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A Dual Pandemic: The Influence of Coronavirus Disease 2019 on Trends and Types of Firearm Violence in California, Ohio, and the United States

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ABSTRACT

Background: This study sought to determine the impact of coronavirus disease 2019 stay-at-home (SAH) and reopening orders on trends and types of firearm violence in California, Ohio, and the United States, hypothesizing increased firearm violence after SAH.
Materials and methods: Retrospective data (January 1, 2018, to July 31, 2020) on firearm incidents/injuries/deaths and types of firearm violence were obtained from the Gun Violence Archive. The periods for SAH and reopening for the US were based on dates for California. Ohio dates were based on Ohio's timeline. Mann—Whitney U analyses compared trends and types of daily firearm violence per 100,000 legal firearm owners across 2018-2020 periods.
Results: In California, SAH and reopening orders had no effect on firearm violence in 2020 compared with 2018 and 2019 periods, respectively. In Ohio, daily median firearm deaths increased during 2020 SAH compared with 2018 and 2019 and firearm incidents and injuries increased during 2020 reopening compared with 2018, 2019 and 2020 SAH. In the United States, during 2020, SAH firearm deaths increased compared with historical controls and firearm incidents, deaths and injuries increased during 2020 reopening compared with 2018, 2019 and 2020 SAH (all P < 0.05). Nationally, when compared with 2018 and 2019, 2020 SAH had increased accidental shootings deaths with a decrease in defensive use, home invasion, and drug-involved incidents.
Conclusions: During 2020 SAH, the rates of firearm violence increased in Ohio and the United States but remained unchanged in California. Nationally, firearm incidents, deaths and injuries also increased during 2020 reopening *versus* historical and 2020 SAH data. This suggests a secondary "pandemic" as well as a "reopening phenomenon," with increased firearm violence not resulting from self-defense.

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Introduction

By the end of August 2020, the United States (US) had a case fatality rate of 3.1% and a total coronavirus disease 19 (COVID-19) death count of over 180,000 Americans.[1] During this time, California had nearly 700,000 confirmed cases and nearly 13,000 fatalities,[2] with some calling it the new COVID-19 "epicenter."[3]

Many measures have been taken to try to eliminate the threat of the virus and slow its transmission. For instance, California, the most populous state, implemented the first statewide stay-at-home (SAH) order in the US on March 19, 2020.[4] However, as a consequence of social distancing, quarantining, and the SAH orders themselves, the social and economic well-being of many Americans has been profoundly impacted. Furthermore, preliminary studies have shown that as a result of SAH, quarantine, and travel ban orders,[5] many individuals have found that their social networks have been depleted.[6] Feelings of isolation because of these national and statewide orders have not only exacerbated preexisting mental health conditions,[7] but these measures are provoking new diagnoses of alcohol and substance abuse disorders.[7,8] In addition, the rate of domestic violence has also increased based on some reports,[9-12] as have rates of self-harm and suicide.[13-15]

Born out of these pandemic-related stressors, one additional public health concern that has emerged is the drastic increase in the sales of firearms. These sales are considered "panic purchases,"[16-19] with owners purporting that they will be needed for self-defense. Some states have even deemed firearm retailers to be "essential businesses."[20] A recent mid-pandemic survey study performed by Kravitz-Wirtz et al. found that, in the state of California, there were an estimated 110,000 adults who acquired a firearm in response to the pandemic. Of these, 47,000 (43.0%) were first-time owners.[21] This may at least partially explain why Hatchimonji et al. demonstrated that firearm-related injuries have persisted unabated throughout the pandemic[22] despite orders to SAH. Commentary from other US trauma centers has postulated that firearm violence is paradoxically increasing despite overall crime rates dropping during the COVID-19 pandemic.[23-25] In addition, the authors of this article have recently published a study detailing the effects of the pandemic on firearm purchases and firearm violence in both the US and New York State during the initial phase of the pandemic.[26]

The purpose of this study was to quantify the impact of SAH and reopening orders on trends and particular types of firearm violence in California, Ohio, and the US. Despite intuition leading one to initially believe that SAH orders might decrease the rates of firearm violence, as a result of the aforementioned reports we hypothesize overall increased rates of firearm violence during SAH that may continue to increase during reopening compared with 2018 and 2019 historical controls. In addition, we hypothesize a decrease in defensive forms of firearm violence (i.e., victim stopping a crime) across the nation with a simultaneous increase in accidental shootings during SAH compared with 2018 and 2019.

Materials and methods

This study was deemed exempt by the Institutional Review Board, and as such, no consent was needed. No funding was provided for this study. Firearm violence data were obtained retrospectively (January 2018 to July 2020) from the Gun Violence Archive (GVA). The GVA is a not-for-profit, independent organization whose goal is to provide accurate, evidence-based research to the American public on gun-related violence in the US. The GVA uses automated Internet queries in addition to manual investigations to parse through over 7500 sources reporting on firearm violence each day. The sources used by the GVA include police reports, news and media, online databases, as well as government and other resources. The data generated from these investigations are then organized into incidents, deaths, and injuries as well as into categories such as accidental shootings, hate crimes, home invasions, domestic violence, defensive gun use, and more. However, real-time data on firearm suicides and armed robberies with no injuries are not reported.[27]

Dates for SAH (March 19, 2020, to May 24, 2020) and reopening orders (May 25, 2020, to July 31, 2020) for California were used for both California and US analyses.[4,28] This was because of the highly variable timing of implementation and cessation of SAH orders for states, as well as the fact that eight states never implemented statewide SAH orders. The states that never implemented SAH were North Dakota, South Dakota, Nebraska, Iowa, and Arkansas and the states that only implemented partial SAH were Wyoming, Utah, and Oklahoma.[4,28] These eight states were excluded from analysis, and as such, only data for the remaining 42 states and the District of Columbia were included.

California was selected as the focus for this article, as the authors' own anecdotal experiences were of increased firearm violence across Southern California. In addition, California has the strictest gun laws in the country (rated first out of 50 states) per the Giffords Law Center.[29] Ohio, which is ranked 24th out of 50, was selected for comparison to California, as the state's gun laws are much less stringent, with no requirements for universal background checks and no regulation of untraceable firearms.[29] However, regarding pandemic policies, both states had relatively similar, strict SAH orders and phased reopenings, making Ohio an ideal control. Ohio's SAH period was defined as March 23, 2020, to May 19, 2020, and its reopening was defined as May 19, 2020, to July 31, 2020.[30]

Data on the number of legal firearm owners by state were obtained from the World Population Review. This is an independent organization with no political affiliations whose goal is to make important data accessible and easy to understand.[31] These numbers were used to weight daily firearm violence by the number of legal firearm owners in each state to allow for comparison between California, Ohio, and the US.

Mann–Whitney U tests were run to quantify the effects of SAH and reopening orders on daily firearm violence per 100,000 legal firearm owners compared with 2018 and 2019 historical control data for California, Ohio, and the US. An

Table 1 — 2018 historical control *versus* 2020 SAH, per 100,000 licensed firearm owners.

Outcome measure	2018 control	SAH	P value
California			
Firearm incidents per day, median (min, max)	2.61 (0.87, 6.09)	2.61 (0.58, 4.93)	0.096
Firearm deaths per day, median (min, max)	0.87 (0.00, 3.77)	0.87 (0.00, 3.19)	0.117
Firearm injuries per day, median (min, max)	1.16 (0.00, 3.77)	1.45 (0.00, 3.77)	0.014
Ohio			
Firearm incidents per day, median (min, max)	4.04 (1.73, 9.23)	3.46 (0.58, 7.50)	0.048
Firearm deaths per day, median (min, max)	0.58 (0.00, 2.88)	0.58 (0.00, 4.04)	0.033
Firearm injuries per day, median (min, max)	1.73 (0.00, 7.50)	1.73 (0.00, 8.07)	0.197
The United States			
Firearm incidents per day, median (min, max)	3.18 (2.59, 4.01)	2.82 (1.93, 4.37)	<0.001
Firearm deaths per day, median (min, max)	0.78 (0.34, 1.32)	0.89 (0.51, 1.46)	0.001
Firearm injuries per day, median (min, max)	1.57 (0.95, 2.38)	1.65 (1.06, 2.97)	0.103

additional analysis for types of firearm incidents for the nation was performed. Only trends that were consistent when comparing 2020 to both 2018 and 2019 were considered to be significant. Because of the very low occurrence of daily firearm violence in California and Ohio, analysis of trends or changes in types of firearm violence was not performed. Statistics were performed on IBM SPSS Statistics, version 26 (IBM Corp, Armonk, NY). Statistical significance was set as $P < 0.05$.

Results

Trends in firearm violence: California, Ohio, and the US

In California, there were no consistent increases in daily firearm violence per 100,000 legal firearm owners during 2020 SAH compared with 2018 and 2019 control periods, respectively. In addition, California did not experience a consistent increase in firearm incidents, deaths and injuries during 2020

reopening compared with 2018, 2019, and 2020 SAH control data.

In contrast, Ohio had increased daily firearm deaths per day in 2020 SAH compared with 2018 (maximum: 2.88 *versus* 4.04; $P = 0.033$) and 2019 (maximum: 2.88 *versus* 4.04; $P = 0.031$). Moreover, Ohio had increased median daily firearm incidents and injuries per 100,000 legal gun owners between 2020 reopening and 2018, 2019, and 2020 SAH (all $P < 0.05$).

Nationally, the US experienced increased firearm deaths in 2020 SAH compared with both 2018 (0.78 *versus* 0.89; $P = 0.001$) and 2019 (0.78 *versus* 0.89; $P < 0.001$). The median daily firearm incidents, deaths and injuries also increased during 2020 reopening in the US compared with 2018, 2019, and 2020 SAH (all $P < 0.05$) (Tables 1-5).

Types of firearm violence during SAH

Median daily accidental shooting deaths per 100,000 legal firearm owners increased in 2020 SAH compared with 2018

Table 2 — 2019 historical control *versus* 2020 SAH, per 100,000 licensed firearm owners.

Outcome measure	2019 control	SAH	P value
California			
Firearm incidents per day, median (min, max)	2.61 (0.58, 4.35)	2.61 (0.58, 4.93)	0.386
Firearm deaths per day, median (min, max)	0.87 (0.00, 2.61)	0.87 (0.00, 3.19)	0.442
Firearm injuries per day, median (min, max)	1.45 (0.00, 4.93)	1.45 (0.00, 3.77)	0.571
Ohio			
Firearm incidents per day, median (min, max)	4.04 (0.58, 8.07)	3.46 (0.58, 7.50)	0.209
Firearm deaths per day, median (min, max)	0.58 (0.00, 2.88)	0.58 (0.00, 4.04)	0.031
Firearm injuries per day, median (min, max)	1.73 (0.00, 5.19)	1.73 (0.00, 8.07)	0.227
The United States			
Firearm incidents per day, median (min, max)	2.93 (2.25, 3.69)	2.82 (1.93, 4.37)	0.331
Firearm deaths per day, median (min, max)	0.78 (0.36, 1.19)	0.89 (0.51, 1.46)	<0.001
Firearm injuries per day, median (min, max)	1.61 (0.93, 2.74)	1.65 (1.06, 2.97)	0.215

Table 3 – 2018 historical control *versus* 2020 reopening, per 100,000 licensed firearm owners.			
Outcome measure	2018 control	Reopening	P value
California			
Firearm incidents per day, median (min, max)	2.90 (1.16, 5.22)	2.90 (1.16, 6.96)	0.453
Firearm deaths per day, median (min, max)	1.16 (0.00, 2.90)	1.45 (0.00, 3.77)	0.056
Firearm injuries per day, median (min, max)	1.45 (0.29, 5.80)	1.74 (0.00, 5.51)	0.031
Ohio			
Firearm incidents per day, median (min, max)	4.61 (1.73, 8.65)	5.19 (1.15, 13.84)	0.028
Firearm deaths per day, median (min, max)	1.15 (0.00, 3.46)	1.15 (0.00, 3.46)	0.060
Firearm injuries per day, median (min, max)	2.31 (0.58, 8.07)	4.04 (0.58, 12.11)	<0.001
The United States			
Firearm incidents per day, median (min, max)	3.14 (2.48, 5.09)	3.89 (2.95, 7.28)	<0.001
Firearm deaths per day, median (min, max)	0.86 (0.59, 1.29)	1.18 (0.59, 2.44)	<0.001
Firearm injuries per day, median (min, max)	1.76 (1.08, 3.33)	2.72 (1.80, 6.92)	<0.001

(0.00 *versus* 0.02; P = 0.007) and 2019 (maximum: 0.13 *versus* 0.17; P = 0.001). Meanwhile, the median daily home invasion, defensive use, and drug-involved incidents all decreased in 2020 SAH compared with 2018 (home invasion: 0.11 *versus* 0.06, P < 0.001; defensive use: 0.11 *versus* 0.06, P < 0.001; drug involved: 0.28 *versus* 0.08, P < 0.001) and 2019 (home invasion: 0.08 *versus* 0.06, P = 0.001; defensive use: 0.08 *versus* 0.06, P = 0.001; drug involved: 0.23 *versus* 0.08; P < 0.001) (Tables 6 and 7).

Types of firearm violence during reopening

There was an increase in 2020 reopening median daily accidental shooting deaths and injuries as well as median daily child-involved shooting incidents and injuries per 100,000 legal firearm owners compared with 2018 (accidental shooting deaths: 0.02 *versus* 0.04, P = 0.001; accidental shooting injuries: 0.06 *versus* 0.11, P < 0.001; child-involved shooting incidents: 0.04 *versus* 0.06, P < 0.001; child-involved shooting injuries: 0.04 *versus* 0.08, P < 0.001), 2019 (accidental shooting deaths: 0.02 *versus* 0.04, P = 0.021; accidental shooting injuries: 0.08 *versus* 0.11, P = 0.014; child-involved shooting incidents: 0.04 *versus* 0.06, P < 0.001; child-involved shooting injuries: 0.02 *versus* 0.08, P < 0.001) and 2020 SAH (accidental shooting deaths: 0.02 *versus* 0.04, P = 0.021; accidental shooting injuries: 0.06 *versus* 0.11, P = 0.001; child-involved shooting incidents: 0.04 *versus* 0.06, P < 0.001; child-involved shooting injuries: 0.04 *versus* 0.08, P < 0.001), whereas there was a decrease in 2020 reopening drug-involved incidents compared with 2018 (0.25 *versus* 0.06, P < 0.001), 2019 (0.02 *versus* 0.01, P = 0.001), and 2020 SAH (0.02 *versus* 0.01, P = 0.015) (Tables 8-10).

Discussion

This retrospective database study indicates a national increase in firearm violence during the 2020 SAH and reopening periods of the COVID-19 pandemic. Although the authors could not report consistently increased firearm violence in California during the two 2020 periods compared

Table 4 – 2019 historical control *versus* 2020 reopening, per 100,000 licensed firearm owners.			
Outcome measure	2019 control	Reopening	P value
California			
Firearm incidents per day, median (min, max)	2.90 (1.16, 5.22)	2.90 (1.16, 6.96)	0.960
Firearm deaths per day, median (min, max)	1.16 (0.00, 3.48)	1.45 (0.00, 3.77)	0.031
Firearm injuries per day, median (min, max)	1.74 (0.29, 6.67)	1.74 (0.00, 5.51)	0.776
Ohio			
Firearm incidents per day, median (min, max)	4.33 (1.15, 10.96)	5.19 (1.15, 13.84)	0.021
Firearm deaths per day, median (min, max)	1.15 (0.00, 4.04)	1.15 (0.00, 3.46)	0.082
Firearm injuries per day, median (min, max)	2.31 (0.00, 6.34)	4.04 (0.58, 12.11)	<0.001
The United States			
Firearm incidents per day, median (min, max)	3.31 (2.23, 5.26)	3.89 (2.95, 7.28)	<0.001
Firearm deaths per day, median (min, max)	0.92 (0.53, 1.61)	1.18 (0.59, 2.44)	<0.001
Firearm injuries per day, median (min, max)	1.82 (1.17, 3.71)	2.72 (1.80, 6.92)	<0.001

Table 5 — 2020 SAH *versus* 2020 reopening, per 100,000 licensed firearm owners.

Outcome measure	SAH	Reopening	P value
California			
Firearm incidents per day, median (min, max)	2.61 (0.58, 4.93)	2.90 (1.16, 6.96)	0.025
Firearm deaths per day, median (min, max)	0.87 (0.00, 3.19)	1.45 (0.00, 3.77)	0.001
Firearm injuries per day, median (min, max)	1.45 (0.00, 3.77)	1.74 (0.00, 5.51)	0.094
Ohio			
Firearm incidents per day, median (min, max)	3.46 (0.58, 7.50)	5.19 (1.15, 13.84)	<0.001
Firearm deaths per day, median (min, max)	0.58 (0.00, 4.04)	1.15 (0.00, 3.46)	0.007
Firearm injuries per day, median (min, max)	1.73 (0.00, 8.07)	4.04 (0.58, 12.11)	<0.001
The United States			
Firearm incidents per day, median (min, max)	2.82 (1.93, 4.37)	3.89 (2.95, 7.28)	<0.001
Firearm deaths per day, median (min, max)	0.89 (0.51, 1.46)	1.18 (0.59, 2.44)	<0.001
Firearm injuries per day, median (min, max)	1.65 (1.06, 2.97)	2.72 (1.80, 6.92)	<0.001

Table 6 — Types of firearm violence 2018 historical control (March 19, 2018, to May 24, 2018) *versus* 2020 SAH (March 19, 2020, to May 24, 2020), per 100,000 licensed firearm owners.

Outcome measure	2018 control	SAH	P value
Accidental shooting, median (min, max)			
Incidents	0.08 (0.00, 0.30)	0.11 (0.02, 0.25)	0.056
Deaths	0.00 (0.00, 0.08)	0.02 (0.00, 0.17)	0.007
Injuries	0.06 (0.00, 0.23)	0.06 (0.00, 0.25)	0.144
Child-involved incidents, median (min, max)			
Incidents	0.04 (0.00, 0.08)	0.04 (0.00, 0.21)	0.077
Deaths	0.00 (0.00, 0.13)	0.02 (0.00, 0.13)	0.024
Injuries	0.02 (0.00, 0.17)	0.04 (0.00, 0.17)	0.054
Home invasion, median (min, max)			
Incidents	0.11 (0.00, 0.21)	0.06 (0.00, 0.19)	<0.001
Deaths	0.02 (0.00, 0.08)	0.02 (0.00, 0.08)	0.664
Injuries	0.04 (0.00, 0.13)	0.02 (0.00, 0.15)	0.012
Officer involved incident, median (min, max)			
Incidents	0.25 (0.11, 0.45)	0.25 (0.11, 0.47)	0.448
Deaths	0.08 (0.00, 0.28)	0.08 (0.00, 0.25)	0.507
Injuries	0.08 (0.00, 0.38)	0.08 (0.00, 0.28)	0.864
Defensive use, median (min, max)			
Incidents	0.11 (0.02, 0.30)	0.06 (0.00, 0.17)	<0.001
Deaths	0.02 (0.00, 0.19)	0.02 (0.00, 0.08)	0.594
Injuries	0.06 (0.00, 0.17)	0.04 (0.00, 0.15)	0.013
Gang involvement, median (min, max)			
Incidents	0.04 (0.00, 0.17)	0.02 (0.00, 0.17)	0.002
Deaths	0.00 (0.00, 0.06)	0.00 (0.00, 0.06)	0.378
Injuries	0.02 (0.00, 0.15)	0.02 (0.00, 0.25)	0.909
Drug involvement, median (min, max)			
Incidents	0.28 (0.06, 0.55)	0.08 (0.02, 0.21)	<0.001
Deaths	0.02 (0.00, 0.08)	0.02 (0.00, 0.13)	0.537
Injuries	0.02 (0.00, 0.15)	0.02 (0.00, 0.11)	0.146
Domestic violence, median (min, max)			
Incidents	0.17 (0.04, 0.34)	0.19 (0.04, 0.36)	0.273
Deaths	0.11 (0.00, 0.30)	0.13 (0.00, 0.25)	0.581
Injuries	0.06 (0.00, 0.17)	0.06 (0.00, 0.28)	0.320

Table 7 — Types of firearm violence 2019 historical control (March 19, 2019, to May, 24, 2019) *versus* 2020 SAH (March 19, 2020, to May 24, 2020), per 100,000 licensed firearm owners.

Outcome measure	2019 control	SAH	P value
Accidental shooting, median (min, max)			
Incidents	0.06 (0.02, 0.21)	0.11 (0.02, 0.25)	<0.001
Deaths	0.02 (0.00, 0.13)	0.02 (0.00, 0.17)	0.001
Injuries	0.04 (0.00, 0.17)	0.06 (0.00, 0.25)	0.003
Child-involved incidents, median (min, max)			
Incidents	0.02 (0.00, 0.08)	0.04 (0.00, 0.21)	0.031
Deaths	0.00 (0.00, 0.11)	0.02 (0.00, 0.13)	0.084
Injuries	0.02 (0.00, 0.15)	0.04 (0.00, 0.17)	0.241
Home invasion, median (min, max)			
Incidents	0.08 (0.02, 0.21)	0.06 (0.00, 0.19)	0.001
Deaths	0.02 (0.00, 0.08)	0.02 (0.00, 0.08)	0.648
Injuries	0.02 (0.00, 0.19)	0.02 (0.00, 0.15)	0.295
Officer involved incident, median (min, max)			
Incidents	0.19 (0.08, 0.40)	0.25 (0.11, 0.47)	<0.001
Deaths	0.06 (0.00, 0.17)	0.08 (0.00, 0.25)	0.053
Injuries	0.06 (0.00, 0.28)	0.08 (0.00, 0.28)	0.048
Defensive use, median (min, max)			
Incidents	0.08 (0.00, 0.17)	0.06 (0.00, 0.17)	0.001
Deaths	0.02 (0.00, 0.15)	0.02 (0.00, 0.08)	0.102
Injuries	0.04 (0.00, 0.15)	0.04 (0.00, 0.15)	0.189
Gang involvement, median (min, max)			
Incidents	0.02 (0.00, 0.13)	0.02 (0.00, 0.17)	0.987
Deaths	0.00 (0.00, 0.08)	0.00 (0.00, 0.06)	0.483
Injuries	0.00 (0.00, 0.21)	0.02 (0.00, 0.25)	0.168
Drug involvement, median (min, max)			
Incidents	0.23 (0.04, 0.47)	0.08 (0.02, 0.21)	<0.001
Deaths	0.02 (0.00, 0.11)	0.02 (0.00, 0.13)	0.156
Injuries	0.02 (0.00, 0.11)	0.02 (0.00, 0.11)	0.185
Domestic violence, median (min, max)			
Incidents	0.15 (0.06, 0.32)	0.19 (0.04, 0.36)	0.024
Deaths	0.08 (0.00, 0.28)	0.13 (0.00, 0.25)	0.040
Injuries	0.06 (0.00, 0.13)	0.06 (0.00, 0.28)	0.147

with control data, it is important to note that SAH orders were unable to decrease daily rates of firearm violence in this state. Perhaps because of California's strict gun laws, only Ohio saw increased firearm violence during SAH and during phased reopening. With regard to national data, although most firearm purchases were reportedly made for reasons of self-defense, defensive use and home invasions involving firearms decreased nationally during SAH. Instead, accidental shooting deaths increased during this time. In addition, a "reopening phenomenon" of increased firearm violence compared with a corresponding 2018 and 2019 historical control and to 2020 SAH was also observed across the US.

SAH orders were implemented in 42 US states and the District of Columbia to mitigate the transmission and effects of COVID-19[4]. Although the reports have shown that these methods appear effective for combating the pandemic,[32]

preliminary data demonstrate that SAH orders may have unintended consequences. For instance, this study demonstrated that firearm deaths in the US increased after SAH orders. Furthermore, SAH orders were unable to decrease the median number of firearm incidents, deaths, and injuries per day even in the first state to enact this order, California. Most intriguingly, although purchasers of firearms intended to use their weapons for defensive purposes, defensive firearm incidents and home invasions actually decreased during SAH. Contrarily, the types of firearm-related deaths that increased were related to accidental shootings. Given that a recent survey study found that around 40% of individuals have been storing at least one firearm unlocked in their home during the pandemic[33] and that other reports have shown a spike in first-time gun owners,[21] our results suggest that pandemic-related firearm ownership may be doing more harm to owners and their families during SAH than good. This suggests that the

Table 8 — Types of firearm violence 2018 historical control (May 25, 2018, to July 31, 2018) *versus* 2020 reopening (May 25, 2020, to July 31, 2020), per 100,000 licensed firearm owners.

Outcome measure	2018 control	Reopening	P value
Accidental shooting, median (min, max)			
Incidents	0.08 (0.02, 0.23)	0.13 (0.04, 0.36)	0.004
Deaths	0.02 (0.00, 0.19)	0.04 (0.00, 0.19)	0.001
Injuries	0.06 (0.00, 0.28)	0.11 (0.02, 0.34)	<0.001
Child-involved incidents, median (min, max)			
Incidents	0.04 (0.00, 0.15)	0.06 (0.00, 0.28)	<0.001
Deaths	0.02 (0.00, 0.11)	0.02 (0.00, 0.17)	0.283
Injuries	0.04 (0.00, 0.28)	0.08 (0.00, 0.34)	<0.001
Home invasion, median (min, max)			
Incidents	0.11 (0.02, 0.23)	0.06 (0.00, 0.17)	<0.001
Deaths	0.02 (0.00, 0.08)	0.02 (0.00, 0.08)	0.646
Injuries	0.04 (0.00, 0.17)	0.02 (0.00, 0.11)	0.024
Officer involved incident, median (min, max)			
Incidents	0.23 (0.08, 0.47)	0.25 (0.11, 0.72)	0.020
Deaths	0.06 (0.00, 0.23)	0.08 (0.00, 0.21)	0.481
Injuries	0.08 (0.00, 0.49)	0.08 (0.00, 0.57)	0.472
Defensive use, median (min, max)			
Incidents	0.11 (0.00, 0.21)	0.08 (0.02, 0.23)	0.004
Deaths	0.04 (0.00, 0.11)	0.04 (0.00, 0.13)	0.432
Injuries	0.06 (0.00, 0.19)	0.04 (0.00, 0.32)	0.704
Gang involvement, median (min, max)			
Incidents	0.04 (0.00, 0.13)	0.02 (0.00, 0.13)	0.001
Deaths	0.02 (0.00, 0.08)	0.02 (0.00, 0.08)	0.547
Injuries	0.02 (0.00, 0.40)	0.02 (0.00, 0.34)	0.504
Drug involvement, median (min, max)			
Incidents	0.25 (0.02, 0.47)	0.06 (0.00, 0.23)	<0.001
Deaths	0.02 (0.00, 0.08)	0.01 (0.00, 0.13)	0.330
Injuries	0.03 (0.00, 0.19)	0.02 (0.00, 0.13)	0.016
Domestic violence, median (min, max)			
Incidents	0.17 (0.04, 0.34)	0.19 (0.02, 0.32)	0.235
Deaths	0.08 (0.00, 0.25)	0.08 (0.00, 0.25)	0.754
Injuries	0.06 (0.00, 0.19)	0.06 (0.00, 0.25)	0.373

determination that firearm retailers are essential businesses may merit future discussion.

In addition, a "reopening phenomenon" of increased firearm violence compared with the corresponding historical timeframe in 2018 and 2019 as well as compared with SAH baselines was observed in the US. In terms of types of violence, accidental shootings and child-involved shootings increased nationally during reopening compared with these periods. This suggests that heightened awareness and increased measures by law enforcement and civilians to mitigate a firearm-related "reopening phenomenon" following a pandemic is needed.

Unlike California, Ohio experienced consistent increases in firearm violence during SAH as well as during phased reopening compared with historical data. Although California had isolated increases in firearm violence throughout these comparison periods, these overall findings suggest that the strength of a state's gun regulations may affect firearm violence seen during the COVID-19 pandemic. This finding may help guide future policy surrounding how to control firearm-related incidents, deaths, and injuries during a pandemic.

Because of the use of retrospective databases, this study is subject to multiple limitations, including missing data and reporting bias. For instance, the GVA is a database that uses multiple sources, such as the media, to track firearm incidents, deaths, and injuries. Because media coverage may be spotty in some areas because of geographic limitations or scarce resources, these reports may not accurately represent all firearm violence that occurs across the US. In addition, many incidents of firearm violence, particularly domestic violence involving a firearm, are likely to go unreported to the authorities or to the media, and thus, this study's results probably represent underestimates of daily firearm violence.

Table 9 – Types of firearm violence 2019 historical control (May 25, 2019, to July 31, 2019) *versus* 2020 reopening (May 25, 2020, to July 31, 2020), per 100,000 licensed firearm owners.			
Outcome measure	2019 control	Reopening	P value
Accidental shooting, median (min, max)			
Incidents	0.11 (0.02, 0.28)	0.13 (0.04, 0.36)	0.074
Deaths	0.02 (0.00, 0.11)	0.04 (0.00, 0.19)	0.021
Injuries	0.08 (0.00, 0.30)	0.11 (0.02, 0.34)	0.014
Child-involved incidents, median (min, max)			
Incidents	0.04 (0.00, 0.15)	0.06 (0.00, 0.28)	<0.001
Deaths	0.00 (0.00, 0.13)	0.02 (0.00, 0.17)	0.003
Injuries	0.02 (0.00, 0.38)	0.08 (0.00, 0.34)	<0.001
Home invasion, median (min, max)			
Incidents	0.08 (0.00, 0.25)	0.06 (0.00, 0.17)	0.005
Deaths	0.02 (0.00, 0.08)	0.02 (0.00, 0.08)	0.666
Injuries	0.03 (0.00, 0.21)	0.02 (0.00, 0.11)	0.309
Officer involved incident, median (min, max)			
Incidents	0.21 (0.11, 0.40)	0.25 (0.11, 0.72)	0.005
Deaths	0.08 (0.00, 0.36)	0.08 (0.00, 0.21)	0.834
Injuries	0.08 (0.00, 0.42)	0.08 (0.00, 0.57)	0.103
Defensive use, median (min, max)			
Incidents	0.08 (0.02, 0.19)	0.08 (0.02, 0.23)	0.355
Deaths	0.02 (0.00, 0.11)	0.04 (0.00, 0.13)	0.060
Injuries	0.04 (0.00, 0.15)	0.04 (0.00, 0.32)	0.603
Gang involvement, median (min, max)			
Incidents	0.02 (0.00, 0.13)	0.02 (0.00, 0.13)	0.604
Deaths	0.00 (0.00, 0.06)	0.02 (0.00, 0.08)	0.214
Injuries	0.00 (0.00, 0.30)	0.02 (0.00, 0.34)	0.439
Drug involvement, median (min, max)			
Incidents	0.23 (0.04, 0.47)	0.06 (0.00, 0.23)	<0.001
Deaths	0.02 (0.00 0.13)	0.01 (0.00, 0.13)	0.001
Injuries	0.02 (0.00, 0.13)	0.02 (0.00, 0.13)	0.040
Domestic violence, median (min, max)			
Incidents	0.17 (0.04, 0.32)	0.19 (0.02, 0.32)	0.178
Deaths	0.11 (0.00, 0.30)	0.08 (0.00, 0.25)	0.613
Injuries	0.06 (0.00, 0.25)	0.06 (0.00, 0.25)	0.369

It warrants repeating that although the cutoff points for SAH and reopening orders are accurate for California, these date ranges were also applied to US data. This is because there were no clear cutoff points for US SAH and reopening orders, as each state declared its plans separately and eight states, which were excluded from analysis, never implemented full statewide orders.[4]

Although the strength of state gun laws and legislation was compared between California and Ohio, it should be acknowledged that the processes and restrictions to acquire a firearm vary state by state. Thus, in the national analysis of the 42 states plus the District of Columbia, this is a significant potential confounder.

Finally, because of the retrospective nature of this study, we cannot draw conclusions regarding cause and effect. Therefore, the associations uncovered within this study may not be solely related to COVID-19 and the orders implemented during the pandemic. In support of this concern, there were numerous confounders we were unable to control for, such as the global economic crisis, the forceful police and federal responses to the killings of Breonna Taylor and George Floyd that heightened largely peaceful protests against systemic racism and oppression across the country[21] and the growing anticipation and anxiety surrounding the 2020 presidential election. To date, there is no scientific literature available discussing the impact of these major current events on trends and the types of firearm violence. Regardless, there was no suggestion of increased use for self-defense independent of any findings related to domestic or nondomestic violence. Despite these limitations, to the knowledge of the authors this is the first large national analysis to quantify the changes in the types of firearm violence surrounding the COVID-19 pandemic.

Table 10 − Types of firearm violence 2020 SAH (March 19, 2020, to May 24, 2020) *versus* 2020 reopening (May 25, 2020, to July 31, 2020), per 100,000 licensed firearm owners.

Outcome measure	SAH	Reopening	P value
Accidental shooting, median (min, max)			
Incidents	0.11 (0.02, 0.25)	0.13 (0.04, 0.36)	0.044
Deaths	0.02 (0.00, 0.17)	0.04 (0.00, 0.19)	0.021
Injuries	0.06 (0.00, 0.25)	0.11 (0.02, 0.34)	0.001
Child-involved incidents, median (min, max)			
Incidents	0.04 (0.00, 0.21)	0.06 (0.00, 0.28)	<0.001
Deaths	0.02 (0.00, 0.13)	0.02 (0.00, 0.17)	0.170
Injuries	0.04 (0.00, 0.17)	0.08 (0.00, 0.34)	<0.001
Home invasion, median (min, max)			
Incidents	0.06 (0.00, 0.19)	0.06 (0.00, 0.17)	0.998
Deaths	0.02 (0.00, 0.08)	0.02 (0.00, 0.08)	0.349
Injuries	0.02 (0.00, 0.15)	0.02 (0.00, 0.11)	0.946
Officer involved incident, median (min, max)			
Incidents	0.25 (0.11, 0.47)	0.25 (0.11, 0.72)	0.584
Deaths	0.08 (0.00, 0.25)	0.08 (0.00, 0.21)	0.172
Injuries	0.08 (0.00, 0.28)	0.08 (0.00, 0.57)	0.256
Defensive use, median (min, max)			
Incidents	0.06 (0.00, 0.17)	0.08 (0.02, 0.23)	0.017
Deaths	0.02 (0.00, 0.08)	0.04 (0.00, 0.13)	0.002
Injuries	0.04 (0.00, 0.15)	0.04 (0.00, 0.32)	0.157
Gang involvement, median (min, max)			
Incidents	0.02 (0.00, 0.17)	0.02 (0.00, 0.13)	0.545
Deaths	0.00 (0.00, 0.06)	0.02 (0.00, 0.08)	0.019
Injuries	0.02 (0.00, 0.25)	0.02 (0.00, 0.34)	1.000
Drug involvement, median (min, max)			
Incidents	0.08 (0.02, 0.21)	0.06 (0.00, 0.23)	0.048
Deaths	0.02 (0.00, 0.13)	0.01 (0.00, 0.13)	0.015
Injuries	0.02 (0.00, 0.11)	0.02 (0.00, 0.13)	0.033
Domestic violence, median (min, max)			
Incidents	0.19 (0.04, 0.36)	0.19 (0.02, 0.32)	0.500
Deaths	0.13 (0.00, 0.25)	0.08 (0.00, 0.25)	0.207
Injuries	0.06 (0.00, 0.28)	0.06 (0.00, 0.25)	0.431

Conclusions

Although the fears surrounding the COVID-19 pandemic have created a surge in the perceived need for protective firearm ownership, particularly among first-time buyers, this study found that defensive use of firearms decreased nationally during SAH orders compared with 2018 and 2019 control data. Instead, a spike in accidental shooting deaths occurred during SAH compared with 2018 and 2019 historical data. Future discussion regarding the status of firearm retailers as essential businesses may be warranted. In addition, a "reopening phenomenon" of further increased firearm violence was notable in Ohio and the US when comparing reopening to 2018 control data, 2019 control data, and 2020 SAH. The strength of gun laws may have an effect on trends in firearm violence during the COVID-19 pandemic; however, this requires further study before any definitive conclusions. Finally, because of the substantial firearm violence noted across the US, the authors recommend that even during a pandemic, public health efforts should continue to focus on firearm safety.

Disclosure

The authors reported no proprietary or commercial interest in any product mentioned or concept discussed in this article.

REFERENCES

1. Johns Hopkins University & Medicine. Mortality analyses. Coronavirus Resource Center. 2020. Available at: coronavirus. jhu.edu/data/mortality. Accessed August 29, 2020.
2. California Department of Public Health. 2020. Available at: Cdph.ca.gov/Programs/CIS/DCDC/Pages/Immunization/ ncov2019.aspx. Accessed August 29, 2020.
3. Poston B. Los Angeles Times. 2020. Available at: Latimes.com/ California/story/2020-08-06/newest-covid-19-cases-surge-in-southeast-la-county. Accessed August 29, 2020.
4. Mervosh S, Lu D, Swales V. See which states and cities have told residents to stay at home. The New York Times. 2020. Available at: Nytimes.com/interactive/2020/us/coronavirus-stay-at-home-order.html. Accessed August 1, 2020.
5. Boserup B, McKenney M, Elkbuli A. Alarming trends in US domestic violence during the COVID-19 pandemic. *Am J Emerg Med.* 2020;38:2753—2755.
6. Ramalho R. Alcohol consumption and alcohol-related problems during the COVID-19 pandemic: a narrative review. *Australas Psychiatry.* 2020:1—3.
7. Kalin NH. COVID-19, substance use, anorexia nervosa, 22q11.2 deletion syndrome, and stress. *Am J Psychiatry.* 2020;177:7.
8. Finlay I, Gilmore I. Covid-19 and alcohol- a dangerous cocktail. *BMJ.* 2020;369:m1987.
9. Mazza M, Marano G, Lai C, Janiri L, Sani G. Danger in danger: interpersonal violence during COVID-19 quarantine. *Psychiatry Res.* 2020;289:113046.
10. Usher K, Bhullar N, Durkin J, Gyamfi N, Jackson D. Family violence and COVID-19: increased vulnerability and reduced options for support. *Int J Ment Health Nurs.* 2020;29:549—552.
11. Viveiros N, Bonomi AE. Novel coronavirus (COVID-19): violence, reproductive rights and related health risks for women, opportunities for practice innovation. *J Fam Violence.* 2020 [Epub ahead of print].
12. Duncan TK, Weaver JL, Zakrison TL, et al. Domestic violence and safe storage of firearms in the COVID-19 era. *Ann Surg.* 2020;272:e55—e57.
13. Devitt P. Can we expect an increased suicide rate due to COVID-19? *Irish J Psychol Med.* 2020:1—5.
14. Mannix R, Lee LK, Fleegler EW. Coronavirus disease 2019 (COVID-19) and firearms in the United States: will an epidemic of suicide follow? *Ann Intern Med.* 2020;173:228—229.
15. Lange C, Probst C, Rehm J. Coronavirus disease 2019 crisis and intentional injuries: now is not the time to erode alcohol control policies. *Can J Public Health.* 2020;111:466—468.
16. 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.

17. Dutheil F, Baker JS, Navel V. Firearms or SARS-CoV-2: what is the most lethal? *Public Health.* 2020;183:44—45.
18. Dutheil F, Baker JS, Navel V. To fight SARS-CoV-2: putting your guns down. *Can J Public Health.* 2020;111:411—412.
19. Schleimer JP, McCort CD, Pear VA, et al. Firearm purchasing and firearm violence in the first months of the coronavirus pandemic in the United States. *medRxiv.* 2020. Preprint.
20. Pomeranz JL. Firearm industry groups are using COVID-19 to expand gun rights. *www.JPHMP.com.* 2020;26(4):320—321.
21. Kravitz-Wirtz N, Aubel A, Schleimer J, Pallin R, Wintemute G. Violence, firearms, and the coronavirus pandemic: findings from the 2020 California Safety and Wellbeing Survey. medRxiv preprint. 2020. Available at: https://www.medrxiv. org/content/10.1101/2020.10.03.20206367v1.full.pdf. Accessed October 20, 2020.
22. Hatchimonji J, Swendiman R, Seamon M, Nance M. Trauma does not quarantine: violence during the COVID-19 pandemic. *Ann Surg.* 2020;272:e53—e54.
23. Mohler G, Bertozzi AL, Carter J, et al. Impact of social distancing during COVID-19 pandemic on crime in Los Angeles and Indianapolis. *J Criminal Justice.* 2020;68:101692.
24. Boman JH, Gallupe O. Has COVID-19 changed crime? Crime rates in the United States during the Pandemic. *Am J Criminal Justice.* 2020;45:537—545.
25. Hodgkinson T, Andresen MA. Show me a man or a woman alone and I'll show you a saint: changes in the frequency of criminal incidents during the COVID-19 pandemic. *J Criminal Justice.* 2020;69:101706.
26. 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.* 2020. https:// doi.org/10.1177/0003134820954827. [Epub ahead of print].
27. Gun Violence Archive. Available at: https://www. gunviolencearchive.org/query. Accessed August 1, 2020.
28. Lee JC, Mervosh S, Avila Y, Harvey B, Matthews AL. See how all 50 states are reopening (and closing again). The New York Times. 2020. Available at: Nytimes.com/interactive/2020/us/ states-reopen-map-coronavirus.html. Accessed August 5, 2020.
29. Annual Gun Law Scorecard. Giffords law center. https:// giffords.org/lawcenter/resources/scorecard/#OH; 2020. Accessed December 22, 2020.
30. Documenting Ohio's reopening and path to recovery from the coronavirus (COVID-19) pandemic, 2020. Ballotpedia. 2020. Available at: https://ballotpedia.org/Documenting_Ohio%27s_ reopening_and_path_to_recovery_from_the_coronavirus_ (COVID-19)_pandemic,_2020. Accessed December 22, 2020.
31. Gun Ownership by State. World Population Review. 2020. Available at: https://worldpopulationreview.com/state-rankings/gun-ownership-by-state. Accessed December 22, 2020.
32. Lyu W, Wehby GL. Stay-at-home orders reduced COVID-19 mortality and reduced the rate of growth in hospitalizations. *Health Aff (Millwood).* 2020;39:1615—1623.
33. Lyons VH, Haviland MJ, Azrael D, et al. Firearm purchasing and storage during the COVID-19 pandemic. *Inj Prev.* 2020;27:87—92.