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# Unintended Consequences of COVID-19 on Pediatric Falls From Windows: A Multicenter Study

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## ABSTRACT

**Introduction:** In attempts to quell the spread of COVID-19, shelter-in-place orders were employed in most states. Increased time at home, in combination with parents potentially balancing childcare and work-from-home duties, may have had unintended consequences on pediatric falls from windows. We aimed to investigate rates of falls from windows among children during the first 6 mo of the COVID-19 pandemic.

**Methods:** Patients <18 y old admitted to three pediatric trauma centers (two - level 1, one - level 2) between 3/19/20 and 9/19/20 (COVID-era) were compared to a pre-COVID cohort (3/19/19 to 9/19/19). The primary outcome was the rate of falls from windows. Secondary outcomes included injury severity score (ISS), injuries sustained, and mortality.

**Results:** Of 1011 total COVID-era pediatric trauma patients, 36 (3.6%) sustained falls from windows compared to 23 of 1108 (2.1%) pre-COVID era patients (OR 1.7,  $P = 0.05$ ). The median ISS was seven pre-COVID versus four COVID-era ( $P = 0.43$ ). The most common injuries sustained were skull fractures (30.5%), extremity injuries (30.5%), and intracranial hemorrhage (23.7%). One-fifth of patients underwent surgery (21.7% pre-COVID versus 19.4% COVID-era,  $P = 1.0$ ). There was one mortality in the COVID-era cohort and none in the pre-COVID cohort ( $P = 1.0$ ).

**Conclusions:** Despite overall fewer trauma admissions during the first 6 mo of the COVID-19 pandemic, the rate of falls from windows nearly doubled compared to the prior year, with substantial associated morbidity. These findings suggest a potential unintended consequence of shelter-in-place orders and support increased education on home safety and increased support for parents potentially juggling multiple responsibilities in the home.

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## Introduction

In attempts to quell the spread of the global pandemic brought on by the SARS-CoV-2 virus (COVID-19), shelter-in-place orders were widely instituted. These orders advised against any unnecessary travel resulted in a significant shift to work-from-home, and were accompanied by closures of schools and daycares throughout the United States. As a result, children and their caregivers were spending significantly more time at home. There has been evidence that these societal shifts have resulted in changes in the type and severity of traumatic injuries seen, in particular with regard to pediatric trauma.<sup>1-3</sup>

Over the course of the COVID-19 pandemic, several centers have reported overall decreased trauma volumes, however with more severe injuries sustained.<sup>2</sup> This finding was unfortunately also observed with cases of child abuse: lower in volume but higher in severity.<sup>4</sup> Cases of domestic violence have been observed to rise during the pandemic.<sup>5</sup> One trauma center noted a higher rate of pediatric falls during COVID-19.<sup>1</sup> It is postulated that more time in the home may result in this change in patterns of injury mechanism.

Pediatric falls from windows are a source of preventable morbidity and mortality. Previous efforts have focused on prevention, including window safety devices and increased caregiver education regarding the dangers of unsecured windows. We hypothesized that there would be an increase in pediatric falls from windows during the COVID-19 pandemic due to increased time at home for children combined with increased demands on caregivers who may now be working from home in addition to providing childcare. We compared rates of pediatric falls from windows out of the overall pediatric trauma volume during the first 6 mo of the COVID-19 pandemic to the same time period of 1 y prior at three large children's hospitals.

## Methods

### Study design and setting

Local institutional review board (IRB) approval was obtained at each participating hospital. Data use agreements were approved for sharing de-identified data as specified in the IRBs. Due to the retrospective nature of the study, a waiver of informed consent was granted. Data were collected at three institutions: University of California Davis in Sacramento, CA; Lucile Packard Children's Hospital in Stanford, CA; and Valley Children's Hospital in Madera, CA. The former two are verified American College of Surgeons (ACS) Level-1 pediatric trauma centers, while Valley Children's Hospital is a verified ACS Level-2 pediatric trauma center.

Pediatric trauma patients <18 y old were reviewed for inclusion over two 6-mo time periods: COVID-era, defined as March 19, 2020 through September 19, 2020, and pre-COVID, defined as March 19, 2019 through September 19, 2019. March 19, 2020, was chosen as the start date as this was the

date of the California-wide shelter-in-place mandate. The same time period of 1 y prior was chosen as a comparison cohort to account for seasonal variation in trauma presentations. Institutional trauma registries at each hospital were queried for patients <18 y old admitted after a fall from a window. The International Classification of Diseases External causes of injury code (ICD E-code) W13.4XXA (fall from, out of, or through window initial encounter) was used to identify falls from windows.

### Data collection

Data were collected at each institution and shared with the main study site (UC Davis) in a de-identified manner. The primary outcome was the proportion of all pediatric trauma activations due to falls from windows, which we hypothesized would be higher in the COVID-era cohort than in the pre-COVID cohort. Additional data collected included patient demographics, insurance status, time of presentation, injury details, including height of fall, presenting Glasgow Coma Scale score (GCS), injury severity score (ISS), injuries sustained, disposition from the emergency department (ED), intensive care unit (ICU) admission and length of stay (LOS), mechanical ventilator use, surgical interventions performed, mortality, and total hospital LOS.

### Data analysis

The COVID-era cohort was compared to the pre-COVID cohort. For examining the temporal patterns within the study periods, the early pandemic (first 3 mo; 3/19-6/18) was compared between years, as well as the later pandemic (second 3 mo; 6/19-9/19). Categorical data are presented as numbers and percentages and compared by chi-square test or Fisher's exact test where appropriate. Continuous data are presented as median and interquartile range and compared by the Mann-Whitney *U* test. Significance was set at  $P < 0.05$ . All analyses were done in Prism version 9.1.2 (GraphPad Software, Inc, San Diego, CA, USA).

## Results

### Overall results

Of 1011 total COVID-era pediatric trauma patients, 36 (3.6%) sustained falls from windows, compared to 23 of 1108 total pre-COVID era patients (2.1%, OR 1.7, 95% CI 1.02-2.91,  $P = 0.05$ ). Patients in both cohorts were a median age of 3 y old ( $P = 0.89$ ), and the majority were male (73.9% of pre-COVID patients versus 58.3% of COVID-era patients,  $P = 0.27$ ). There were no significant differences in the races or ethnicities of presenting patients or in the proportion of patients with public or private insurance (Table 1). When evaluated by time period, the early pandemic period (3/19 – 6/18) was associated with significantly more falls from windows compared to the same 3-mo period 1 y earlier (5.0% COVID-era versus 2.0%

**Table 1 – Presenting characteristics and outcomes of pediatric patients sustaining falls from windows.**

Variable	Pre-COVID n = 23	COVID-era n = 36	P value
Age, years: median (IQR)	3 (2-4)	3 (1-6)	0.89
Sex, male: n (%)	17 (73.9)	21 (58.3)	0.27
Race: n (%)			0.38
White	9 (39.1)	14 (38.9)	
Black	3 (13.0)	4 (11.1)	
Asian	1 (4.3)	7 (19.4)	
Other	10 (43.5)	11 (30.6)	
Ethnicity: n (%)*			1.0
Hispanic or Latino	6 (26.1)	8 (22.9)	
Non-Hispanic or Latino	17 (73.9)	27 (77.1)	
Insurance: n (%)			0.40
Private	9 (39.1)	10 (27.8)	
Public	14 (60.9)	26 (72.2)	
Time of day: n (%)			0.78
Daytime (7 AM-7 PM)	15 (65.2)	25 (69.4)	
Nighttime (7 PM-7 AM)	8 (34.8)	11 (30.6)	
Fall height: n (%)			0.93
1st floor	2 (8.7)	4 (11.1)	
2nd floor	20 (87.0)	30 (83.3)	
3rd floor	1 (4.3)	2 (5.6)	
ED GCS: median (IQR)	15 (15-15)	15 (15-15)	0.49
Injury severity score: median (IQR)	5 (1-11)	4 (1-10)	0.34
Admitted to hospital: n (%)	16 (69.6)	27 (75.0)	0.77
Admission disposition: n (%)			1.0
ICU	6/16 (37.5)	9/27 (33.3)	
Ward	10/16 (62.5)	18/27 (66.7)	
ICU admission: n (%)	6 (26.1)	9 (25.0)	1.0
ICU LOS, days: Median (IQR)	4 (1.8-7.8)	2 (1-3.5)	0.13
Mechanical ventilation: n (%)	0 (0)	3 (8.3)	0.27
Injury sustained: n (%)	14 (60.9)	21 (58.3)	1.0
Surgical interventions: n (%)	5 (21.7)	7 (19.4)	1.0
Hospital LOS, days: Median (IQR)	1 (0-3)	1 (0.25-2)	0.50
In-hospital mortality: n (%)	0 (0)	1 (2.8)	1.0

IQR = interquartile range; ED = emergency department; GCS = Glasgow Coma Scale; ICU = intensive care unit; LOS = length of stay.

\*Note one patient in the COVID-era cohort did not have ethnicity reported.

pre-COVID,  $P = 0.01$ ). In contrast, during the latter 3 mo of the study period (6/19-9/19), rates of falls from windows had returned to baseline (2.3% COVID-era versus 2.1% pre-COVID,  $P = 0.8$ ).

### Presenting characteristics

Most patients presented during the daytime hours between 7 AM and 7 PM (65.2% pre-COVID and 69.4% COVID-era,  $P = 0.78$ ). Falls were most commonly from second-storey windows (87.0% of pre-COVID patients and 83.3% of COVID-era patients,  $P = 0.93$ ). The median presenting GCS was 15 in both cohorts ( $P = 0.49$ ). Most patients did not sustain severe injuries, with a median ISS of seven in the pre-COVID patients and four in the COVID-era patients ( $P = 0.43$ ). Patients were more commonly admitted to the hospital than discharged

home from the emergency department in both cohorts (69.6% pre-COVID and 75.0% COVID-era,  $P = 0.77$ ). In each cohort, about a quarter of patients required an ICU admission (26.1% pre-COVID and 25.0% COVID-era,  $P = 1.0$ ).

### Injuries, interventions, and outcomes

Injuries were identified in 60.9% of pre-COVID patients and 58.3% of COVID-era patients ( $P = 1.0$ ). There were no differences noted in the types of injuries sustained between cohorts (Table 2). The most common injuries included skull fractures (18/59 patients, 30.5%), extremity injuries (18/59 patients, 30.5%), and intracranial hemorrhage (14/59 patients, 23.7%). One-fifth of patients in each cohort underwent surgical interventions (21.7% pre-COVID and 19.4% COVID-era,  $P = 1.0$ ), which mostly were common orthopedic surgical procedures

**Table 2 – Injuries sustained.**

Injuries	Pre-COVID n = 23	COVID-era n = 36	P value
Skull fracture	8 (34.8)	10 (27.8)	0.58
Intracranial hemorrhage	6 (26.1)	8 (22.2)	0.76
Facial fracture	4 (17.4)	2 (5.6)	0.20
Thoracic injury	2 (8.7)	5 (13.9)	0.69
Vertebral injury	3 (13.0)	1 (2.8)	0.29
Extremity injury	6 (26.1)	12 (33.3)	0.77

(7/59, 11.9%) and neurosurgical procedures (4/59, 6.8%, Table 3). There was only one in-hospital mortality, which occurred in the COVID-era cohort; this patient proceeded to organ donation. The median hospital LOS was 1 d in both cohorts ( $P=0.50$ ).

## Discussion

In this multicenter study of pediatric trauma patients, we identified a 1.7-fold increase in the proportion of patients presenting after a fall from a window during the shelter-in-place orders enacted during the COVID-19 pandemic when compared to an earlier identical time period of 1 y. There were no differences in injury severity, hospital admission rates or lengths of stay, injuries sustained, or surgical interventions performed. This is the first study to report these findings, and these results highlight a striking unintended consequence of the COVID-19 pandemic. The reasons for this finding are likely multifactorial, but the authors hypothesize that this is the result of increased time at home for both children and parents, with competing duties as more families had to juggle work-from-home in addition to childcare.

Falls have long been the most common mechanism of injury in pediatric trauma patients.<sup>6</sup> While a majority of these falls are not from windows, nearly 100,000 children were injured in falls from windows over a 20-y period, according to an analysis of the emergency department data from the National Electronic Injury Surveillance System.<sup>7</sup> This mechanism of injury predominantly affects children under the age of 6 y old,<sup>6</sup> which is supported by our finding that the median age of children injured in falls from windows was 3 y old. Falls are most commonly from second-story windows, although fatal falls are more commonly from higher floors.<sup>6</sup> Head injuries are the most common injury sustained in these falls,<sup>7</sup> which we also found to be true in our cohorts. These injuries and

fatalities are preventable, and window guards have been adopted as part of the Health Code in cities such as New York, with a significant decrease in annual fatal and nonfatal falls from windows.<sup>8,9</sup> However, the efficacy of interventions aimed at reducing pediatric falls from windows have been poorly studied, and variable results have been reported.<sup>10</sup>

Changing patterns of mechanisms of injury among pediatric trauma patients have been identified during the COVID-19 pandemic. Multiple studies have reported an overall lower volume of trauma patients presenting to the hospital compared to prior years.<sup>1,2</sup> One level-1 trauma center reported half as many pediatric trauma activations during the first 6 wk of the COVID-19 pandemic compared to years prior, but with slightly higher injury severity scores.<sup>1</sup> They also noted a significant rise in the proportion of children injured in falls, at 73% of trauma activations during COVID-19 compared to 53-56% in the 2 y prior. However, a subgroup analysis of different types of falls was not performed. Notably, traffic-related injuries such as children injured in motor vehicle collisions or struck by cars were significantly less common during COVID-19, which was attributed to more time spent at home during shelter-in-place orders.<sup>1</sup> Another multicenter study of six pediatric trauma centers around the country noted a rise in nonmotorized vehicle collision, nearly double that of prior years.<sup>2</sup> Rates of pediatric firearm violence also nearly doubled in that study.<sup>2</sup> Overall, they noted that patients injured during COVID-19 shelter-in-place orders presented with higher injury severity scores and had longer ICU lengths of stay, suggesting more severe injuries.<sup>2</sup> A study of children injured in Los Angeles County also identified an increased rate of pediatric firearm injuries, as well as burns,<sup>11</sup> which may be another injury mechanism related to more time spent at home during the pandemic. Pediatric patients sustaining fractures were more likely to be injured at home than outside the house.<sup>12</sup> Data regarding injuries sustained at home, specifically falls from

**Table 3 – Surgical interventions performed.**

Surgical interventions	Pre-COVID n = 23	COVID-era n = 36	P value
Neurosurgery	2 (8.7)	2 (5.6)	0.64
ENT surgery	1 (4.3)	0 (0)	1.0
Orthopedic surgery	2 (8.7)	5 (13.9)	0.69
Spine surgery	1 (4.3)	0 (0)	1.0
Organ procurement	0 (0)	1 (2.8)	1.0

ENT = ear, nose, and throat.

windows, have not been reported and our findings of a two-fold increase in pediatric falls from windows reveal a focus area for preventative efforts and educational messaging to caregivers at home during the pandemic.

Sheltering at home, school closures, and working from home are societal changes that have been necessary to attempt to mitigate the spread of COVID-19, in particular in the early months before development of safe and effective vaccines. Unintended consequences of these orders have included the noted rise in injuries sustained at home in this study and others, including falls from windows. Other studies have noted a rise in injuries due to domestic violence.<sup>5</sup> In California alone, reports of domestic violence submitted to Child Protective Services rose 25% after school closures began on March 16, 2020.<sup>13</sup> Cases of child abuse were noted to be higher in one study<sup>14</sup> while others have noted fewer reported cases of child abuse,<sup>15</sup> and this disconnect is concerning for potential underreporting due to sequestration of children at home, away from mandated reporters such as teachers and healthcare professionals. A study from the Netherlands found that school closures were associated with a 3-times higher rate of emotional abuse, defined as emotional neglect or witnessing domestic violence.<sup>16</sup> The rise in firearm injuries during the pandemic has been noted in pediatric patients<sup>2,11</sup> and adult patients.<sup>17-20</sup> A rise in firearm sales during the pandemic has also been noted.<sup>19,21</sup> During the pandemic, 10% of surveyed households with teenagers at home purchased a firearm,<sup>22</sup> and another survey of new firearm owners during the pandemic found that 40% had at least one firearm stored in an unsafe manner; that is, unlocked.<sup>23</sup> A survey of firearm-owning parents found that a minority, 5%, intentionally made their firearms more accessible during the pandemic, most commonly due to concern for increased civil unrest or riots.<sup>24</sup> Rising firearm purchases are correlated with increases in unintentional firearm deaths, and in particular, have been associated with a rising rate of unintentional deaths due to firearms among children aged 1-4 y old.<sup>25</sup> Indeed, during the first 6 mo of the pandemic, there was an increased risk of firearm injuries in young children, as well as firearm injuries in which a child <12 y old fired the gun.<sup>26</sup>

These findings have significant implications for public health measures moving forward as the COVID-19 pandemic continues, and ensuring children are not placed in environments where they are at risk for further injury is imperative. In particular, resources must be devoted to ensuring increased home safety measures are available and implemented in homes with children. Providers taking care of children must ensure they discuss important measures such as window guards, which can be done at routine well-child visits. Telehealth video visits in the patient's home may even potentially allow providers to identify unsafe home environments and provide recommendations for improving home safety. Efforts should be made by providers to ensure routine well-child visits continue to occur at regularly scheduled intervals to ensure children have access to mandated reporters to identify cases of potential abuse or neglect. In light of the above findings of increased firearm injury prevalence in the pediatric population, families must be counseled on safe firearm storage to avoid tragic and preventable deaths.<sup>27</sup> While these measures have always been critical, the heightened stressors

of the pandemic and the changing landscape of school, work, and day-to-day life imposed by the COVID-19 pandemic have made home safety measures of paramount importance in protecting children from preventable injury.

### Limitations

Our study is limited due to the small sample size of pediatric falls from windows; however, as we queried two large level-1 pediatric trauma centers and a level-2 pediatric trauma center, we believe our findings will likely hold true at other similar institutions around the country. There is geographic variability in the peaks of the COVID-19 pandemic waves and thus, variability in timing of shelter-in-place orders and the time frame associated with heightened risk for injuries sustained at home may vary by hospital location. National or international studies would provide insight into larger-scale trends and are an area of future research. Last, data was not available on each individual family's circumstances surrounding the fall; that is, it is unknown if children came from a single or double parent household, if parents were engaged in work-from-home during the time of the injury, or other factors that may contribute to increasing the risk of falls from windows, including possible lack of appropriate supervision of the injured child.

### Conclusions

Despite overall fewer trauma admissions during the first 6 mo of the COVID-19 pandemic, falls from windows occurred at twice the rate compared to the prior year. These findings suggest a potential unintended consequence of shelter-in-place orders and support increased education on home safety and increased support for parents potentially juggling multiple responsibilities in the home.

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### Author Contributions

Study design was performed by Drs. Theodorou, Brown, Jackson, and Beres. Data collection was performed by Drs. Theodorou, Castle, and Chao. Data analysis and manuscript creation were performed by Dr. Theodorou. Critical revisions were performed by Drs. Theodorou, Brown, Jackson, Castle, Chao, and Beres.

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### Disclosure

None declared.

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## Meeting Presentation

This study was presented as a poster presentation at the 2021 Pediatric Trauma Society Annual Meeting.

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