

# COVID-19 pandemic restrictions unmask dangers of frequent injury mechanisms for common surgically treated pediatric fractures

Bryn R Gornick<sup>1,2</sup>, Mashgan Mostamand<sup>3</sup> , Evelyn S Thomas<sup>1</sup>, Matthew Weber<sup>4</sup>, and John A Schlechter<sup>1,2,4</sup> 

## Abstract

**Purpose:** This study examined the volume and characteristics of common surgically treated fractures in children during the COVID-19 pandemic. The worldwide spread of COVID-19 affected the society in numerous ways. Social distancing led to changes in the types of activities performed by individuals, including children. Physicians saw a shift in orthopedic trauma volume and distribution. We predicted that with the change in activities children participated in, the number or type of injuries sustained would change as well.

**Methods:** A retrospective review was performed of children who sustained a surgically treated fracture of the forearm, supracondylar humerus, femur, or any open fracture during the COVID-19 pandemic compared to the previous 2 years (pre-pandemic). Patient demographics, insurance status, and mechanism of injury were recorded. Statistical analysis was performed.

**Results:** Review of the medical records identified 791 children. The number of fractures decreased from an average of 295 per year pre-pandemic to 201 during the pandemic ( $p=0.09$ ). During the pandemic, there was a decrease in injuries resulting from a fall from the monkey bars for supracondylar humerus (21.2% to 8.2%,  $p<0.01$ ) and for forearm fractures (15.5% to 4.3%,  $p=0.04$ ). In contrast, the frequencies of falls from a skateboard, hoverboard, scooter, or bicycle and falls from household furniture increased during the pandemic.

**Conclusion:** The observed decrease in monkey bar-related injuries provides further evidence as to the dangers of this piece of playground equipment in contributing to upper-extremity fractures in children.

**Level of evidence:** Level III: Prognostic and Epidemiological.

**Keywords:** COVID-19, pediatrics, fractures, supracondylar humerus fractures, monkey bars

## Purpose

By late February 2020, more than 50 million public school children across the United States began online schooling and spending the majority of their days at home, unable to visit the playground or participate in sporting activities, due to the rapid spread of COVID-19.<sup>1</sup> Prior to the pandemic, children spent over half of their days at school, after-school programs, and sports. During the COVID-19 pandemic, outdoor recreation was encouraged to help with the practice of social-distancing: while playgrounds were closed, children were still free to spend time outdoors on bicycles, skateboards, and other personal sporting equipment.

Pediatric fractures account for approximately 15% of pediatric emergency department (ED) visits. Many of these fractures are commonly related to playground

equipment, with an annual incidence rate of 119.2 injuries per 100,000 children.<sup>2</sup> More than 50% of pediatric extremity fractures requiring hospitalization are due to

<sup>1</sup>Department of Orthopaedic Surgery, Children's Hospital of Orange County, Orange, CA, USA

<sup>2</sup>Pediatric Orthopedic Specialists of Orange County, Orange, CA, USA

<sup>3</sup>School of Medicine, University of California, Riverside, Riverside, CA, USA

<sup>4</sup>Department of Orthopaedic Surgery, Riverside University Health System Medical Center, Moreno Valley, CA, USA

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### Corresponding Author:

John A Schlechter, Pediatric Orthopedic Specialists of Orange County, 1310 West Stewart Drive Suite 508, Orange, CA 92868, USA.  
Email: [info@youthsportsortho.com](mailto:info@youthsportsortho.com)



play on monkey bars and climbing gyms. A large proportion of pediatric supracondylar humerus fractures are also from playground equipment.<sup>3</sup>

With the dramatic change in environment for children at play during the pandemic, a difference in pediatric fracture occurrence and mechanism is expected. One recent study published early in the pandemic showed a large reduction in the volume of pediatric fractures at a trauma hospital in Philadelphia.<sup>4</sup> Our institution is a leading trauma center which is the only freestanding children's hospital and pediatric-based tertiary referral center in our County, serving a catchment area of 4,787,711 children. The objective of this study was to consider how the COVID-19 pandemic has affected pediatric fracture epidemiology in our region, while also looking at trends in the prevalence of various fracture types including supracondylar humerus fractures, forearm fractures, and femur fractures.

## Methods

Children aged 0–18 years old who sustained a surgically treated fracture of the forearm, supracondylar humerus (SCHFx), femur, or any other open fracture from 1 March 2018 through 28 February 2021 were retrospectively reviewed for this Institutional Review Board (IRB)—approved study. Children ( $n=898$ ) were identified via current procedural terminology (CPT) codes 25515, 25545, 25574, 25575, 25600, 25605, 25606, 25607, 25608, 25609, 25438, 27502, 27506, 29305, 29325, 11010, 11011, and 11012. Children who underwent care in the ED but were not taken to the operating room ( $n=107$ ) were excluded from the study. This included 105 children who sustained a radius and/or ulna fracture treated with closed reduction under conscious sedation with cast application and two children who sustained an open fracture that was treated with antibiotic administration, wound irrigation, fracture reduction, and limb immobilization in the ED.

Information related to patient demographics including age, sex, ethnicity, race, primary language spoken in the household, and primary insurance type was collected. The mechanism of injury for each fracture type was recorded and classified as: fall from furniture; fall from a height; ground-level fall; fall from monkey bars; fall from a skateboard, scooter, or hoverboard; fall on a trampoline or bounce house; or other. The duration of the procedure and duration of in-hospital stay was recorded.

Patients who presented from 1 March 2018 to 29 February 2020 were assigned to the pre-pandemic group; patients who presented from 1 March 2020 to 28 February 2021 were assigned to the pandemic group. Informed consent was not obtained as this was a retrospective study.

Descriptive statistics were calculated for all variables. Chi-square analysis was used to compare categorical outcomes between patients who sustained a fracture during the non-pandemic period, compared with those who sustained

a fracture during the pandemic. Analysis of variance (ANOVA) was used to compare averages for continuous outcomes based on categorical independent variables. Continuous variables were checked for normality and homogeneity of variance before analysis with parametric statistics. Analyses were performed using SPSS version 25, and alpha was set at  $p < 0.05$  to declare significance (SPSS Statistics for Windows, Version 25.0 (2017) IBM Corp.).

## Results

Seven hundred ninety-one children were identified. The average age of children treated for surgically treated fractures in 2018, 2019, and 2020 were  $7.1 \pm 3.7$ ,  $7.7 \pm 4.0$ , and  $7.2 \pm 4.1$  years, respectively. The distribution of injuries among fracture types did not differ significantly between the pre-pandemic and pandemic periods ( $p=0.12$ ). The number of overall fractures decreased from an average of 295 per year during the pre-pandemic period to 201 during the pandemic period ( $p=0.09$ ). The average numbers of femur fractures per year during the pre-pandemic period and pandemic period were comparable (39 and 40, respectively). There was a decrease in the prevalence of SCHFx from an average of 184 fractures per year during the pre-pandemic period to 110 fractures during the pandemic period. The average number of forearm fractures seen annually was higher during the pre-pandemic period (58 fractures per year), compared to the pandemic period (46 fractures). No significant difference between male versus female patients in the prevalence of fractures was observed in 2018, 2019, or 2020 ( $p=0.98$ ). However, when the data for 2018, 2019, and 2020 were combined, a significant difference between male versus female patients was observed for the prevalence of femur, SCHFx, forearm, and other open fractures ( $p < 0.01$ ). Fracture location differed significantly, as well, when patients were categorized by race (Asian, Black, White, and other;  $p < 0.05$ ) with majority of fractures of all types occurring in Whites. No significant difference in the occurrence of fracture was seen when patients were grouped by ethnicity ( $p=0.22$ ), race ( $p=0.37$ ), primary language spoken in the household ( $p=0.23$ ), or primary type of medical insurance (government, private, or self-pay,  $p=0.15$ ) in each pre-pandemic year and the pandemic year. No difference in duration of procedure or hospital stay between the pre-pandemic years and pandemic year was observed ( $p=0.12$  and  $p=0.83$ , respectively). Table 1 shows the observed trends for fracture prevalence during the pandemic period compared with the pre-pandemic period.

The distribution of injury mechanism of all fractures between the pre-pandemic and pandemic years changed with fewer fractures occurring in the pandemic year ( $p < 0.01$ ). Significant changes in femur fractures due to mechanism of injury were seen ( $p < 0.01$ ). During the

**Table 1.** Differences in fractures during pandemic period versus pre-pandemic period.

	Falls from furniture in house (%)	Falls from skateboard, scooter, bicycle, or hoverboard (%)	Falls from height (%)	Ground-level falls (%)	Falls from trampoline or bounce house (%)	Falls from monkey bars (%)	Other mechanisms of injury (%)	p value
SCH	↑ 12	↑ 4.5	↑ 3.6%	↓ 5.9	↓ 2.1	↓ 13.0	↑ 0.8	*<0.01
Femur	↑ 9.8	↑ 24.8	↓ 0.3	↓ 8.2	↓ 3.9	↓ 11.2	↓ 21	*<0.01
Forearm	↑ 2.6	↑ 24.6	↑ 1.8	↓ 4.6	↓ 3.0	↓ 1.3	↓ 10.3	*0.04
Open fractures	↑ 8.2	↑ 13.7	↑ 1.8	↓ 5.4	↓ 2.4	↓ 10.9	↓ 4.9	*<0.01

SCH: supracondylar humerus.

Increased percentage of fractures indicated with ↑. Decreased percentage of fractures indicated with ↓.

\*Significant p values < 0.05.

pandemic, more femur fractures occurred due to falls from non-motorized vehicles (7.7% to 32.5%) and falls from household furniture (7.7% to 17.5%), and fewer femur fractures were attributed to falls from height (10.3% to 10.0%), ground level (28.2% to 20.0%), and trampoline or bounce house (6.4% to 2.5%). The percentage of femur fractures attributed to other mechanisms of injury decreased during the pandemic period, compared with the pre-pandemic period (38.5% to 17.5%). The distribution of injury mechanism for SCHFx also differed significantly between pre-pandemic and pandemic years ( $p < 0.01$ ). During the pandemic, SCHFx were attributed to: falls from household furniture (20.7% to 32.7%); falls from height (18.2% to 21.8%); falls from skateboard, scooter, bicycle, or hoverboard use (7.3% to 11.8%); and other mechanisms of injury (6.5% to 7.3%). During the pandemic, the occurrence of SCHFx from ground-level falls decreased from 20.4% to 14.5%, and the prevalence of falls from trampolines or bounce houses decreased from 5.7% to 3.6%. The distribution of injury mechanism for forearm fractures also differed significantly between pre-pandemic and pandemic years ( $p = 0.04$ ). During the pandemic, the percentage of forearm fractures caused by falls from skateboards, scooters, hoverboards, or bicycles increased from 27.6% to 52.2%. There was also an increase in forearm fractures due to falls from household furniture (1.7% to 4.3%) and height (11.2% to 13.0%). The percentage of forearm fractures caused by ground-level falls decreased (15.5% to 10.9%), as did the percentages of falls from trampolines or bounce houses (5.2% to 2.2%) and the percentage of falls attributed to other mechanisms of injury (23.3% to 13.0%).

For other types of open fractures, there was no significant difference between the pre-pandemic and pandemic periods in the distribution of various injury mechanisms ( $p = 0.88$ ). The relative percentages of falls from height and ground-level falls decreased (3.6% to 0.0% and 7.1% to 0.0%, respectively). Fractures due to falls from skateboards, scooters, hoverboards, or bicycles, and other mechanisms of injury increased (14.3% to 20.0% and 75.0% to 80.0%, respectively).

During the pandemic, there was a decrease in the relative percentage of injuries resulting from a fall from the monkey bars (femur fractures, 1.3% to 0.0%,  $p < 0.01$ ; SCHFx, 21.2% to 8.2%,  $p < 0.01$ ; forearm fractures, 15.5% to 4.3%,  $p = 0.04$ ).

## Discussion

Falls are the most common cause of injury and/or fracture in the pediatric population.<sup>5</sup> This trend reflects the fact that younger patients have not fully developed proper balance and have a more cephalad center of gravity; hence, children fall onto their upper body (upper extremities, torso, and head).<sup>5,6</sup> In pediatric patients, the three most common fracture types are distal radius fractures, both bone fractures, and SCHFx.<sup>7,8</sup>

The findings presented above are similar to those reported by other studies in which we saw a decrease in the total number of pediatric fractures treated at our institution during the height of the COVID-19 pandemic.<sup>4,8,9</sup> Our retrospective review of the medical records for these patients revealed a significant shift in the distribution of the associated mechanisms of injury that led to fractures. For all fracture types examined, falls from household furniture, skateboards, scooters, bicycles, or hoverboards, and height occurred more often during the pandemic. For all fracture types, the prevalence of ground-level falls and falls from trampolines or bounce houses decreased during the pandemic. For femur, SCHFx, and forearm fractures, the relative percentages caused by falls from household furniture and falls from non-motorized vehicles increased during the pandemic period. The most dramatic difference observed was the increase in the percentage of femur fractures attributed to falls from non-motorized vehicle use. This increase, as well as the observed increases in the relative percentages of all fracture types caused by falls from household furniture and non-motorized vehicles, may be explained by the increased amount of time children began spending at home during the pandemic due to national social-distancing guidelines and the inability to attend school in person or to participate in organized sports. In a

recent study, Bram et al.<sup>4</sup> also found a significant increase in injuries that occurred at home, on bicycles, or from high-energy falls, with 57.8% of fractures occurring at home during the pandemic, compared to 32.5% during the pre-pandemic period. Similarly, Olech et al.<sup>10</sup> noted a 16.9% increase in surgical indications and interventions for distal radius fractures in the pediatric population seen at their institution, possibly due to an increase in high-energy injuries. Another study noted a decrease only in surgically treated lower limb fractures, which may reflect the impact of prohibitions against participation in organized sports on their cohort during the COVID-19 pandemic.<sup>11</sup> Prohibitions against participation in organized sports also impacted the cohort at the institution where this study was conducted, likely contributing to the observed decrease in the percentage of all fracture types caused by ground-level falls.

Our data showed that the prevalence of femur, SCHFx, and forearm fractures related to playground injuries, especially those due to falls from monkey bars, significantly decreased during the pandemic period, compared to the pre-pandemic period. Multiple studies have shown that children sustain a high number of injuries when playing on the playground, with one study reporting that 64.2% of ED presentations after falls from the monkey bars were due to fractures.<sup>2,5,12,13</sup> SCHFx are the most common type of fracture associated with falls from the monkey bars, accounting for nearly 40% of long-bone fractures, and 75% of these SCHFx require hospital admission for surgical intervention.<sup>5,14</sup> Over the years, there has been a decline in injuries from using the slide or swings on playgrounds, but the prevalence of injuries associated with the use of the monkey bars has remained unchanged.<sup>6</sup> During the pandemic, we saw a significant 13% decrease in the occurrence of SCHFx due to falls from monkey bars. There was also a significant 11.2% decrease in the occurrence of forearm fractures due to falls from monkey bars. The pandemic period may be the first time in many years where a significant decrease in injuries, especially fractures, caused by falls from the monkey bars has been seen due to playgrounds at schools and parks being closed to public use.

Our study uncovered the dangers of playing on the monkey bars and how many injuries, especially SCHFx, can be avoided when children do not use this piece of playground equipment. Although children can be prone to injury due to their highly active and curious nature, other methods or equipment for play should be used. Of note, Teitelbaum et al.<sup>6</sup> found that many of the monkey bar sets on playgrounds are not built according to the recommendations set by the U.S. Product Safety Commission in the Public Playground Safety Handbook, often exceeding the height recommendations and/or the maximal distance between grips. Some studies have considered the effect of ground surface type on the rate of injury, but no significant

findings were reported.<sup>5,6</sup> Based on these trends, physicians should have a high degree of suspicion for fractures when patients present for falls from monkey bars.<sup>13</sup> Avoiding monkey bars can help children avoid painful fractures that require costly hospitalization and surgical intervention. We support the stance taken by Teitelbaum et al. and Pilla et al. that the American Academy of Pediatrics should advise against the use of monkey bars or the increased compliance of the guidelines set forth by the U.S. Product Safety Commission in the construction of monkey bars and building static monkey bars rather than mobile monkey bars, just as the organization did for the use of trampolines, leading to a general decrease in injuries from trampoline use.<sup>6,14,15</sup>

Notably, this study had some limitations. Because of the retrospective nature of this study, it was not possible to directly interview patients to obtain a more accurate description of the injured child's activity and mechanism of injury. Our study included only surgically treated fractures, which may have resulted in an underestimation of the actual number of fractures that occurred during the pre-pandemic and pandemic periods. Although this study included a large cohort of children who received treatment at a metropolitan Level-II children's hospital, which also serves as a regional tertiary referral center, the lack of statistical significance for some of the observed trends may reflect the need for additional studies with larger patient populations and greater statistical power.

## Conclusion

During the pandemic there was a change in the mechanism of injury for common surgically treated fractures in children, likely secondary to the change in activity after the "shutdown" of schools, sports, and recreational areas. The decrease in monkey bar-related injuries provides further evidence of the dangers of this piece of playground equipment in relation to upper-extremity fractures in children.

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## Author contributions

B.R.G.: Investigation, data curation, and writing—original draft preparation and review and editing.

M.M.: Investigation, data curation, and writing—review and editing.

E.S.T.: Writing—original draft preparation and review and editing.

M.W.: Conceptualization, methodology, investigation, data curation, and writing—review and editing.



J.A.S.: Conceptualization, supervision, methodology, and writing—review and editing.

### Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: the Principal Investigator of this study is a speaker for Arthrex Inc. All other authors declare that they have no conflict of interest.

### Ethical approval

This retrospective chart review study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Institutional Review Board (IRB) of Children's Hospital of Orange County approved this study IRB# 200448.

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### Informed consent

Informed consent was not obtained from any patient due to the retrospective nature of this study.

### Research involving human participants and/or animals

This article does not contain any studies with human participants performed by any of the authors.

### ORCID iDs

Mashgan Mostamand  <https://orcid.org/0000-0003-3933-4641>

John A Schlechter  <https://orcid.org/0000-0001-8389-8407>

### References

- World Health Organization. Coronavirus, <https://www.who.int/emergencies/diseases/novel-coronavirus-2019> (accessed 19 March 2021).
- Blanchard A, Hamilton A, Li G, et al. Playground equipment-related extremity fractures in children presenting to US emergency departments, 2006–2016. *Inj Epidemiol* 2020; 7(1): 56.
- Holt JB, Glass NA and Shah AS. Understanding the epidemiology of pediatric supracondylar humeral fractures in the United States: identifying opportunities for intervention. *J Pediatr Orthop* 2018; 38(5): e245–e251.
- Bram JT, Johnson MA, Magee LC, et al. Where have all the fractures gone? The epidemiology of pediatric fractures during the COVID-19 pandemic. *J Pediatr Orthop* 2020; 40(8): 373–379.
- Waltzman ML, Shannon M, Bowen AP, et al. Monkeybar injuries: complications of play. *Pediatrics* 1999; 103(5): e58.
- Teitelbaum MP, Stankovits L and Curatolo E. Monkey bar dimensions associated with pediatric upper extremity fractures show deviations from United States Product Safety Commission recommendations. *Cureus* 2020; 12(1): e6534.
- Sheridan GA, Nagle M and Russell S. Pediatric trauma and the COVID-19 pandemic: a 12-year comparison in a level-1 trauma center. *HSS J* 2020; 16(Suppl. 1): 92–96.
- Nabian MH, Vosoughi F, Najafi F, et al. Epidemiological pattern of pediatric trauma in COVID-19 outbreak: data from a tertiary trauma center in Iran. *Injury* 2020; 51(12): 2811–2815.
- Murphy T, Akehurst H and Mutimer J. Impact of the 2020 COVID-19 pandemic on the workload of the orthopaedic service in a busy UK district general hospital. *Injury* 2020; 51(10): 2142–2147.
- Olech J, Ciszewski M and Morasiewicz P. Epidemiology of distal radius fractures in children and adults during the COVID—19 pandemic—a two-center study. *BMC Musculoskelet Disord* 2021; 22(1): 306.
- Raitio A, Ahonen M, Jääskelä M, et al. Reduced number of pediatric orthopedic trauma requiring operative treatment during COVID-19 restrictions: a nationwide cohort study. *Scand J Surg* 2021; 110(2): 254–257.
- Loder RT. The demographics of playground equipment injuries in children. *J Pediatr Surg* 2008; 43(4): 691–699.
- Migneault D, Chang A, Choi E, et al. Pediatric falls: are monkey bars bad news? *Cureus* 2018; 10(11): e3548.
- Pilla NI, Rinaldi J, Hatch M, et al. Epidemiological analysis of displaced supracondylar fractures. *Cureus* 2020; 12(4): e7734.
- Council on Sports Medicine and Fitness. Trampoline safety in childhood and adolescence. *Pediatrics* 2012; 130(4): 774–779.