Firearms Injuries Involving Young Children in the United States During the COVID-19 Pandemic

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OBJECTIVES: Increased rates of firearm ownership, school closures, and a suspected decrease in supervision during the coronavirus disease 2019 (COVID-19) pandemic place young children at increased risk of firearm injuries. We measured trends in firearm injuries in children and inflicted by children discharging a firearm during the pandemic and correlated these changes with a rise in firearm acquisition.

METHODS: In this cross-sectional study with an interrupted time series analysis, we used multiyear data from the Gun Violence Archive. We compared trends in (1) firearm injuries in children younger than 12 years old and (2) firearm injuries inflicted by children younger than 12 years old during the pre-COVID-19 period (March to August in the years 2016–2019) and during the first 6 months of the COVID-19 pandemic (March 2020 to August 2020). Linear regression models were developed to evaluate the relationship between firearm injuries and new firearm acquisitions.

RESULTS: There was an increased risk of (1) firearm injuries in young children (relative risk = 1.90; 95% confidence interval 1.58 to 2.29) and (2) firearm injuries inflicted by young children (relative risk = 1.43; 95% confidence interval 1.14 to 1.80) during the first 6 months of the COVID-19 pandemic as compared to the pre-COVID-19 study period. These increased incidents correlate with an increase in new firearm ownership (P < .03).

CONCLUSIONS: There has been a surge in firearm injuries in young children and inflicted by young children during the first 6 months of the COVID-19 pandemic. There is an urgent and critical need for enactment of interventions aimed at preventing firearm injuries and deaths involving children.

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WHAT’S KNOWN ON THIS SUBJECT: Firearms are a leading cause of injury and death among youth. Increased rates of firearm ownership, school closures, and a suspected decrease in parental supervision during the COVID-19 pandemic may contribute to a surge in firearm injuries involving young children.

WHAT THIS STUDY ADDS: The COVID-19 pandemic is associated with a surge in fatal and nonfatal firearm injuries both in young children and inflicted by young children, correlating with a rise in firearm acquisitions. Strategies to prevent further injuries are urgently needed.
In March 2020, the World Health Organization declared coronavirus disease 2019 (COVID-19) a global pandemic.1 In the absence of vaccination, physical distancing has become the primary means of curtailing viral spread.2 Taking cues from previous influenza epidemics, widespread school and recreational facility closures intended to interrupt viral transmission have led to children being confined at home.3 In addition to increasingly recognized mental and physical health consequences of stay-at-home orders, children are also experiencing changes in home injury patterns.4–7

Unintentional injury is the number one cause of death in children younger than 12 years of age.8 Firearm injuries account for more than one-quarter of all unintentional deaths among children in the United States.8,9 The COVID-19 pandemic has been associated with dramatic increases in firearm purchases10 and rates of firearm-related urban and interpersonal violence.11,12 There is an association of firearm ownership with increased rates of firearm injury, which may account for some of the increased rates of firearm violence.10,11,13,14

People with children living in the home have been more likely to purchase firearms during the pandemic.15 Additionally, factors specific to children confined to the home, such as their natural curiosity and a suspected decrease in parental supervision during the pandemic, may also place young children at a heightened risk for firearm injuries. We hypothesized higher rates of firearm injury in young children and inflicted by young children discharging firearms during the COVID-19 pandemic compared to previous years. Furthermore, we hypothesized that these increases correlate with a rise in new firearm acquisitions.

**METHODS**

**Study Design and Data Source**

In this multiyear cross-sectional study, we used data collected from the Gun Violence Archive (GVA). The GVA is a publicly available, real-time repository of firearm injuries and deaths in the United States with incidents collected from >7500 law enforcement, media, government, and commercial sources.16 We identified 2 distinct categories of injuries: (1) firearm injuries (both fatal and nonfatal) in children younger than 12 years of age and (2) firearm injuries (fatal and nonfatal) in any person inflicted by a child younger than 12 years of age from March to August in the years 2016–2020. Twelve years of age was used as an upper age limit to most accurately reflect accidental childhood injuries without including incidents during the adolescent years, when intentional firearm injuries and deaths may be more likely. The number of new background checks per 100 000 persons was used as a proxy for new firearm acquisitions.10 We used the Federal Bureau of Investigation’s publicly available National Instant Criminal Background Check System (NICS) to determine the number of new background checks during the study period. In the United States, firearm dealers, manufacturers, or importers who hold a firearms license are required to undertake an NICS background check on prospective buyers before transferring a firearm. We used data from the US Bureau of Census for population estimates of children <12 years of age. This study was considered exempt from institutional review board review because of the use of publicly available data.

**Data Analysis**

We identified all firearm injuries in aggregate and by outcome (fatal and nonfatal) and calculated population-level rates of injury per 1 000 000 US children by month from March to August in the years 2016–2020. We used the same months in each time period as comparatives to limit potential confounding from seasonal trends. We estimated firearm purchases over the same period on the basis of the number of background checks by month and year. We evaluated trends in (1) firearm injuries (fatal and nonfatal) in children younger than 12 years of age and (2) firearm injuries (fatal and nonfatal) in any person inflicted by a child younger than 12 years of age.

Poisson regression, typically used to model data counts, was used to estimate rates per million in the population, and linear regression, used to model the relationship between two variables, was used to relate background checks to injury rates generated by the Poisson models. Using Poisson regression models, we tabulated semiannual rates (SARs), rates of firearm injuries per million children in 6-month time intervals, from March to August for each study year in the years 2016–2020. We calculated the relative risk (RR) of firearm injuries during the COVID-19 pandemic (March 2020 to August 2020) compared to the pre-COVID-19 period (March to August 2016–2019). We conducted an interrupted time series analysis (ITSA) using the ITSA procedure in Stata version 14.2 (Stata Corp, College Station, TX) to compare changes in the rates of firearm injuries from March to August in the pre-COVID-19 period with those during the first 6 months of the COVID-19 pandemic.17 The ITSA procedure was used to define differences between the two time periods. The rates of gun injuries and deaths derived from the Poisson regression model were juxtaposed.
with the numbers of background checks in the same time periods, and linear regression models were developed to evaluate the relationship between firearm injuries and new firearm acquisitions over the same period. For these analyses, we do not differentiate between pre- and post-COVID-19 time periods but measure the relationship between the numbers of background checks and the rates of gun injuries and deaths. The proportion of the variance in firearm injuries explainable by firearm purchases is represented by the coefficient of determination ($r^2$). All analyses were performed by using Stata version 14.2.

RESULTS

Firearm Injuries in Children Younger than 12 Years of Age

During the study period, there were 797 firearm injuries in children younger than 12 years, representing an overall rate of 16.43 firearm incidents per million US children. The majority of these incidents (525 [65.87%]) were nonfatal (10.82 per million US children), whereas 272 (5.61 per million children) were fatal.

In the pre-COVID-19 study period, there were 550 total firearm injuries in children younger than 12 years (average SAR = 2.8 per million). Of these, 183 were fatal (average SAR = 0.94 per million) and 367 were nonfatal (average SAR = 1.89 per million). During the 2020 COVID-19 pandemic, there were a total of 247 (SAR = 5.09 per million) firearm injuries in children younger than 12 years. Of these, 89 were fatal (SAR = 1.83 per million) and 158 were nonfatal (SAR = 3.26 per million). Young children had a higher risk of total firearm injuries ($RR = 1.90; 95\% CI 1.45 to 2.51$), nonfatal firearm injuries ($RR = 1.89; 95\% CI 1.41 to 2.55$) during the COVID-19 pandemic compared with the pre-COVID-19 years. Table 1 provides estimates of SARs during each pre-COVID-19 year (2016–2019) and during the 2020 pandemic. The rate of change estimates in Table 1 were produced by an ITSA analysis and show consistency between the estimated rates of change and actual rates per time period determined by the Poisson regression analysis.

There was an increase in the rate of childhood firearms injuries during the first 6 months of the COVID-19 pandemic (March 2020 to August 2020) when compared to corresponding months in the pre-COVID-19 period (2016–2019). In the pre-COVID-19 period, the rates of firearm injuries in children younger than 12 years old ranged from 0.30 to 0.68 per million children monthly and remained stable from year to year ($P = .79$). From March 2020 to August 2020, the rates of firearm injuries in children younger than 12 years ranged from 0.52 to 1.20 per million children monthly. The rate of increase during the COVID-19 pandemic differed from the average pre-COVID-19 period rate of change per month in total firearm injuries in children (0.128 vs 0.001; $P < .001$) (Fig 1A).

Association of Firearm Injuries With Firearm Acquisitions

During the COVID-19 pandemic, the average number of new firearm acquisitions in units of 100 000 increased from a mean of 21.28 before the pandemic to a mean of 33.12 during the COVID-19 pandemic, representing an increase in new firearm acquisitions of 11.84 (95\% CI 5.36 to 18.32) per 100 000 (Fig 2). This increase in new firearm purchases correlates with the rise in firearm injuries in children younger than 12 years of age ($r^2 = 0.35; P = .001$) and firearm injuries inflicted by children younger than 12 years...
DISCUSSION

We found a dramatic increase in firearm incidents involving young children during the first 6 months of the COVID-19 pandemic compared to the corresponding prepandemic months in 2016–2019. The Council on Criminal Justice, a nonpartisan think tank, and many prominent news sources have reported an increase in gun violence and gun purchases during the pandemic. In addition, in a recent analysis of data from the GVA, the relationship between firearm ownership and interpersonal gun violence was measured, revealing an increase in overall gun violence during the pandemic compared to corresponding prepandemic months in 2016–2019. Although previous studies have linked firearm availability to unintentional firearm deaths in children, to our knowledge, this is the first report to link the impact of increased firearm acquisitions on increased firearm incidents involving young children during the first 6 months of the COVID-19 pandemic.

| TABLE 1 Fatal and Nonfatal Firearm Injuries Involving Children in March to August Before and During COVID-19 Pandemic |
|---------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                                | 2016 | 2017 | 2018 | 2019 | Rate of Change | 2020 | Rate of Change |
|                                | Pre- | Pre- | Pre- | Pre- | (95% CI) | Pre- | Pre- | Change (95% CI) |
| **Fatal and nonfatal firearm incidents to children** |       |       |       |       |         |       |       |         |
| Total injuries | 130 (2.68 | 155 (3.19 | 134.0 (2.76 | 131 (2.70 | 0.001 | 247 (5.09 | 0.128 | 1.90 |
| Nonfatal injuries | 83 (1.71 | 95 (1.96 | 94 (1.94 | 95 (1.98 | 0.002 | 158 (3.26 | 0.083 | 1.90 |
| fatalities | 47 (0.97 | 60 (1.24 | 40.0 (0.82 | 36 (0.74 | 0.001 | 89 (1.83 | 0.083 | 1.89 |
| **Fatal and nonfatal firearm incidents inflicted by children** |       |       |       |       |         |       |       |         |
| Total injuries | 74 (1.53 | 82 (1.89 | 68.0 (1.40 | 63 (1.29 | 0.002 | 106 (2.18 | 0.013 | 1.43 |
| Nonfatal injuries | 45 (0.93 | 49 (1.01 | 42.0 (0.87 | 41 (0.84 | 0.001 | 62 (1.26 | 0.008 | 1.38 |
| Fatal injuries | 29 (0.60 | 33 (0.88 | 26.0 (0.54 | 22 (0.45 | 0.001 | 44 (0.91 | 0.004 | 1.51 |
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**SARs** are based on 6-mo study period estimates per million population.
young children during the COVID-19 pandemic.

Although adolescent and adult firearm injuries are more likely to be intentional, firearm injuries and deaths in young children and inflicted by young children are often unintentional. Young children may be at particular risk for sustaining and inflicting unintentional injuries during the COVID-19 pandemic because of limited supervision. During the pandemic, there has been an overall decline in trauma rates; however, these effects have been either less pronounced or nonexistent in children. Some parents and guardians are working from home without the usual methods of child supervision, such as day care, in-person school, and organized recreation, and others who are required to be physically present.

**FIGURE 1**

**FIGURE 2**
Numbers of background checks (in units of 100,000) before and during the COVID-19 pandemic.
at work may have no choice but to leave children at home without any supervision. In addition, increased parental and guardian substance use and addiction behaviors\textsuperscript{21} and distracting social stressors within the home, such as unemployment and illness, may contribute to a surge in pediatric home injuries.

New firearm acquisitions correlate with increased rates of firearm injury and death in children.\textsuperscript{22} First-time gun owners are encouraged to obtain firearm safety instructions regarding safe storage; however, stay-at-home orders likely limit access to firearm safety training. The lack of organized firearm safe storage training may result in more unsecured guns in homes, which are more easily accessible to poorly supervised children.\textsuperscript{23} Required safety training for new firearm purchases, partnering with ranges or gun shops to promote safe storage, and increased public awareness of firearm safety may help to prevent unintentional firearm-related incidents in the home.

Health care providers should ensure screening for firearm access and counsel families as well as provide tools for safe storage to restrict access to firearms for children.\textsuperscript{24} These interventions may be instrumental in preventing further unintentional firearm injuries and deaths in young children.\textsuperscript{25,26} Additionally, although the only studied mass media campaign promoting safe firearm storage did not find any statistically significant effects on improving safe storage practices,\textsuperscript{27} historically, public health messaging through media communication has been successfully employed to influence public health behaviors, such as smoking cessation and seatbelt use, and therefore should be considered as a potential strategy. States should strongly consider enacting policy focused on firearm injury prevention, firearm safety training, and safe storage. Further study of state-level firearm injury data, comparing states with and without stringent child access prevention laws, could help shed light on the efficacy of these laws in preventing firearm injuries involving children during the COVID-19 pandemic.\textsuperscript{28} Considering the immediate relevance, national policy makers should consider passing temporary firearm safety requirements amid other measures with specific relevance to the pandemic. Moreover, these findings should trigger further study into the impact of multiple real and perceived stresses imposed by the current pandemic on the health and safety of children, particularly how it relates to injuries in the home.

There are some limitations to this study that should be considered. First and foremost, our study is reliant on national public archiving of data, which may be incomplete and may be subject to reporting bias, particularly as it relates to differential news and media reporting by region. Therefore, our data likely underestimate the total number of firearm injuries, particularly regarding less severe firearm injuries and near misses without associated injuries. In addition, there are inherent limitations in the use of background checks reported to NICS as a proxy to estimate new firearm acquisitions. There is significant variation in state laws mandating background checks, with some states imposing new laws mandating background checks during the study period. This may have led to an overestimation of new firearm purchases. However, because
background checks are only required for gun sales through licensed firearm dealers, the number of background checks as a proxy for new gun ownership does not account for gun sales through other dealers. Additionally, the correlation between background checks and firearm injuries at the national level provides limited information. This relationship is likely more nuanced, and further research, taking regional differences into account, is needed to advance knowledge and guide national and local priorities. Furthermore, additional covariates that may have changed appreciably in the periods just before and during the COVID-19 pandemic were not easily accessible in the GVA database. However, the variations presented here are major, and to substantially mitigate these results, potential confounders would not only have to have a strong association but would have also had to change in parallel with the onset of COVID-19. Finally, our study only demonstrates a correlation between firearm acquisitions and firearm injuries involving children and does not indicate causality.

CONCLUSIONS
During the first 6 months of the COVID-19 pandemic, we demonstrate a surge in fatal and nonfatal gun injuries in young children and in those inflicted by young children who discharged a firearm. These increased rates of injury were associated with a concurrent rise in firearm acquisitions. There is an urgent need for enactment of both interventions in the local health care setting and state- and federal-level legislation aimed at preventing firearm injuries and deaths involving children during the COVID-19 pandemic.

ABBREVIATIONS
CI: confidence interval
COVID-19: coronavirus disease 2019
GVA: Gun Violence Archive
ITSA: interrupted time series analysis
NICS: National Instant Criminal Background Check System
RR: relative risk
SAR: semiannual rate

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