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## Traumatic Pediatric Firearm Injuries During the COVID-19 Pandemic

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### Introduction

The pediatric population remains heavily affected by the public health crisis of firearm injuries, which are a leading cause of deaths due to injury among children in the United States (US).<sup>1-7</sup> Pediatric firearm injury occurs in predictable patterns that vary by age, with children and younger teens (0 to 14 years old) primarily incurring unintentional firearm injuries, often in the home, while adolescents and young adults from 15 to 19 years old become victims of intentional injuries due to assault.<sup>8,9</sup> Prior studies have demonstrated that boys, adolescents, and minority children are disproportionately victimized by firearm injury, with black children having the highest firearm mortality.<sup>1-3,8,10,11</sup> Black children in the US have a firearm mortality rate of 4.1 deaths per 100,000 children overall and 3.49 homicide-related firearm deaths per 100,000 children, compared to White children who had a firearm mortality rate of 1.5 deaths per 100,000 children overall and 0.35 homicide-related firearm deaths per 100,000 children.<sup>10</sup>

On March 11, 2020, the World Health Organization (WHO) declared a pandemic from the novel severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) and stay-at-home orders were implemented across the US.<sup>12,13</sup> Subsequently, the COVID-19 pandemic caused unprecedented stress on both the economy and the mental health of the public, evoking increased anxiety, depression, loneliness, and fear.<sup>14-20</sup> Though the full effect of psychosocial stressors on firearm violence during the pandemic is unknown, an increase in firearm purchases has been demonstrated, and individuals in multiple studies stated that their motivation for purchasing a firearm was due to uncertainty, fear, and feeling a need for protection.<sup>21-25</sup>

A study in New York state revealed a firearm purchasing rate of 164.4 firearm purchases per 100,000 individuals in February 2020 and a rate of 308.5 firearm purchases per 100,000 in March 2020.<sup>21</sup> Simultaneously, studies also documented a rise in community violence and firearm injuries among adults during the pandemic.<sup>25-30</sup> In Washington, DC, crime statistics demonstrated that the incidence of violent crime rose significantly from March through May 2020 (6.3%) compared to March through May in 2019 (4.2%), mostly due to increased firearm-related crime.<sup>27</sup> Additionally, at a level 1 trauma center in Louisiana, the proportion of trauma center activations attributable to firearm injuries was 26% higher

than expected during the stay-at-home order.<sup>28</sup> These city and statewide increases were similarly demonstrated on a national level, where an estimated 4075 more firearm injuries and mortalities than expected occurred from April through July 2020, correlating to a 27% increase.<sup>25</sup>

The objective of the current study was to evaluate the volume, injury type (violent vs. unintentional), and sociodemographic characteristics associated with firearm injury sustained in the pediatric trauma population prior to and during the COVID-19 pandemic at a level 1 pediatric trauma center in the midwestern US. Given the impact of the pandemic on all facets of daily life, paired with increases in access to firearms and domestic and community violence, we hypothesized that the frequency of firearm injury in pediatric trauma patients increased during this time, specifically in younger children under 10 years old.

## **Methods**

This is a retrospective chart review of patients assessed by a pediatric trauma surgery team at a large midwestern level 1 pediatric trauma center for firearm injuries between February 1, 2019, and March 30, 2021. On March 10, 2020, a state of emergency was declared in Ohio due to COVID-19, and on March 11, 2020, the WHO declared COVID-19 a pandemic. Based on these dates, the pre-pandemic time included February 1, 2019 – March 9, 2020, and the pandemic period included March 10, 2020 – March 31, 2021. Chart reviews were conducted by members of the study team. Case narratives were reviewed and coded by two members of the study team to identify circumstances of the injury (eg, child playing with a gun) and identified as unintentional, occurring during an act of violence, or unknown. Coding discrepancies were discussed by members of the study team and recoded according to consensus.

Cases of pediatric firearm injury were included in the study if the patient was assessed for a gunshot wound by the pediatric trauma surgery team during the study period and the child was 0-18 years old at the time of the injury. The trauma surgery team responds to all level 1 activations, which includes all firearm injuries except those involving non-powder firearms. The trauma team may also become involved in firearm injuries that have been stabilized at an outside hospital and transferred to our center at the discretion of the emergency department (ED) or admitting physician. Cases were excluded from the study if the patient was treated in the ED for a firearm-related injury, but the trauma surgery team did not assess the injury. Patients with injuries from non-powder firearms, such as air rifles and BB guns, were also excluded from the study.

The following variables from the electronic health record were included in the analyses: patient age (dichotomized to children less than 10 years old and children 10-17 consistent with prior literature), patient sex, patient race as reported by the patient or their family during registration, and injury date. In addition, the study team coded data from case narratives to determine if the injury was unintentional, related to violence, intentionally self-inflicted, or unknown. Injuries were categorized as violent if they occurred during an altercation, drive-by shooting, or criminal activity. Unintentional injuries included injuries that occurred while the victim or shooter was playing with, cleaning, loading, or mishandling a gun. Cases that lacked sufficient details to determine the circumstances of the injury were categorized as unknown. Finally, zip code data was used to categorize each incident as occurring in a rural or urban area. Zip code data was obtained from chart review from sources including emergency medical services documentation and case narrative. Federal Office of Rural Health Policy definitions and zip code data files were used to identify rural zip codes.<sup>29</sup>

Data were analyzed using Microsoft Excel data analysis software. Distributions are described using frequencies and percentages or means and standard deviations, and statistical significance of observed differences were determined using chi-square and Fisher's exact tests, with a p-value  $\leq 0.05$  indicating significance. This study was approved by the Institutional Review Board at the authors' institution.

## Results

Twenty-eight children were assessed by the pediatric trauma team for firearm injury in the pre-pandemic period, as compared to 80 children during the pandemic (Table 1). Racial composition between these groups was similar, with pre-pandemic cases consisting of 16 Black (57.1%), 8 White (28.6%), and 4 multiracial children (14.2%), and pandemic cases including 56 Black (70.0%), 15 White (18.8%), 6 multiracial (7.5%), 2 Hispanic children (2.5%), and 1 unknown (1.3%) ( $p=0.36$ ).

Table 1. Demographics of Patients Seen by the Trauma Surgery Team for Firearm Injuries During the Pre-pandemic and Pandemic Periods

	Pre-Pandemic (n=28)	Pandemic (n=80)	Measure of association and significance
<b>Gender</b>			
Female	6 (21.5%)	21 (26.0%)	$\chi^2=0.06$ $p=0.81$
Male	22 (78.5%)	59 (74.0%)	
<b>Race</b>			
Black	16 (57.1%)	56 (70.0%)	Fisher's exact test $p=0.36$
White	8 (28.6%)	15 (20.0%)	
Multiracial	4 (14.3%)	6 (7.5%)	
Hispanic	0	2 (2.5%)	
Unknown	0	1 (1.3%)	
<b>Age (y)</b>			
< 10	5 (17.9%)	17 (21.2%)	$\chi^2=0.15$ $p=0.70$
10-17	23 (82.1%)	63 (78.8%)	

Sex composition of the pre-pandemic and pandemic groups was similar, with 22 males (78.6%) pre-pandemic and 59 males (73.8%) during the pandemic ( $\chi^2=0.06$ ,  $p=0.81$ ). No significant difference was seen in the age of patients with firearm injury in the pre-pandemic group compared to the pandemic group. Five of the 28 children (17.9%) in the pre-pandemic group were less than 10 years old, compared to 17 of the 80 children in the pandemic group (21.2%) ( $\chi^2=0.15$ ,  $p=0.70$ ).

Despite a threefold increase in violent firearm injury, from 17 in the pre-pandemic period to 54 during the pandemic, the proportions of violent and unintentional firearm injuries remained unchanged (Table 2). Using Fisher's exact test, there was no significant difference in the proportion of unintentional firearm injuries due to children exploring and finding poorly secured guns or playing with or mishandling a gun between the pre-pandemic (n=8) and pandemic periods (n=22,  $p=0.51$ ). No intentionally self-inflicted firearm injuries were seen in the study period.

Table 2. Nature of Firearm Injuries in the Pre-pandemic and Pandemic Periods

	Pre-pandemic	Pandemic	Measure of association and significance
Violent	17 (60.7%)	54 (67.5%)	Fisher's exact test p=0.51
Unintentional	8 (28.6%)	22 (27.5%)	
Unknown	3 (10.7%)	4 (5.0%)	

Finally, no difference was seen in the breakdown of where a firearm injury occurred based on zip code data, with 50% occurring in urban areas, 10.7% in rural areas, and 39.2% unknown in the pre-pandemic period compared to 71.2% in urban areas, 6.3% in rural areas, and 22.5% unknown during the pandemic (p=0.11) (Table 3).

Table 3. Location of Firearm Injuries in the Pre-pandemic and Pandemic Periods

	Pre-pandemic	Pandemic	Measure of association and significance
Urban	14 (50.0%)	57 (71.2%)	Fisher's exact test p=0.11
Rural	3 (10.7%)	5 (6.3%)	
Unknown	11 (39.3%)	18 (22.5%)	

## Discussion

Our study identified a threefold increase in the number of firearm injuries among trauma surgery patients since the onset of the pandemic as compared to the prior year. As we were unable to account for out-of-hospital pediatric firearm deaths, this noted increase is likely an underestimate of the true occurrence, as prior evidence has shown a large proportion of firearm deaths occur outside of the hospital.<sup>30</sup> Additionally, most cases occurred in Black children, males, and children 10 years or older in both the pre-pandemic and pandemic timeframes.

Although we did not find a significant difference in racial composition of those presenting with firearm injuries during the pre-pandemic period as compared to the pandemic period, our study did identify a continued pattern of racial distribution with Black children being overrepresented, comprising a striking 70% of cases during the pandemic. Unintended consequences of

pandemic mitigation strategies have additionally disproportionately affected racial and ethnic minority groups in several ways including mental health, food insecurity, unemployment and loss of health insurance, housing instability, and preventive healthcare services.<sup>31</sup> Our findings reflect persistent disparities leading to an increased burden of pediatric firearm injuries in racial and ethnic minority populations during the pandemic. This is consistent with some racial and ethnic minority groups being disproportionately affected during the pandemic, including increased risk of exposure to COVID-19, severe illness, hospitalization, and death.

By utilizing zip code data, we demonstrated that an overwhelming majority of firearm injuries occurred in urban areas in both the pre-pandemic and pandemic timeframes, although this is somewhat limited by the number of unknown injury locations. These findings are consistent with those of previous studies demonstrating that an older adolescent age in urban locations is a primary risk factor for firearm injury.<sup>8,32,33</sup> These same studies have also demonstrated that hospitalizations due to firearm injuries occur at a disproportionately elevated rate in both African American and Hispanic youth and that these individuals are at increased risk of sustaining injuries secondary to firearm assault. In a study using the Kids' Inpatient Database, Herrin et al found that the overall rate of hospitalization due to firearm injuries in children and adolescents was highest among 15- to 19-year-olds living in urban areas and most were due to assault.<sup>34</sup> Our findings are similar to these prior studies, emphasizing that the escalation of firearm injury in this population demonstrates the critical need for intensive community intervention and prevention efforts.

Our results also showed that firearm injuries due to children exploring and finding poorly secured guns or playing with or mishandling guns continued to be a problem during the pandemic, although the overall proportion remained unchanged before and during the pandemic. Our findings highlight the significance of pediatricians and other health care providers who care for children in providing anticipatory guidance for the primary prevention of firearm injury in children and adolescents. The American Academy of Pediatrics (AAP) has issued multiple statements on the need for safe firearm storage and strongly supports the prevention of firearm-related injuries with an emphasis on safety counseling during routine health maintenance visits as well as stronger legislation regulating the sale and purchase of firearms.<sup>35,36</sup> Despite this recommendation, Hoops and Crifasi recently demonstrated that this anticipatory guidance is not always routinely delivered.<sup>37</sup> Recent studies have shown positive results surrounding community-based interventions to promote safe gun storage

practices.<sup>38</sup> Child safety laws and child access prevention laws have also been associated with safer firearm storage in families with preschool-aged children and are effective in reducing unintentional firearm and suicide deaths among children.<sup>39-42</sup>

Our study did not identify any confirmed self-inflicted firearm injuries. This finding should be interpreted with caution and not misconstrued to downplay the known negative effects the pandemic has had on the mental health of children and adolescents. The Centers for Disease Control and Prevention reported that the proportion of mental health-related ED visits occurring among adolescents aged 12-17 years increased by 31% nationally in 2020 compared with the rate in 2019.<sup>43</sup> Further, the mean weekly number of ED visits of adolescents for suspected suicide attempts was 22.3% higher during summer 2020 and 39.1% higher during winter 2020 than during the corresponding periods in 2019, with a more pronounced increase among females.<sup>43</sup> Hill et al reported increased rates of suicide-related behaviors in youth 11 to 21 years seen in a pediatric ED in 2020 as compared to similar months in 2019, with a significantly higher rate of suicide ideation and attempts corresponding to times when COVID-19-related stressors and community responses were heightened.<sup>44</sup> It was not possible in this study to determine the number of self-inflicted firearm injuries in youth who may not have survived to receive hospital services, which remains a consideration given the high case fatality rate associated with intentional firearm injuries.<sup>45,46</sup> It is prudent that the rate of intentional firearm injuries continues to be investigated during the pandemic and that comprehensive prevention strategies be widely implemented within schools and communities. Additionally, the AAP recommends that physicians screen for access to firearms in all patients with mood disorders, substance abuse, or history of suicide attempts, and researchers have demonstrated the importance of reducing access to firearms in youth suicide prevention.<sup>47,48</sup>

There are several limitations to this study. First, as a retrospective study, there may be variations in the quality and completeness of the data. Although the hospital's trauma registry is maintained prospectively in a fastidious manner, we cannot exclude the possibility that there could have been omissions during the study period. Second, there was potential for coding error by both the trauma registry and the study team. Third, the nature of the firearm injury was sometimes not identified or was unknown. Although this may in some cases suggest hesitation by the victim to disclose a known perpetrator for fear of retribution, we were unable to determine this for certain. Even when recorded, it is possible that the nature of injury was



misclassified. Fourth, there was an overall small sample size and results may differ with larger, multicenter studies. Fifth, our study did not capture the patients with firearm injuries not assessed by the trauma team, although all gunshot wound injuries involving a powder firearm should trigger trauma alerts at our institution. Additionally, the number of fatal cases of pediatric firearm injuries not surviving for hospital care within counties included in the catchment area served by the hospital was unknown and therefore not included. Finally, these findings were seen in a single, large level 1 pediatric trauma center hospital and may not be generalizable to other settings.

In conclusion, COVID-19 pandemic has exacerbated concerning patterns of these extremely high-risk injuries; this study highlights the need for focused intervention. Future prospective studies are needed to continue to track firearm injuries among youth to assist with development of targeted preventive measures.

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