020 historical, daily median (min, max)	After reopening, daily median (min, max)	P
Total incidents	182.0 (119, 353)	176.0 (115, 293)	0.186
Total deaths	55.0 (27, 118)	58.0 (25, 94)	<b>0.033</b>
Total injuries	120.0 (55, 339)	121.0 (67, 281)	0.279
Child involved incidents	3.0 (0, 13)	3.0 (0, 11)	0.139
Child involved deaths	1.0 (0, 8)	1.0 (0, 7)	0.404
Child involved injuries	3.0 (0, 16)	3.0 (0, 23)	0.230
Home invasion incidents	4.0 (1, 9)	2.0 (0, 8)	<b>&lt; 0.001</b>
Home invasion deaths	1.0 (0, 4)	0 (0, 4)	<b>0.040</b>
Home invasion injured	1.0 (0, 7)	1.0 (0, 6)	<b>0.016</b>
Defensive use incidents	4.0 (0, 11)	3.0 (0, 10)	0.197
Defensive use deaths	2.0 (0, 7)	1.0 (0, 7)	0.381
Defensive use injured	2.0 (0, 15)	2.0 (0, 22)	0.848
Mass shooting incidents	2.0 (0, 15)	2.0 (0, 11)	0.266
Mass shooting deaths	1.0 (0, 12)	2.0 (0, 11)	<b>0.021</b>
Mass shooting injured	6.0 (0, 73)	9.0 (0, 51)	0.339
Officer involved incidents	13.0 (5, 34)	13.0 (5, 22)	0.158
Officer involved deaths	5.0 (0, 12)	5.0 (0, 13)	0.277
Officer involved injured	4.0 (0, 27)	4.0 (0, 11)	0.885

Bold values indicate statistically significant values ( $P < 0.05$ ).

widespread community reopening compared to the 2020 pandemic time period control data. Moreover, median daily mass shooting deaths also increased during this time (2020 historical: one death versus after: two deaths,  $P = 0.021$ ) (Table 5).

## Discussion

Pandemic-related restrictions have been instrumental in curtailing the spread and severity of COVID-19.<sup>23</sup> Thus, given the stabilization of COVID-19 burden, the US has been enabled to resume daily societal activities.<sup>24</sup> However, this retrospective database study demonstrates increased overall firearm violence incidents, injuries, and deaths after widespread community reopenings in the US as well increases in the number of daily mass shooting incidents, injuries, and deaths. There was no difference in defensive firearm use and a decrease in home invasion incidents and deaths in the period after reopening. In all, these spikes in firearm violence following societal reopening point to a “reopening phenomenon” of significantly increased firearm-related incidents, injuries, and deaths associated with societal re-emergence.

Firearm violence has continued to be a healthcare epidemic with around 40,000 firearm deaths annually in the US,<sup>25</sup> which is more than 11 times greater than other high-income countries.<sup>26</sup> Startlingly, the authors’ current study suggests even further worsening of the increased firearm violence seen during the early phases of the pandemic<sup>6,27-31</sup> including domestic firearm violence<sup>32</sup> and pediatric firearm violence.<sup>13</sup> Interestingly, as described in the authors’ previous study, the spikes in firearm violence were not seen with defensive shootings such as home invasion and defensive use. This is despite many

Americans obtaining firearms for the purported reason of protection against socioeconomic uncertainties and fears of rising crime.<sup>12</sup> As such, given the decrease in COVID-19 related deaths, especially in urban cities,<sup>33</sup> a focus of resources must be given to curtail this public health crisis. On a community level, these efforts may include increased education on safe storage of firearms,<sup>34,35</sup> more resources dedicated to protecting adult and pediatric victims of domestic violence,<sup>34</sup> and improving access to mental health services, particularly for individuals who misuse alcohol<sup>36</sup> or other illicit substances.<sup>37</sup> On the state or national level, implementation of stronger gun laws may also help reduce the number of pediatric shooting incidents.<sup>13</sup>

Mass shootings are an unfortunate “American problem”. While Americans comprise approximately 4.4% of the global population, over 31% of the perpetrators of mass shootings historically have been American.<sup>38</sup> This retrospective study demonstrated an increase in mass shooting incidents, injuries, and deaths in the US following a relative lull brought on by the pandemic. This return of mass shootings has been predicted dating back to the beginning of COVID-19.<sup>39</sup> With increased congregation again at schools, places of worship, bars, restaurants, and concerts, there are more opportunities for this form of mass violence.<sup>36</sup> In addition, increased firearm purchases<sup>6</sup> as well as social,<sup>40</sup> economic,<sup>41</sup> and psychological stressors<sup>42</sup> brought on by the pandemic may be linked to this resurgence in mass shootings.<sup>43</sup> However, previous research has described potential interventions that may be effective at decreasing the incidence of mass shootings.<sup>44,45</sup> Examples include: preventing known perpetrators of domestic violence from purchasing a firearm,<sup>44</sup> utilizing extreme risk protection orders to reduce firearm access when the imminent risk of firearm violence is deemed high,<sup>45</sup> and increasing funding of



interdisciplinary research on mass shootings that will continue to inform future policy.

As a retrospective database study, there are certain limitations inherent to the study design including classification/coding errors and missing information. Additionally, as the GVA uses automated internet queries to search police and media reports, there may be an underrepresentation of parts of the country that receive less coverage. However, the GVA is nationally recognized and has been utilized for research previously.<sup>13,46</sup> Because there is no consensus definition of what constitutes a “mass shooting”,<sup>47</sup> this study used the definition provided by the GVA, which aligns exactly with the definition provided by the Federal Bureau of Investigation.<sup>48</sup> Moreover, although these findings suggest that stronger gun laws may be appropriate to address the “reopening phenomenon” of increased firearm violence following widespread community reopening, the authors acknowledge that there are many other risk factors that must be addressed in order to curtail the surge of daily firearm injuries and deaths. Additionally, as the database does not allow for a breakdown of homicide, suicide, and accidental shootings, it is difficult to identify targeted public policy interventions at this time and a broader approach may be needed first to curtail the spike in firearm violence until more is known specifically about the types of shootings. And, finally, although the cutoff point for “before” versus “after” widespread community reopening was set based off vaccination data as well as reopening decisions from multiple major cities, the inability to set a true cutoff date that is applicable nationally is a significant limitation of this study.

### Conclusions

This retrospective analysis demonstrates a worsening “reopening phenomenon” following widespread lifting of pandemic-related restrictions in the setting of increased firearm purchases and overall socioeconomic chaos brought on by the start of the COVID-19 pandemic. This study also provides evidence of an increase in mass shootings in the aftermath of the pandemic. As COVID-19 related deaths have begun to stabilize, increased efforts to curtail a worsening firearm related epidemic in the US are immediately needed.

### Author Contributions

M.R.D. and J.N. were involved in conception and design, analysis and interpretation of the data, drafting the article, critically revising the article and providing final approval. C.K., B.S., L.S., C.D., A.G. and S.S. were involved in the design, interpretation of the data, critically revising the article and providing final approval.

### Acknowledgments

None.

### Disclosure

None declared.

### Funding

None.

### REFERENCES

1. Donnelly MR, Barie PS, Grigorian A, et al. New York State and the nation: trends in firearm purchases and firearm violence during the COVID-19 pandemic. *Am Surg.* 2021;87:690–697.
2. Crifasi CK, Ward JA, McGinty EE, Webster DW, Barry CL. Gun purchasing behaviours during the initial phase of the COVID-19 pandemic, March to mid-July 2020. *Int Rev Psychiatry.* 2021;33:593–597.
3. Caputi TL, Ayers JW, Dredze M, Suplina N, Burd-Sharps S. Collateral crises of gun preparation and the COVID-19 pandemic: infodemiology study. *JMIR Public Health Surveill.* 2020;6:e19369.
4. Lyons VH, Haviland MJ, Azrael D, et al. Firearm purchasing and storage during the COVID-19 pandemic. *Inj Prev.* 2021;27:87–92.
5. Anestis MD, Bryan CJ. Threat perceptions and the intention to acquire firearms. *J Psychiatr Res.* 2021;133:113–118.
6. Schleimer JP, McCort CD, Shev AB, et al. Firearm purchasing and firearm violence during the coronavirus pandemic in the United States: a cross-sectional study. *Inj Epidemiol.* 2021;8:43.
7. Young KN, Yeates EO, Grigorian A, et al. Drug and alcohol positivity of traumatically injured patients related to COVID-19 stay-at-home orders. *Am J Drug Alcohol Abuse.* 2021;47:605–611.
8. Satre DD, Meacham MC, Asarnow LD, Fisher WS, Fortuna LR, Iturralde E. Opportunities to integrate mobile app-based interventions into mental health and substance use disorder treatment services in the wake of COVID-19. *Am J Health Promot.* 2021;35:1178–1183.
9. Sarani B. COVID-19 and firearm injury: a uniquely American problem. *J Am Coll Surg.* 2021;232:168–169.
10. Cohen JS, Donnelly K, Patel SJ, et al. Firearm injuries involving young children in the United States during the COVID-19 pandemic. *Pediatrics.* 2021;148. e2020042697.
11. Abdallah HO, Zhao C, Kaufman E, et al. Increased firearm injury during the COVID-19 pandemic: a hidden urban burden. *J Am Coll Surg.* 2021;232:159.
12. Donnelly MR, Grigorian A, Inaba K, et al. A dual pandemic: the influence of coronavirus disease 2019 on trends and types of firearm violence in California, Ohio, and the United States. *J Surg Res.* 2021;263:24–33.
13. Donnelly M, Grigorian A, Swentek L, et al. Firearm violence against children in the United States: trends in the wake of the COVID-19 pandemic. *J Trauma Acute Care Surg.* 2021;92:65–68.
14. NY Times. See reopening plans and mask mandates for all 50 states. 2021. Available at: <https://www.nytimes.com/interactive/2020/us/states-reopen-map-coronavirus.html>. Accessed December 11, 2021.
15. Northwestern Now. Why is violent behavior spiking as pandemic ebbs? Isn't this supposed to be a happy time?. 2021. Available at: <https://news.northwestern.edu/stories/2021/06/why-is-violent-behavior-spiking-as-pandemic-ebbs/&fj=1>. Accessed November 14, 2021.

16. Gun Violence Archive. Available at: <https://www.gunviolencearchive.org/>. Accessed August 17, 2021.
17. Centers for Disease Control and Prevention. COVID data tracker. 2021. Available at: <https://covid.cdc.gov/covid-data-tracker/#datatracker-home>. Accessed August 17, 2021.
18. Office of Governor Gavin Newsom. Governor Newsom outlines the state's next step in the COVID-19 pandemic recovery, moving beyond the blueprint. 2021. Available at: <https://www.gov.ca.gov/2021/04/06/governor-newsom-outlines-the-states-next-step-in-the-covid-19-pandemic-recovery-moving-beyond-the-blueprint/>. Accessed October 30, 2021.
19. Hills M. COVID vaccine rollout gives US hope amid variant concerns. BBC News. 2021. Available at: <https://www.bbc.com/news/world-us-canada-55952899>. Accessed July 12, 2022.
20. NPR. New York City. Former COVID-19 epicenter, to 'fully reopen' on July 1. 2021. Available at: <https://www.npr.org/sections/coronavirus-live-updates/2021/04/29/991949214/new-york-city-former-covid-19-epicenter-to-fully-reopen-on-july-1>. Accessed October 30, 2021.
21. Mayor's Press Office. Mayor lightfoot announces the launch of "open chicago.". 2021. Available at: [https://www.chicago.gov/city/en/depts/cdph/provdrs/health\\_protection\\_and\\_response/news/2021/april/mayor-lightfoot-announces-the-launch-of-open-chicago-.html](https://www.chicago.gov/city/en/depts/cdph/provdrs/health_protection_and_response/news/2021/april/mayor-lightfoot-announces-the-launch-of-open-chicago-.html). Accessed October 30, 2021.
22. World Health Organization. COVID-19 weekly epidemiological update. 2021. Available at: <https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19--28-december-2021>. Accessed July 16, 2022.
23. Centers for Disease Control and Prevention. Science brief: COVID-19 vaccines and vaccination. 2021. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/fully-vaccinated-people.html>. Accessed October 30, 2021.
24. COVID19.CA.GOV. Current safety measures. 2021. Available at: <https://covid19.ca.gov/safely-reopening/>. Accessed October 30, 2021.
25. Centers for Disease Control and Prevention. National center for health statistics: all injuries. 2021. Available at: <https://www.cdc.gov/nchs/fastats/injury.htm>. Accessed October 30, 2021.
26. Grinshteyn E, Hemenway D. Violent death rates in the US compared to those of the other high-income countries. *Prev Med*. 2015;2019:20–26.
27. Yeates EO, Grigorian A, Barrios C, et al. Changes in traumatic mechanisms of injury in Southern California related to COVID-19: penetrating trauma as a second pandemic. *J Trauma Acute Care Surg*. 2021;90:714–721.
28. Collings AT, Farazi M, Van Arendonk KJ, et al. The COVID-19 pandemic and associated rise in pediatric firearm injuries: a multi-institutional study. *J Pediatr Surg*. 2022;57:1370–1376.
29. Murrett J, Fu E, Maher Z, Bae C, Satz WA, Schreyer KE. Impact of COVID-19 and shelter in place on volume and type of traumatic injuries. *West J Emerg Med*. 2021;22:1060–1066.
30. Kim DY, Phillips SW. When COVID-19 and guns meet: a rise in shootings. *J Crim Justice*. 2021;73:101783.
31. Afif IN, Gobaud AN, Morrison CN, et al. The changing epidemiology of interpersonal firearm violence during the COVID-19 pandemic in Philadelphia, PA. *Prev Med*. 2022;158:107020.
32. Cantor E, Salas R, Torres R. Femicide and attempted femicide before and during the COVID-19 pandemic in Chile. *Int J Environ Res Publ Health*. 2022;19:8012.
33. CBS News. Covid-19 death rate in rural America now double that of urban communities. 2021. Available at: <https://www.cbsnews.com/news/covid-19-deaths-rural-america-double-urban-communities/>. Accessed November 14, 2021.
34. Duncan TK, Weaver JL, Zakrisson TL, et al. Domestic violence and safe storage of firearms in the COVID-19 era. *Ann Surg*. 2020;272:e55–e57.
35. Hemenway D, Rausher S, Violano P, Raybould TA, Barber CW. Firearms training: what is actually taught? *Inj Prev*. 2019;25:123–128.
36. Morgan ER, Gomez A, Rivara FP, Rowhani-Rahbar A. Firearm storage and adult alcohol misuse among Washington state households with children. *JAMA Pediatr*. 2019;173:37–43.
37. Hohl BC, Wiley S, Wiebe DJ, Culyba AJ, Drake R, Branas CC. Association of drug and alcohol use with adolescent firearm homicide at individual, family, and neighborhood levels. *JAMA Intern Med*. 2017;177:317–324.
38. The New York Times. Why does the U.S. Have so many mass shootings? Research is clear: guns. 2017. Available at: <https://www.nytimes.com/2017/11/07/world/americas/mass-shootings-us-international.html>. Accessed October 30, 2021.
39. Klemko R. Gatherings as states reopen could spell return of another dark American phenomenon: mass shootings. 2020. Available at: [https://www.washingtonpost.com/national/coronavirus-reopening-mass-shootings/2020/05/28/8b8ea396-a02e-11ea-81bb-c2f70f01034b\\_story.html](https://www.washingtonpost.com/national/coronavirus-reopening-mass-shootings/2020/05/28/8b8ea396-a02e-11ea-81bb-c2f70f01034b_story.html). Accessed October 23, 2021.
40. Elmer T, Mephram K, Stadtfeld C. Students under lockdown: comparisons of students' social networks and mental health before and during the COVID-19 crisis in Switzerland. *PLoS One*. 2020;15:e0236337.
41. Ettman CK, Abdalla SM, Cohen GH, Sampson L, Vivier PM, Galea S. Low assets and financial stressors associated with higher depression during COVID-19 in a nationally representative sample of US adults. *J Epidemiol Community Health*. 2020. jech-2020–215213.
42. Ettman CK, Abdalla SM, Cohen GH, Sampson L, Vivier PM, Galea S. Prevalence of depression symptoms in US adults before and during the COVID-19 pandemic. *JAMA Netw Open*. 2020;3:e2019686.
43. McPhedran S. Australian mass shootings: an analysis of incidents and offenders. *J Interpers Violence*. 2020;35:3939–3962.
44. Gold LH. Domestic violence, firearms, and mass shootings. *J Am Acad Psychiatry Law*. 2020;48:35–42.
45. Wintemute GJ, Pear VA, Schleimer JP, et al. Extreme risk protection orders intended to prevent mass shootings: a case series. *Ann Intern Med*. 2019;171:655–658.
46. Peña PA, Jena A. Mass shootings in the US during the COVID-19 pandemic. *JAMA Netw Open*. 2021;4:e2125388.
47. Bates J. What counts as a mass shooting? Why so much of America's gun violence gets overlooked. 2021. Available at: <https://time.com/5947893/what-constitutes-a-mass-shooting/>. Accessed October 23, 2021.
48. Department of Criminology Penn Arts & Sciences. What is a mass shooting? What can be done? Available at: <https://crim.sas.upenn.edu/fact-check/what-mass-shooting-what-can-be-done>. Accessed November 21, 2021.