Original Clinical Article

JOURNAL OF CHILDREN'S ORTHOPAEDICS

Journal of Children's Orthopaedics
1–10

DOI: 10.1177/18632521231180161
journals.sagepub.com/home/cho

Epidemiology of pediatric trauma and fractures during and beyond the COVID-19 pandemic

Liam R Butler, Erin Abbott, Paulos Mengsteab, Calista L Dominy, Jashvant Poeran, Abigail K Allen, and Sheena C Ranade

Abstract

Purpose: Previous literature has shown decreases in pediatric trauma during the COVID-19 outbreak, but few have analyzed beyond the peak of the pandemic. This study assesses the epidemiology of pediatric trauma cases in a high-volume teaching hospital in New York City before, during, and after the height of the COVID-19 pandemic.

Methods: Institutional data on pediatric trauma orthopedic cases from January 1, 2018 to November 30, 2021 were extracted. The following time frames were studied: (1) April 1–June 22 in 2018 and 2019 (pre-pandemic), (2) April 1–June 22, 2020 (peak pandemic), and (3) April 1–June 22, 2021 (post-peak pandemic). Inferential statistics were used to compare patient and trauma characteristics.

Results: Compared to the pre-pandemic cohort (n = 6770), the peak pandemic cohort (n = 828) had a greater proportion of fractures ($p < 0.01$) and had a significantly decreased overall traumas per week rate ($p < 0.01$) and fractures per week rate ($p < 0.01$). These decreased trauma ($p < 0.01$) and fracture rates ($p < 0.01$) persisted for the post-peak pandemic cohort (n = 2509). Spatial analysis identified zip code clusters throughout New York City with higher rates of emergency department presentation during the peak pandemic compared to pre-pandemic, and these areas aligned with lower-income neighborhoods.

Conclusion: During the peak of the pandemic, overall trauma and fracture volumes decreased, the types of prevalent injuries changed, and neighborhoods of different economic resources were variably impacted. These trends have mostly persisted for 12 months post-peak pandemic. This longitudinal analysis helps inform and improve long-term critical care and public health resource allocation for the future.

Level of evidence: Level III

Keywords: COVID-19, pediatric orthopedic trauma, pediatric fractures, healthcare utilization, geospatial analysis

Introduction

In the United States, New York City (NYC) was the initial epicenter of the COVID-19 pandemic, which significantly impacted physician roles, hospital policies, and social interactions.[1,2] Due to the closure of schools and public recreation spaces, the pediatric population was particularly impacted by the pandemic in multiple facets of their health and development.[3–5] The objective of the current study is to assess the epidemiology of pediatric trauma and fracture cases in a high-volume teaching hospital in NYC before, during, and after the height of the COVID-19 outbreak.

Prior studies on the impact of the pandemic on orthopedic workload and injuries have shown an expected general reduction in not only orthopedic care as a whole[6,7] but also pediatric trauma and fracture rates[3,8,9] along with significantly decreased emergency department (ED) utilization for pediatric orthopedic care.[10,11] Moreover, one study

Department of Orthopaedic Surgery, Icahn School of Medicine at Mount Sinai, New York City, NY, USA

Date received: 23 January 2023; accepted: 1 May 2023

Corresponding Author:
Sheena C Ranade, Department of Orthopaedic Surgery, Icahn School of Medicine at Mount Sinai, 5 East 98th Street, 9th Floor, New York, NY 10029, USA.
Email: Sheena.ranade@mountsinai.org

noted that pediatric trauma made up a significantly larger proportion (>25%) of pediatric ED visits during the pandemic.[12] Studies have also provided insight into mechanisms of injury during the pandemic and have reported decreased proportions of traumas due to multiple etiologies, including motor vehicle collisions, playground/public space injuries, and athletics injuries.[3,8,9] Finally, there has also been a noted increase in domestic injuries contributing more substantially to pediatric trauma during the pandemic and potentially increased the rates of child abuse.[13–15]

While the above literature has shown many differences in pediatric orthopedic trauma during the peak of the COVID-19 pandemic, few studies have followed these trends beyond the height of the outbreak. A paucity of longitudinal analyses makes it somewhat difficult to guide critical resource allocation and planning for future variants and outbreaks. Therefore, this study analyzes patient demographics, trauma and fracture characteristics, and healthcare utilization patterns to better understand the long-term impacts of the COVID-19 pandemic on the NYC population. In addition, spatial mapping analysis is used to identify patient neighborhoods variably impacted by COVID-19. We hypothesized that, similar to prior literature, trauma and fracture volume reduced during the peak pandemic in NYC and that this reduction persisted beyond social distancing restrictions.

Materials and methods

Study design and patient cohort

Our institutional review board approved this retrospective cohort study using institutional data. Institutional records were queried to identify pediatric patients (age 0–17 years) diagnosed with a trauma event using International Classification of Diseases 10th Edition (ICD 10) codes S00.XXXX–S99.XXXX in either the ED or outpatient (OP) setting between January 1, 2018 and November 30, 2021. Patients were divided into multiple cohorts based on the date of presentation. The peak pandemic cohort (peak PC; April 1–June 22, 2020) aligned with the closing and reopening of playgrounds/recreational areas in NYC. The pre-pandemic cohort (pre-PC; April 1–June 22 in 2018 and 2019) and post-peak pandemic cohort (post-peak PC; April 1–June 22, 2021) were used as comparison groups. In addition, trauma cases beyond June 22, 2020 were broken into 3-month intervals (i.e. July 1–September 30, 2020) ending in November 2021. These cohorts were each compared to the respective pre-pandemic period (i.e. July 1–September 30, 2020 versus July 1–September 30 in 2018 and 2019).

Data collection and variables

The initial dataset included all encounters, including initial and follow-up visits, matching the trauma event ICD-10 codes for the time period. To account for follow-up visits for the same presenting injury while including separate injuries, encounters with the same diagnosis code for a single patient that occurred within 90 days were counted as a follow-up rather than initial encounter. This attempts to condense multiple follow-up visits into a single encounter. The variables collected for analysis included the ICD-10 code, primary diagnosis, type of injury (crushing, dislocation/sprain, fracture, intracranial, muscular/tendon/ocular/orbital, open, superficial, unspecified), body region (abdomen/low back/pelvis, ankle/foot/toes, elbow/forearm, head/neck, hip/thigh, knee/lower leg, shoulder/upper arm, thorax, and wrist/hand/fingers), date of admission, care type (ED versus OP), age, acuity if ED encounter (immediate, emergent, urgent, less urgent, and non-urgent), and residential zip code. Fracture events were identified and further classified by fracture type, region, bone, and laterality. Rate variables for weekly fracture and traumas were determined using the total number of encounters within each category in a calendar week, which were then aggregated to the average weekly trauma/fracture rate for each 3-month period.

Spatial mapping

Zip codes for each unique encounter were mapped on a zip code boundary shapefile for NYC from NYC OpenData.[16] Residential zip codes linked to each unique encounter that were outside of the NYC limits, such as patients from other states who presented to a hospital within the institution network in NYC, were not included in the spatial mapping. Choropleth maps were created for the pre-PC, peak PC, and post-peak PC using five equal breaks between the maximum and minimum range across the three time periods. Maps showing median household income and ED versus OP presentation were visually compared between the three time periods. Median household income (Source code: B19013) for five-Digit ZIP Code tabulation area was collected from the 2021 American Community Survey: 5-year (2017–2021) data via IPUMS NHGIS.[17]

Statistical analysis

Data were compared between the pre-PC, peak PC, and post-peak PC. Descriptive and comparative statistics were analyzed for all encounters. Univariable analysis of categorical data was performed using a chi-square test, while a two-sample t-test was used for continuous data. Statistical significance was set to a p-value less than 0.05.

Results

Demographics

This study identified 51,178 total initial pediatric encounters with a trauma diagnosis from January 1, 2018 to

Table 1. Demographics.

Demographics	Pre-pandemic April–June (N=6770)	Peak pandemic April–June (N=828)	Post-peak pandemic April–June (N=2509)
Median age (Q1–Q3)	9.0 (4.0–13.0)	6.0 (2.0–12.0)**	9.0 (4.0–14.0)
Age groups (years)		**	†
0–5, N (%)	2040 (30.1)	394 (47.6)	793 (31.6)
6–11, N (%)	2250 (33.2)	214 (25.8)	727 (29.0)
12–17, N (%)	2480 (36.6)	220 (26.6)	989 (39.4)
Gender		*	
Male, N (%)	3899 (57.6)	444 (53.6)	1489 (59.3)
Female, N (%)	2847 (42.1)	377 (45.5)	1008 (40.2)

*denotes if pre versus peak p-value is < 0.05.
**denotes if pre versus peak p-value is < 0.01.
†denotes if pre versus post p-value is < 0.05.

November 30, 2021. The peak PC (April 1–June 22, 2020, $n=828$) was significantly younger (6.0 (2.0–12.0) versus 9.0 (4.0–13.0) years, $p<0.01$) and had significantly more female patients (45.5% versus 42.1%, $p=0.04$) compared to the pre-PC (April 1–June 22 in 2018 and 2019, $n=6770$). However, the post-peak PC (April 1–June 22, 2021, $n=2509$) was similar in age to the pre-PC ($p=0.91$) and had no difference in patient sex ($p=0.11$). Complete demographic data can be seen in Table 1.

Trauma characteristics

With respect to trauma encounters, there was a significant 72% decrease in traumas per week in the peak PC compared to the pre-PC (79.7 traumas/week ± 27.3 versus 288.0 traumas/week ± 39.2, $p<0.01$) (Figure 1). There were also significant decreases to the proportion of dislocations/sprains (8.7% versus 15.5%, $p<0.01$) and unspecified traumas (16.1% versus 21.2%, $p<0.01$) while there were significantly more fractures (24.4% versus 18.3%, $p<0.01$) and open wounds (22.5% versus 17.0%, $p<0.01$) between the peak PC and pre-PC. A smaller proportion of trauma patients initially presented to the ED during the peak pandemic (43.5% versus 53.1%, $p<0.01$), but the ED presentations were more likely to be "Urgent," "Emergent," or "Immediate" (50.9% versus 44.6%, $p=0.03$) than the pre-PC. Trauma patients in the peak PC were also more likely to attend a follow-up appointment for their initial injury in either the ED or OP setting than the pre-PC (20.4% versus 14.3%, $p<0.01$).

Many of the changes observed for peak PC versus pre-PC persisted when comparing the post-peak PC to the pre-PC, including decreased trauma rates (214.0 traumas/week ± 32.2 versus 288.0 traumas/week ± 39.2, $p<0.01$), a smaller proportion of patients initially presenting to the ED (50.3% versus 53.1%, $p=0.02$), ED cases being more likely to have acuity of "Urgent," "Emergent," or "Immediate" (55.7% versus 44.6%, $p<0.01$), and more patients attending a follow-up appointment for their initial encounter in either the ED or OP setting (20.6% versus 14.3%, $p<0.01$). The post-peak PC also observed more fracture injuries (21.6% versus 18.3%, $p<0.01$) and less superficial (17.1% versus 19.6%, $p<0.01$) and unspecified traumas (16.6% versus 21.2%, $p<0.01$) compared to the pre-PC. Complete trauma characteristic data can be found in Table 2.

Fracture characteristics

For solely fracture encounters, the peak PC saw a 62% decrease in fracture rates compared to the pre-PC (19.9 ± 8.4 fractures/week versus 52.5 fractures/week ± 12.7, $p<0.01$). However, a significantly lower proportion of peak PC fractures initially presented to the ED (37.6% versus 45.4%, $p=0.04$) but there was no difference in the proportion of fractures that patients attended a follow-up visit for ($p=0.42$). In addition, the only body region that had a significantly different proportion of fractures was the wrist/hand/fingers (11.9% peak PC versus 23.3% pre-PC, $p<0.01$) and there was no significant difference in laterality of fractures between the two cohorts ($p=0.52$). However, the most commonly fractured bones did change from pre-PC to peak PC. While the radius was consistently the most fractured bone (22.8% peak PC versus 21.8% pre-PC, $p=0.75$), the peak PC had a significantly greater proportion of tibia fractures (10.4% versus 5.0%, $p<0.01$) and significantly less hand phalanx fractures (5.0% versus 16.3%, $p<0.01$). The top five most commonly fractured bones for both groups also included the humerus (15.8% peak PC versus 12.7% pre-PC, $p=0.21$) and clavicle (8.4% peak PC versus 5.7% pre-PC, $p=0.14$).

The only change noted above that persisted for the post-peak PC was the decreased fracture rate compared to the pre-PC (46.7 fractures/week ± 10.0 versus 52.5 fractures/week ± 12.7, $p<0.01$). A similar proportion of the post-peak PC initially presented to an ED with a fracture ($p=0.41$) and attended a follow-up appointment for their fracture ($p=0.19$) as the pre-PC. There were also no

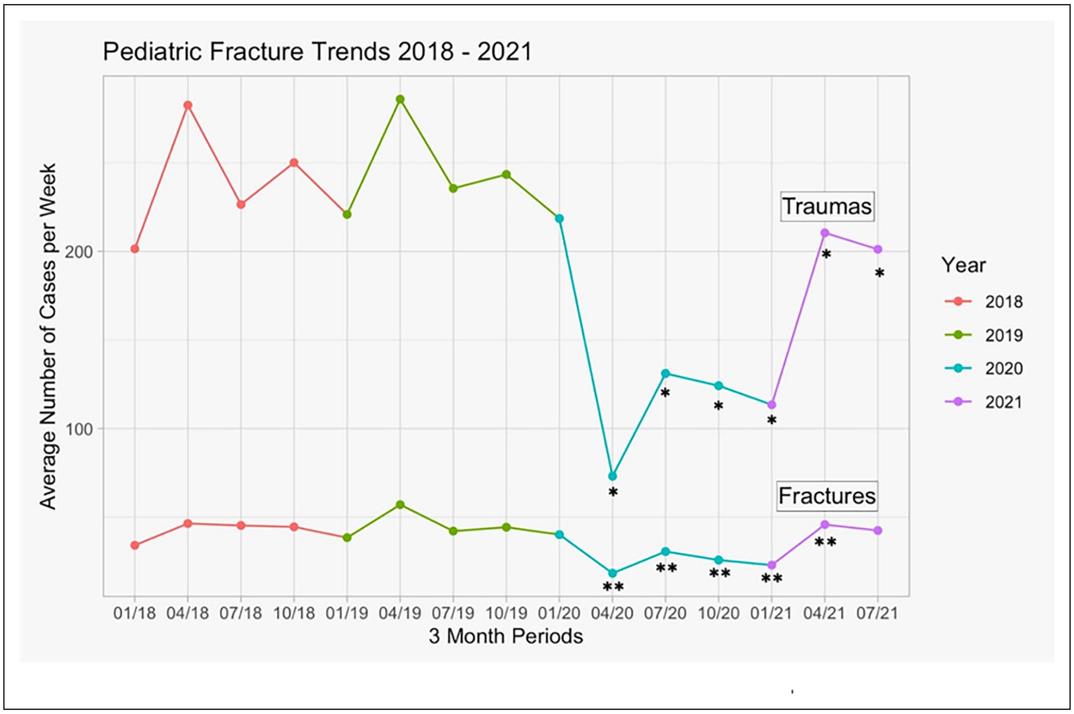

Figure 1. Trauma and fracture rates over 3-month intervals.
*Traumas per week value is significantly different from the corresponding pre-pandemic value.
**Fractures per week value is significantly different from the corresponding pre-pandemic value.

Table 2. Trauma characteristics.

Trauma characteristic	Pre-pandemic April–June (N = 6770)	Peak pandemic April–June (N = 828)	Post-peak pandemic April–June (N = 2509)
Mean traumas/week ± SD	288.0 ± 39.2	79.7 ± 27.3**	214.0 ± 32.2††
Trauma type, N (%)			
Crushing injury	41 (0.6)	5 (0.6)	18 (0.7)
Dislocation/sprain	1046 (15.5)	72 (8.7)**	382 (15.2)
Fracture	1241 (18.3)	202 (24.4)**	543 (21.6)††
Intracranial injury	177 (2.6)	14 (1.7)	62 (2.5)
Muscular/tendon injury	171 (2.7)	14 (1.7)	62 (2.5)
Ocular/orbital injury	137 (2.0)	22 (2.7)	48 (1.9)
Open wound	1151 (17.0)	186 (22.5)**	466 (18.6)
Superficial injury	1327 (19.6)	166 (20.0)	429 (17.1)††
Unspecified	1434 (21.2)	133 (16.1)**	416 (16.6)††
Initial presentation			
ED, N (%)	3595 (53.1)	360 (43.5)**	1261 (50.3)†
OP, N (%)	3116 (46.0)	452 (54.6)**	1221 (48.7)†
Acuity if ED, N (%)		*	††
Immediate	5 (0.1)	0 (0.0)	3 (0.2)
Emergent	213 (5.9)	19 (5.3)	72 (5.7)
Urgent	1389 (38.6)	164 (45.6)	628 (49.8)
Less urgent	1887 (52.5)	175 (48.6)	528 (41.9)
Non-urgent	78 (2.2)	2 (0.6)	17 (1.3)
Required follow-up, N (%)	965 (14.3)	169 (20.4)**	516 (20.6)††

*denotes if pre versus peak p-value is < 0.05.
**denotes if pre versus peak p-value is < 0.01.
†denotes if pre versus post p-value is < 0.05.
††denotes if pre versus post p-value is < 0.01.
Note: For level of acuity, chi-square analysis was performed on the sum of immediate, emergent, and urgent versus the sum of less urgent and non-urgent.

Table 3. Fracture characteristics.

Fracture characteristic	Pre-pandemic April–June (N = 1241)	Peak pandemic April–June (N = 202)	Post-peak pandemic April–June (N = 543)
Mean fractures/week ± SD	52.5 ± 12.7	19.9 ± 8.4**	46.7 ± 10.0††
Initial presentation, N (%)			
ED	563 (45.4)	76 (37.6)*	235 (43.3)
OP	651 (52.5)	117 (57.9)	302 (55.6)
Follow-up			
Required follow-up, N (%)	607 (48.9)	105 (52.0)	284 (52.2)
Mean no. of follow-ups ± SD	1.1 ± 1.7	1.4 ± 1.9	1.1 ± 1.7
Laterality, N (%)			
Right	550 (44.4)	83 (41.1)	228 (42.0)
Left	585 (47.1)	98 (48.5)	265 (48.8)
Unspecified	59 (4.8)	10 (5.0)	23 (4.2)
N/A	47 (3.8)	11 (5.4)	27 (5.0)

*denotes if pre versus peak p-value is < 0.05.
**denotes if pre versus peak p-value is < 0.01.
††denotes if pre versus post p-value is < 0.01.

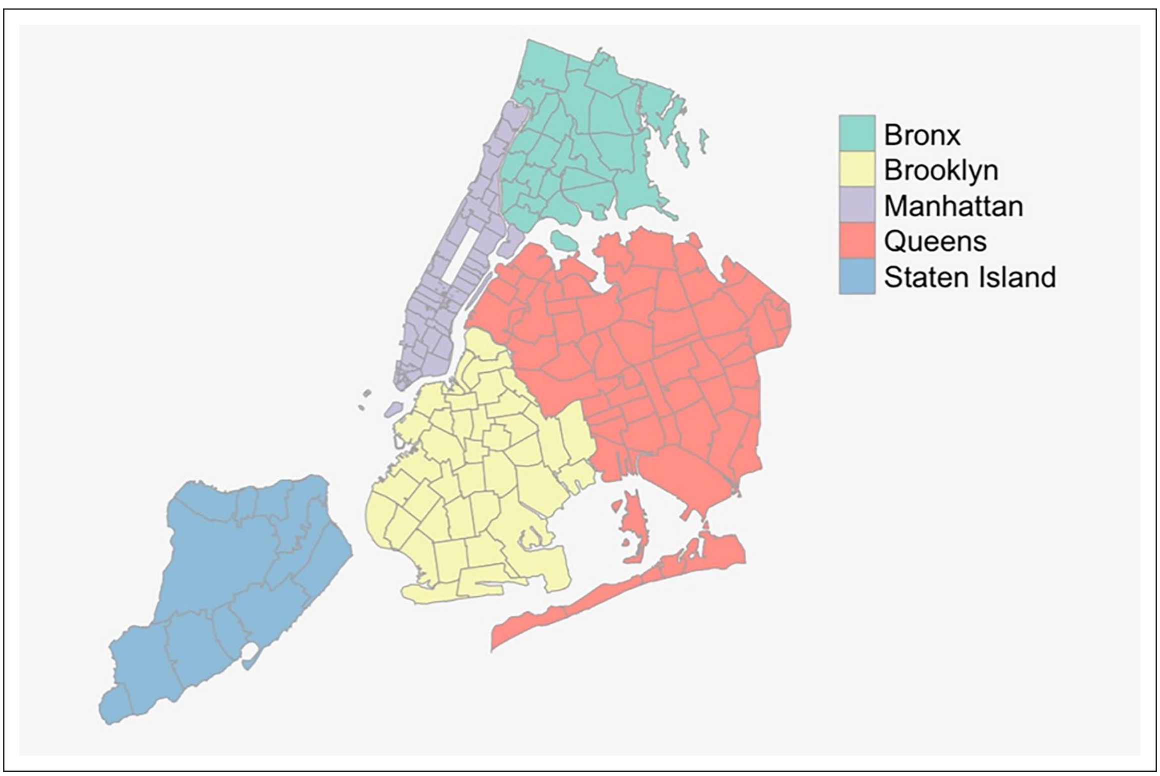

Figure 2. NYC bureaus distribution by zip code.

significant differences in the proportion of body regions that were fractured or laterality of fractures (p = 0.41). The most commonly fractured bones for the post-peak PC had the same top five (radius 24.1%, hand phalanges 15.3%, humerus 11.2%, clavicle 5.7%, and tibia 5.2%) and had no significantly different proportions as the pre-PC. Complete fracture data can be seen in Table 3.

Spatial analysis

Specific zip codes belonging to each NYC bureau (Bronx, Brooklyn, Manhattan, Queens, and Staten Island) are displayed in Figure 2. We visualized the proportion of cases in each zip code initially presenting to an ED versus OP setting in the pre-PC, peak PC, and post-peak PC in

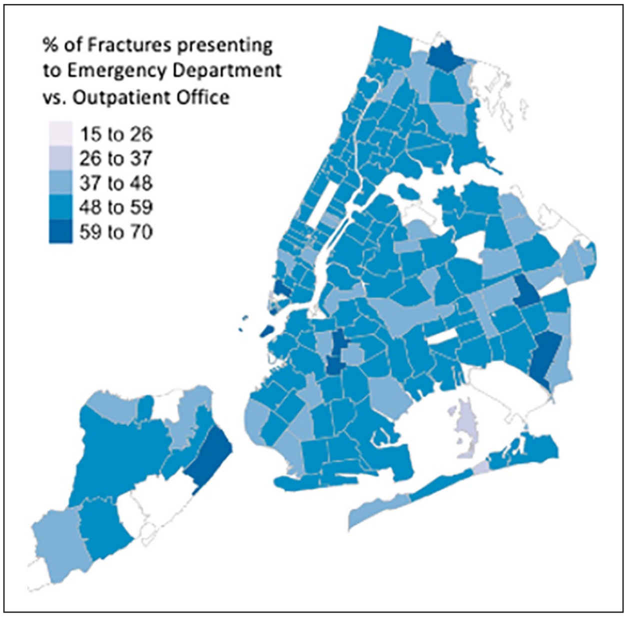

Figure 3. Spatial analysis of fracture presentation by zip code in NYC before the COVID-19 pandemic.
Legend: Zip code color represents the percentage of all fractures within a specific time frame that initially presented to the ED versus an OP office. Represents the pre-PC (April–June 2018 and 2019).

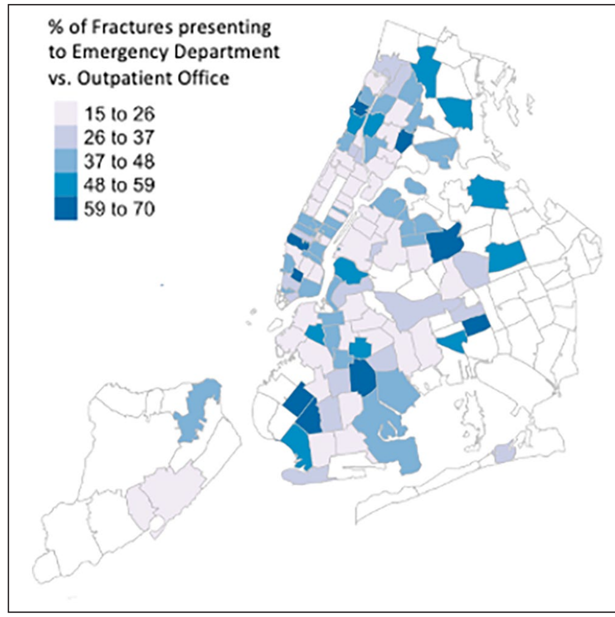

Figure 4. Spatial analysis of fracture presentation by zip code in NYC during the COVID-19 pandemic.
Legend: Zip code color represents the percentage of all fractures within a specific time frame that initially presented to the ED versus an OP office. Represents the peak PC (April–June 2020).

Figures 3–5, respectively. These maps were visually compared to a map of median household income in each zip code seen in Figure 6. Notably, while the mean percentage of fracture cases initially presenting to an ED dropped, the decrease is not uniform across the city with multiple zip clusters in Brooklyn, Queens, Lower Manhattan, and the Bronx with equal or higher rates of ED presentation compared to pre-pandemic. In the post-peak pandemic period, ED presentation rates for fractures had a similar spatial homogeneity as the pre-pandemic period, with a non-significant lower proportion of ED presentations.

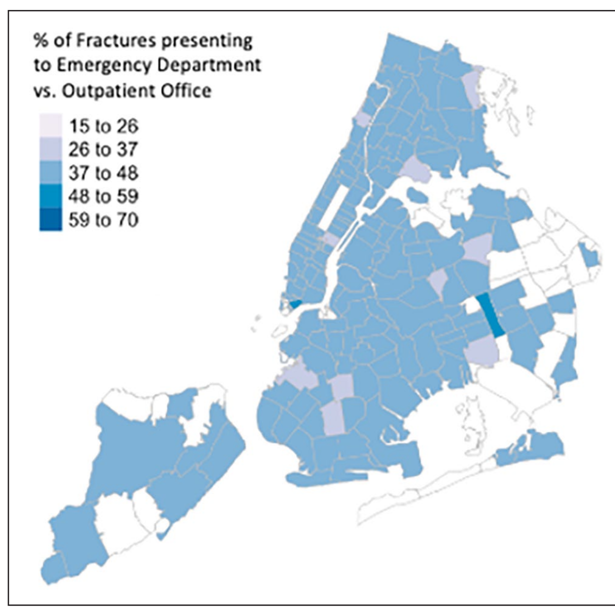

Figure 5. Spatial analysis of fracture presentation by zip code in NYC after the COVID-19 pandemic.
Legend: Zip code color represents the percentage of all fractures within a specific time frame that initially presented to the ED versus an OP office. Represents post-peak pandemic (April–June 2021).

Discussion

Literature has consistently shown that the COVID-19 pandemic and the policies enacted to mitigate its spread both directly and indirectly affected people's health.[11,18,19] While many of these policies have been phased out and much of the general public have reverted to their pre-pandemic routines, it is yet to be determined whether the previously noted changes to health outcomes have persisted or similarly reverted. This study functions to analyze the epidemiology of pediatric trauma in an urban area before, during, and after the COVID-19 pandemic to understand its short and long-term effects on pediatric orthopedics. We found a significant reduction in the volume of pediatric traumas and fractures that has continued through at least 12 months post-peak pandemic, and shifts in the types of traumas sustained and varying impacts of the pandemic on neighborhoods in NYC with different socioeconomic resources.

As the COVID-19 pandemic significantly impacted peoples' ability to engage in their typical activities, namely

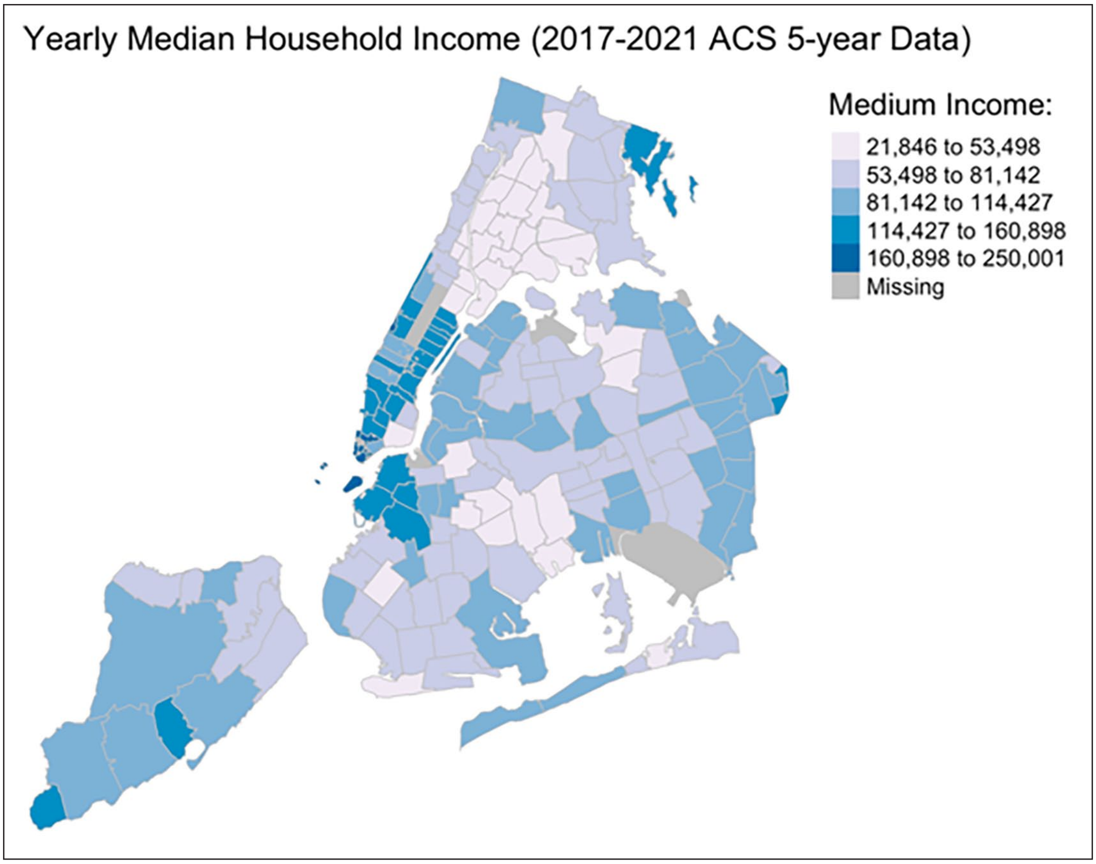

Figure 6. Median household income by Zip Code in NYC, NY.[17]

exercise and recreational activity, it makes sense that certain demographics may have been less susceptible to injury. Previous research has shown that younger children sustained a larger proportion of injuries during the pandemic, as adolescents were unable to partake in activities setting them up for injury.[3] We found a similar trend, as trauma patients in the peak PC were approximately 3 years younger and the majority of traumas occurred in the 0- to 5-year-old age group. However, both of these changes reverted to pre-pandemic values. In addition, males have been shown to be more likely to sustain traumatic injuries especially in the 10- to 19-year-old age range.[20] Studies have proposed this may be due to higher sports participation and sex-related differences in activity and risk-taking.[21,22] Therefore, the cancelation of recreational and organized athletics is likely contributing to our observed increase in the proportion of female trauma patients compared to the pre-PC, which is further supported by the post-peak PC having no differences in age or sex distribution when compared to the pre-PC.

However, not all of the observations noted for the peak PC returned to their pre-pandemic levels. Like multiple studies have previously noted,[3,8,9] we observed a significant decrease in both overall trauma and fracture rates during the height of the pandemic. We also found that trauma patients presenting during the peak pandemic were significantly more likely to be graded as “urgent,” “emergent,” or “immediate” need for treatment when presenting to an ED, which is consistent with prior literature.[23,24] Furthermore, the proportion of fractures and open wounds, which we typically imagine as more serious injuries, drastically increased while dislocations and sprains, which often require less invasive management, decreased in the peak PC. Similarly, patients with fractures who presented during the peak pandemic were much less likely to have finger fractures and more likely to have tibial fractures. All of these etiologies of increased injury severity in the peak PC are likely explained by the public’s fear of contracting COVID-19 in overwhelmed EDs and public health advice to avoid EDs unless absolutely necessary.[25,26] Therefore, less serious injuries likely either went to an OP office instead, which we directly observed in this study, or delayed their presentation for the issue beyond the peak of the pandemic. Unique to this study, though, we noted that decreased trauma/fracture volumes, higher acuities of initial presentations, and greater proportions of initial encounters at an OP office have persisted to at least 12 months post-peak pandemic, albeit in a less extreme fashion than in the peak pandemic period. This may suggest that some patients have become more selective with what injuries they feel are urgent enough for an ED versus what can wait for an OP appointment or simply do not require any medical management. This is additionally supported by the increased proportion of patients attending follow-up appointments for their trauma injury both in the peak PC and post-peak PC. Physicians should remain aware of this potential shift in patient and caregiver thought/behavior, while reinforcing the appropriate caregiver response to common pediatric injuries, as children continue to be at risk whether at home or in recreational spaces.

The final component of our analysis involved spatial mapping to better understand variable impacts on various NYC neighborhoods, as prior studies have shown the pandemic impacted populations with less socioeconomic resources more severely than others.[27,28] While the overall peak PC initially presented to an OP office more often, this study's spatial analysis identified multiple zip clusters in NYC with an opposite outcome. Notably, these clusters aligned with generally lower median income neighborhoods in Brooklyn, Queens, and the Bronx, implying these families may rely more heavily on EDs as their primary care providers. Based on the above findings, ED physicians should be reminded that they may be serving an additional primary care role for their patients and should take the opportunity to counsel them on factors beyond their presenting issue including diet, exercise, and modifiable risk factors. In addition, one study suggests assisting uninsured patients lacking access to primary care find a local "safety-net" provider has lowered subsequent ED visits.[29] ED physicians and social work staff should be aware of similar services in their vicinity and attempt to identify patients who would benefit from such a resource. This would not only provide patients with greater consistency of care but also minimize avoidable ED encounters.

Our spatial analysis merely begins the discussion and analysis of key social issues impacting the equity of healthcare for various socioeconomic groups. Commonly cited reasons for parents using EDs over other primary care sites include convenience, difficulty scheduling timely appointments, and parental perceptions of illness severity.[30,31] However, overreliance on EDs can impact continuity of care for pediatric patients, potentially harming the coordination of care for future visits and access to preventive care.[32,33] Prior literature suggests that in addition to financial resources, increased reliance on EDs as primary care for children has been associated with public/uninsured insurance status, race/ethnicity, education, and employment status.[33–35] As evidenced by the plethora of prior literature, these social issues are not novel. Instead, our data suggest that the COVID-19 pandemic exacerbated variations in healthcare utilization for higher risk populations, specifically those with lower family incomes. In the future, we hope to expand our analyses to include racial demographics, insurance status, and other socioeconomic factors to guide our understanding for the etiology of our observations; although, it is likely that an intersection of multiple of these factors is contributing to the observed disparities. Therefore, these future methodologies should help inform community-based approaches for improving access to care in higher risk neighborhoods. Prior studies have proposed health education forums and offering preventive primary care in nontraditional settings that may be more accessible.[32] We hope to use this study and future studies to identify similar interventions relevant to NYC.

The design of this study is not without inherent limitations. Namely, the analysis was performed retrospectively, so we were unable to assess patient or caregiver sentiment regarding the pandemic and their health. Also, as our study pertained to a multi-site institution within a single city, the context of the findings may not directly apply to other settings. However, we still believe our findings to be relevant as prior literature from other urban areas, such as Philadelphia, Baltimore, and Chicago, found similar peak pandemic trends. In addition, the time period correlating to each cohort is relatively short at 82 days, but the size of our cohorts allowed for adequate statistical confidence. Finally, as we have city-wide data for the entirety of 2018 through 2021, we hope to follow the trends noted in this study to observe when, if ever, they return to pre-pandemic values. In addition, we plan to perform more detailed spatial analyses related to zip code-specific impacts and outcomes for social and economic resource allocation purposes. Finally, we hope to survey pediatric orthopedic surgeons to gauge whether the decrease in fracture and trauma volume noted here has noticeably impacted their workload.

In this study, we found that during the peak pandemic, younger patients made up a greater proportion of trauma encounters, overall pediatric trauma and fracture rates decreased, traumas initially presenting to an ED had higher acuity ratings, and patients were more likely to present with fractures or open wound traumatic injuries. While much of this is supported by prior literature, we are one of the first studies to follow these trends beyond the peak of the pandemic and have shown that many changes persisted through at least 12 months post-peak pandemic in NYC. Separately, we visualized that neighborhoods with lower median income initially presented to EDs at increased rates and may rely more heavily on EDs for their first-line care. These longitudinal analyses can inform ED and orthopedic physicians on patient and caregiver behaviors in the current health climate and assist with critical care and social resource allocation currently and for future outbreaks.

Author contributions

L.R.B. (BS), E.A. (BA), P.M. (PhD), C.L.D. (BS), J.P. (MD, PhD), A.K.A. (MD), and S.C.R. (MD) contributed in study design and participated in article preparation and approval; L.R.B., E.A., and J.P. participated in data acquisition and analysis; and S.C.R. performed data acquisition.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Compliance with ethical standards

This study was approved by the Icahn School of Medicine at Mount Sinai Institutional Review Board (Study No. 20-00752). Informed consent was not required for this retrospective study.

ORCID iD

Liam R Butler https://orcid.org/0000-0002-4647-5488

References

1. Congiusta DV, Otero K, Ippolito J, et al. A new role for orthopaedic surgeons: ongoing changes, lessons learned, and perspectives from a level I trauma center during the COVID-19 pandemic. *J Shoulder Elbow Surg* 2020; 29(10): 1951–1956.
2. Liu Q, Luo D, Haase JE, et al. The experiences of healthcare providers during the COVID-19 crisis in China: a qualitative study. *Lancet Glob Hsealth* 2020; 8(6): e790–e798.
3. 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.
4. Charney SA, Camarata SM and Chern A. Potential impact of the COVID-19 pandemic on communication and language skills in children. *Otolaryngol Head Neck Surg* 2021; 165(1): 1–2.
5. Tester JM, Rosas LG and Leung CW. Food insecurity and pediatric obesity: a double Whammy in the era of COVID-19. *Curr Obes Rep* 2020; 9(4): 442–450.
6. Blum P, Putzer D, Liebensteiner MC, et al. Impact of the Covid-19 pandemic on orthopaedic and trauma surgery—a systematic review of the current literature. *In Vivo* 2021; 35(3): 1337–1343.
7. Wong JSH and Cheung KMC. Impact of COVID-19 on orthopaedic and trauma service: an epidemiological study. *J Bone Joint Surg Am* 2020; 102(14): e80.
8. Markiewitz ND, Garcia-Munoz J, Lilley BM, et al. Epidemiologic changes in pediatric fractures presenting to emergency departments during the COVID-19 pandemic. *J Pediatr Orthop* 2022; 42(8): e815–e820.
9. Keays G, Friedman D and Gagnon I. Injuries in the time of COVID-19 (Les Blessures Au Temps De La COVID-19). *Health Promot Chronic Dis Prev Can* 2020; 40(11–12): 336–341.
10. Pepper MP, Leva E, Trivedy P, et al. Analysis of pediatric emergency department patient volume trends during the COVID-19 pandemic. *Medicine* 2021; 100(27): e26583.
11. Bessoff KE, Han RW, Cho M, et al. Epidemiology of pediatric trauma during the COVID-19 pandemic shelter in place. *Surg Open Sci* 2021; 6: 5–9.
12. Haddadin Z, Blozinski A, Fernandez K, et al. Changes in pediatric emergency department visits during the COVID-19 pandemic. *Hosp Pediatr* 2021; 11(4): e57–e60.
13. Bolzinger M, Lopin G, Accadbled F, et al. Pediatric traumatology in “green zone” during Covid-19 lockdown: a single-center study. *Orthop Traumatol Surg Res* 2021; 109: 102946.
14. Kourti A, Stavridou A, Panagouli E, et al. Domestic violence during the COVID-19 pandemic: a systematic review. *Trauma Violence Abuse* 2023; 24: 719–745.
15. Sethuraman U, Kannikeswaran N, Singer A, et al. Trauma visits to a pediatric emergency department during the COVID-19 quarantine and “Stay at Home” Period. *Am Surg* 2021; 13: 31348211047497.
16. NYC OpenData. Department of information technology & telecommunications [Zip Code Boundaries] 2014, https://data.cityofnewyork.us
17. Manson S, Schroeder J, Van Riper D, et al. IPUMS National historical geographic information system: version 17.0 [2021 American Community Survey: 5-Year Data [2017-2021, Block Groups & Larger]. Minneapolis, MN: IPUMS, 2022, http://doi.org/10.18128/D050.V17.0
18. McGuine TA, Biese KM, Petrovska L, et al. Mental health, physical activity, and quality of life of US adolescent athletes during COVID-19-related school closures and sport cancellations: a study of 13000 athletes. *J Athl Train* 2021; 56(1): 11–19.
19. Woolford SJ, Sidell M, Li X, et al. Changes in body mass index among children and adolescents during the COVID-19 pandemic. *JAMA* 2021; 326(14): 1434–1436.
20. Stracciolini A, Casciano R, Levey Friedman H, et al. Pediatric sports injuries: a comparison of males versus females. *Am J Sports Med* 2014; 42(4): 965–972.
21. Naranje SM, Erali RA, Warner WC Jr, et al. Epidemiology of pediatric fractures presenting to emergency departments in the United States. *J Pediatr Orthop* 2016; 36(4): e45–e48.
22. Hedström EM, Svensson O, Bergström U, et al. Epidemiology of fractures in children and adolescents. *Acta Orthop* 2010; 81(1): 148–153.
23. Tuygun N, Karacan CD, Göktuğ A, et al. Evaluation of changes in pediatric emergency department utilization during COVID-19 pandemic. *Arch Pediatr* 2021; 28(8): 677–682.
24. Sokoloff WC, Krief WI, Giusto KA, et al. Pediatric emergency department utilization during the COVID-19 pandemic in New York City. *Am J Emerg Med* 2021; 45: 100–104.
25. Garrafa E, Levaggi R, Miniaci R, et al. When fear backfires: emergency department accesses during the Covid-19 pandemic. *Health Policy* 2020; 124(12): 1333–1339.
26. Sürme Y, Özmen N and Ertürk Arik B. Fear of COVID-19 and related factors in emergency department patients. *Int J Ment Health Addict* 2023; 21: 28–36.
27. Mena GE, Martinez PP, Mahmud AS, et al. Socioeconomic status determines COVID-19 incidence and related mortality in Santiago, Chile. *Science* 2021; 372(6545): eabg5298.
28. Green H, Fernandez R and MacPhail C. The social determinants of health and health outcomes among adults during the COVID-19 pandemic: a systematic review. *Public Health Nurs* 2021; 38(6): 942–952.

29. Kim TY, Mortensen K and Eldridge B. Linking uninsured patients treated in the emergency department to primary care shows some promise in Maryland. *Health Aff* 2015; 34(5): 796–804.
30. Fieldston ES, Alpern ER, Nadel FM, et al. A qualitative assessment of reasons for nonurgent visits to the emergency department: parent and health professional opinions. *Pediatr Emerg Care* 2012; 28(3): 220–225.
31. LaCalle E and Rabin E. Frequent users of emergency departments: the myths, the data, and the policy implications. *Ann Emerg Med* 2010; 56(1): 42–48.
32. Goyal MK, Richardson T, Masonbrink A, et al. Reliance on acute care settings for health care utilization: a comparison of adolescents with younger children. *Pediatric Emergency Care* 2021; 37(12): e1128–e1132.
33. Kroner EL, Hoffmann RG and Brousseau DC. Emergency department reliance: a discriminatory measure of frequent emergency department users. *Pediatrics* 2010; 125(1): 133–138.
34. Krieg C, Hudon C, Chouinard MC, et al. Individual predictors of frequent emergency department use: a scoping review. *BMC Health Services Research* 2016; 16(1): 594.
35. Schlichting LE, Rogers ML, Gjelsvik A, et al. Pediatric emergency department utilization and reliance by insurance coverage in the United States. *Acad Emerg Med* 2017; 24(12): 1483–1490.