

## A traumatic pandemic: High acuity pediatric trauma in the COVID19 era

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### ABSTRACT

**Objective:** Gaps remain in our understanding on how COVID19 affects trends in pediatric trauma, the leading cause of mortality and morbidity during childhood and adolescence.

**Methods:** We compared high acuity trauma visits (requiring admission, surgery, or fatality) presenting between March through February 2021 to corresponding months in 2017–2019. We evaluated the differences in mechanisms of injury, age, and Area Deprivation Index (ADI), a measure of socioeconomic disadvantage, during this time period. Data were analyzed using longitudinal time series analyses and t-tests.

**Results:** Of 687 traumas presenting from March 2020 through February 2021, 322 were high acuity traumas. High acuity traumas declined significantly to a nadir of 16 in April 2020. High acuity traumas increased and surpassed previous years to a peak of 40 visits in August 2020 and from October through December 2020. There were more visits for high acuity assaults and confirmed or suspected physical child abuse but fewer for falls, drownings, and motor vehicle accidents from March to August 2020 and from October through December 2020 compared to prior years. High acuity assaults and physical child abuse cases on average were from the most disadvantaged areas, and physical child abuse patients were younger during the peak of the Pandemic compared to Pre-Pandemic months.

**Conclusion:** This analysis provides insight into how the COVID19 pandemic has affected high acuity trauma in an inner-city pediatric population. Findings may be used to guide public health measures on safety and injury prevention as the pandemic continues.

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### Introduction

The COVID19 pandemic and its associated policy response has been associated with shifts in health care utilization in many different arenas [1]. Decreased utilization of Emergency Department (ED) services during the pandemic are being seen globally, especially in areas of historically high utilization like Portugal [2]. These trends may reflect a collective fear of hospitals as highly infectious zones and the downstream effects of quarantine and self-isolation [3].

**Abbreviations:** COVID19, Coronavirus Disease 19; SARS-CoV-2, Severe acute respiratory syndrome-coronavirus-2; ED, Emergency Department; HAT, High Acuity Trauma; ADI, Area Deprivation Index; UK, United Kingdom.

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There is concern that this sudden change in utilization may have negative downstream effects on chronic illnesses that are not being promptly treated [4]. There is ongoing research looking at how chronic illnesses in the adult population are being exacerbated during the COVID19 pandemic, such as myocardial infarction and stroke [5]. These trends are also being seen in the pediatric population in the United States as hospitals are seeing significant decreases in pediatric asthma related ED visits [6].

Did trends of non-chronic medical problems such as traumatic injury during the COVID19 pandemic change as well? Brewster et al. studying the incidence of pediatric burns at their center in the UK found a 30-fold increase in the number of scalds due to steam inhalation as a potential remedy for the respiratory symptoms of SARS-CoV2. This finding was duplicated in other centers throughout the UK, which showed a 50% increase of scalds correlating to areas with higher prevalence of COVID19 [7]. A recent Australian study demonstrated that while ED utilization was lower,

there was a proportionally higher rate of traumatic injuries during one month of the pandemic compared to previous years [8].

The objective of this current study is to identify trends in traumatic injury in our East Baltimore pediatric ED during the COVID19 pandemic and to compare them to previous years. We focused on high acuity trauma (HAT) because they are unlikely to be affected by care-avoidance during the pandemic because of the need for urgent medical attention and thus we could more accurately elucidate the underlying incidence of trauma in the population. Our hypothesis is that there will be a statistically significant difference in both the number and types of traumas presenting to our ED during the COVID19 pandemic compared to similar months in 2017-2019. Findings will shed light on the downstream effects of COVID19 on child safety and will be used to identify and prevent child injury both locally and nationally.

**Methods**

Our site is an urban, Mid-Atlantic Pediatric ED and level 1 Pediatric Trauma Center with an annual census of 25,000 patients primarily serving our East Baltimore neighborhood but also receiving referrals from the greater Maryland area, specialty referrals primarily from DE, PA, VA, DC, and WV, and international patients. Our center caters to all patients regardless of their means of payment and complies with the Emergency Medical Treatment and Labor Act. Our research group consisted of a multidisciplinary team of nurses and physicians. We queried our institutional database to identify all high acuity trauma (HAT) visits from January 2017–February 2021. All traumas in this time period were registered to our state trauma registry, which ensured the inclusion of all traumas within this time period. Visits were included if a trauma diagnosis was entered by an ED provider into the electronic health record using a validated *International Classification of Diseases* code grouping system [9]. Visits were excluded if there was missing/incomplete data regarding either their final diagnosis or disposition. HAT was defined as trauma requiring admission, emergent surgical intervention, or resulting in a fatality. We used student’s t-tests and longitudinal time series plots to compare the number of monthly HAT visits in March 2020–February 2021 to corresponding Pre-Pandemic months in 2017–2019. Multiple Pre-Pandemic years were selected in order to establish clear trends for comparison. The data met the normality assumption of the t-test via Shapiro-Wilk test and examination histograms. To reflect the two initial waves of COVID19 spread in Maryland, we

then divided our data into two time periods, March–August 2020 and October–February 2021. We compared mechanisms of HAT in these time periods to prior years as well as age. Additionally, we characterized HATs by Area Deprivation Index (ADI), a tool initially created by the Health and Resources & Service Administration and has been since been validated in the literature [10]. ADI is a composite measure of 17 census variables designed to describe socioeconomic disadvantage based on income, education, and household characteristics with range 1–10 where higher scores indicate more disadvantage [11]. All analyses were computed in Microsoft Excel. Johns Hopkins IRB was submitted and approved for data analysis.

**Results**

We identified 322 HATs among 687 traumas from March 2020–February 2021. There were no HATs identified with missing data. Monthly HATs declined significantly after the Maryland state government declared a state of emergency restricting residents from leaving their home, to a nadir of 16 in April 2020 ( $p<0.001$ ). As restrictions were lifted, HATs surpassed previous years to a peak of 40 visits in August 2020 ( $p<0.001$ ) as well as a peak of 31 in October 2020 (Fig. 1). In addition to an increase in HAT in certain months during the pandemic, HAT as a proportion of total Emergency Department visits were higher as COVID19 cases peaked in March 2020 and onwards compared to prior years (Fig. 2). When we compared visits in March–August 2020 to prior years, we observed higher visits for high acuity assaults ( $n=10$ , 2017-19 mean 6.7,  $p<0.001$ ) and suspected or confirmed physical child abuse ( $n=16$ , 2017-19 mean 8.7,  $p<0.001$ ) but fewer for falls ( $n=51$ , 2017-19 mean 68.7,  $p<0.001$ ), drownings ( $n=6$ , 2017-19 mean 8.7,  $p<0.001$ ), and motor vehicle accidents (MVA) ( $n=63$ , 2017-19 mean 77.3,  $p<0.001$ ) from March-August 2020 compared to prior years, while visits for animal attacks remained stable ( $n=5$ , 2017-19 mean 5.7,  $p=0.38$ ) (Table 1). HAT due to physical child abuse involved significantly younger patients (average age 2.4 years, 95% CI[1.8-3]) compared to Pre-Pandemic patients (average age 4.8 years, 95% CI[3.9-5.6]). HAT due to assault (state ADI decile average 8.9, 95% CI[8.18-9.62]) and due to physical child abuse (state ADI decile average 7.4, 95% CI[6.1-8.7]) were from the most disadvantaged areas, but these results were not statistically significant when compared to assaults (state ADI decile average 7.8, 95% CI[7-8.7]) and physical child abuse (state ADI decile average 7.7, 95% CI[7-8.4]) from 2017-2019.

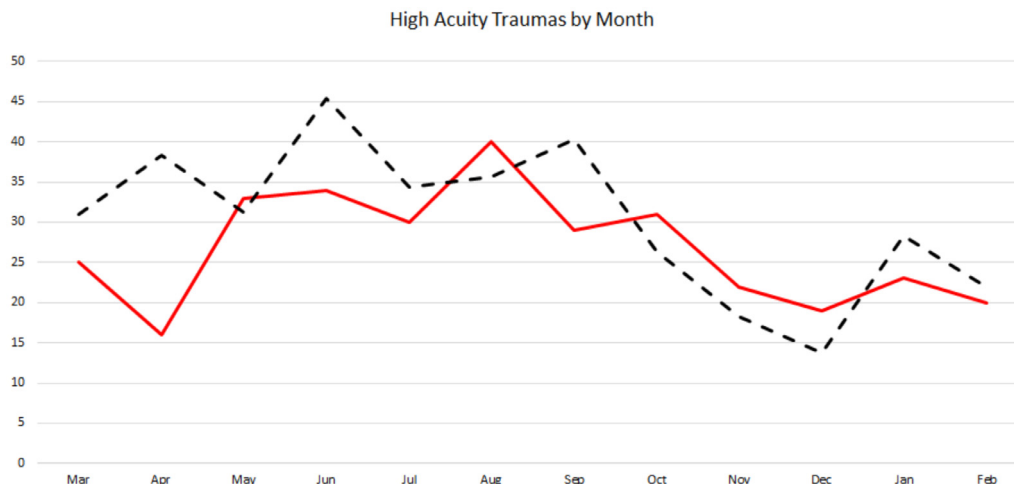


Fig. 1. High Acuity Traumas by Month during the COVID19 Pandemic compared to previous years.

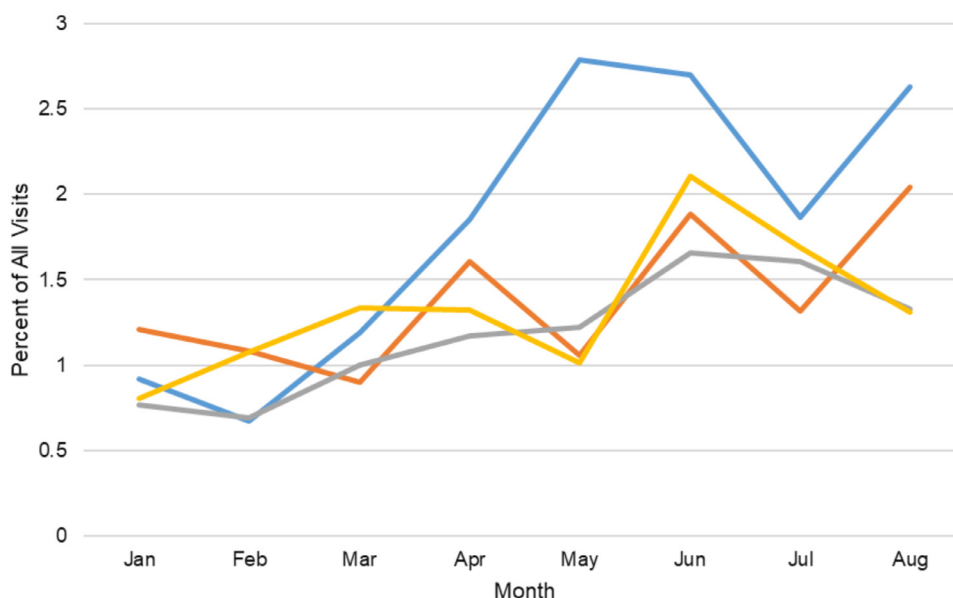


Fig. 2. High Acuity Trauma as Proportion of all ED Visits for 2<sup>nd</sup> wave of COVID-19 cases.

**Table 1**  
Comparison of Total High Acuity Traumas for January -August 2020 Versus Prior Periods.

Trauma Type	Pre-Pandemic Mean Total Visits Mar-Aug	Pre-Pandemic Mean Total Visits Oct-Dec	Pandemic Mean Total Visits Mar-Aug	Pandemic Total Visits Oct-Dec	P-Value Mar-Aug	P-value Oct-Dec
Assaults	6.7	3	<b>10</b>	1	<b>&lt;0.001</b>	0.0513
Motor Vehicle Accidents	77.3	22.7	63	20	<b>&lt;0.001</b>	0.3765
Falls	68.7	20.3	51	18	<b>&lt;0.001</b>	0.44
Drowning	8.7	0	6	0	<b>&lt;0.001</b>	n/a
Child Abuse	8.7	3	<b>16</b>	<b>6</b>	<b>&lt;0.001</b>	0.14
Animal Attack	5.7	1.3	5	4	=0.38	0.01

During the third wave of COVID-19 cases from October through December 2020, there were more visits for high acuity suspected or confirmed physical child abuse and animal attacks while visits for falls, drownings, motor vehicle accidents, and assaults stayed the same (Table 1). There were no significant age differences from patients during this wave of COVID-19. HAT due to physical child abuse cases were from more disadvantaged areas (state ADI decile average 8.3, 95% CI[7.2-9.4]) but these results were not statistically significant when compared to 2017-2019 (state ADI decile average 5.8, 95% CI[3.2-8.4]).

**Discussion**

Although ED visits throughout our institution decreased during the peak months of COVID-19, HAT as a proportion of all ED visits were higher compared to previous years. Additionally, as restrictions were lifted, HAT increased and surpassed the average of previous years in August of 2020 as well as in October-Dec 2020. These increases were primarily due to an increase of suspected or confirmed physical child abuse. Other common sources of high acuity pediatric trauma remained at a lower level or were not significantly different from previous years.

Our data are unable to fully elucidate the reasons behind the change in the patterns of our trauma in the ED. Given reduced mobility and travel that resulted from physical distancing measures implemented in the Baltimore metro area, it is not surprising that MVAs would decrease during our study period. Additionally, upon further chart review on cases of child abuse occurring the

Pandemic, it was found that their family support dynamics did not change.

More concerning is the rise in HAT caused by both assault and child abuse. A recent report from Spain showed that intimate partner violence against women increased by 23% during the first lockdown [12] while another report from the UK showed a rising share of traumas secondary to domestic violence [13], and there have been reports of this locally in the Baltimore region [14]. Data showing the increase in child abuse in the US could be consistent with a rise in domestic violence incidence as physical distancing measured persisted through December 2020. An increase of serious physical child abuse cases from more disadvantaged areas during the third peak of the pandemic may have reflected an increase of caregivers’ presence at home due to working remotely and a lack of community surveillance as essential workers returned to work and schools/daycares continued to be closed. These data support widespread concern that child abuse may now be more likely to go undetected in the pediatric population because children have been less likely to be observed by other adults in educational and childcare contexts during the Pandemic. As physical distancing measures continue to relax, it will be essential for caregivers in these settings to be aware of these trends, especially those in more disadvantaged areas. Caregivers and health care providers may need to be extra vigilant for child abuse even in infants and toddlers during the Pandemic. Furthermore, these data will add awareness to an increase of psychosocial stressors due to the Pandemic leading to traumatic injury like child abuse and will encourage providers to routinely screen for these during both inpatient and outpatient encounters.

The etiology of increase in HAT secondary to assault in our study period is difficult to explain. Nationally, most forms of crime have decreased but there has been less change to violent crime [15]. It is possible that the increase in assault exhibited in our population reflects this broader trend. However, we cannot exclude that physical distancing measures and school closures also may have had a significant effect on traumatic assaults and abuse in the pediatric population, although much of our data exhibiting this increase took place during the summer when many children are not in school. Future studies should compare trends in HAT secondary to child abuse and assault in metro areas that reopened schools versus those that opened later to better elucidate this question.

Our data show that our trauma center receives a disproportionate number of high acuity traumas from neighborhoods in Maryland and surrounding states that are socioeconomically disadvantaged. Based on ADI from Pre-Pandemic and Pandemic HAT, this finding did not change significantly during the Pandemic. These findings support the growing body of literature that show a possible association between socioeconomic status and severe traumatic injury [16].

Our study has several strengths, including that our focus on the data from one pediatric emergency room allows us to better review detailed HAT characteristics such as the ADI as well as easily stratify our data compared to previous years' baseline. Our findings are subject to at least four limitations. First, because of our focus on incidence and proportion of cases, we are not able to characterize in detail any differences present in the free text chart between HAT cases before and after the pandemic. For example, the increase in HAT secondary to abuse could be because these injuries go untreated for longer thus increasing their acuity at presentation rather than a true increase in child abuse. A detailed chart review might reveal some evidence of this, although we expect it would be difficult to elucidate. Second, while our data allowed more granular review compared to national public health datasets, we were unable to compare trends in our population to other metro areas with different COVID19 policies in educational and childcare settings. Third, while we can identify an increase in HAT secondary to abuse, our data do not account for other forms of abuse such as neglect. Finally, while we identified a significant increase in HAT and difference in age during March–August 2020, the observed increase in Oct–Dec 2020, increased ADI, and age differences were not statistically significant, though this may reflect small sample size.

## Conclusions

In summary, we identified an overall decrease in HAT during the first months of COVID19 pandemic but a concerning increase in child abuse during the second and third peaks of cases, especially in disadvantaged urban areas. These findings support recent CDC guidance toward safe conduction of school while continuing public health measures to enable children to attend safely [17] and supports further injury prevention interventions both locally and nationally as the Pandemic continues. As children return to more regular educational and healthcare settings, adult caregivers should be carefully attuned to signs of abuse and risk of assault in the pediatric population.

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

- [1] Iyengar K, Mabrouk A, Jain VK, Venkatesan A, Vaishya R. Learning opportunities from COVID-19 and future effects on health care system. *Diab Metab Syndrome Clinic Res Rev* 2020;14(5):943–6.
- [2] Santana R, Joana S Sousa, Soares P, Lopes S, Boto P, João V Rocha. The demand for hospital emergency services: trends during the first month of COVID-19 response. *Portuguese J Public Health* 2020:1–7.
- [3] Will S, Elly Y. Eerie emptiness of ERs worries doctors as heart attack and stroke patients delay care. *TCA News Service* 2020.
- [4] Driggin E, Madhavan MV, Bikdeli B, et al. Cardiovascular considerations for patients, health care workers, and health systems during the COVID-19 pandemic. *J Am Coll Cardiol* 2020;75(18):2352–71.
- [5] Zhao J, Li H, Kung D, Fisher M, Shen Y, Liu R. Impact of the COVID-19 epidemic on stroke care and potential solutions. *Stroke* 2020;51(7):1996–2001.
- [6] Kenyon CC, Hill DA, Henrickson SE, Bryant-Stephens TC, Zorc JJ. Initial effects of the COVID-19 pandemic on pediatric asthma emergency department utilization. *The journal of allergy and clinical immunology in practice* (Cambridge, MA). 2020.
- [7] Brewster CT, Choong J, Thomas C, Wilson D, Moiemien N. Steam inhalation and paediatric burns during the COVID-19 pandemic. *Lancet* 2020;395(10238):1690.
- [8] Harris D, Ellis DY, Gorman D, Foo N, Hausteud D. Impact of COVID-19 social restrictions on trauma presentations in South Australia. *Emerg Med Australas* 2021;33:152–4. doi:10.1111/1742-6723.13680.
- [9] Raymond GC, Robert CL. Measuring quality improvement in healthcare. New ed. US: Asq - American Society For Quality; 2001.
- [10] Kind AJH, Buckingham WR. Making neighborhood-disadvantage metrics accessible – the neighborhood atlas. *N Engl J Med* 2018;378(26):2456–8.
- [11] Maroko AR, Doan TM, Arno PS, Hubel M, Yi S, Viola D. Integrating social determinants of health with treatment and prevention: a new tool to assess local area deprivation. *Preventing Chronic Dis* 2016;13:E128. <https://www.ncbi.nlm.nih.gov/pubmed/27634778>. doi:10.5888/pcd13.160221.
- [12] Vives-Cases C, Parra-Casado DL, Estévez JF, Torrubiano-Domínguez J, Sanz-Barbero B. Intimate partner violence against women during the COVID-19 lockdown in Spain. *Int J Environ Res Public Health* 2021;18(9):4698. <https://www.ncbi.nlm.nih.gov/pubmed/33925021>. doi:10.3390/ijerph18094698.
- [13] Domestic abuse in england and wales overview: November 2020. Key Non Parliamentary Papers Social Relief And Welfare. 2021.
- [14] Anderson, Jessica. “The Warnings Came True: Domestic Violence Has Spiked in Baltimore Area amid Pandemic, Data and Experts Reveal.” *Baltimoresun.com*, Baltimore Sun, 2 Apr. 2021. <https://www.baltimoresun.com/news/crime/bs-md-ci-cr-domestic-violence-increases-20210402-6lfezjoqonbsdc4erd2pwvyyq6a-story.html>.
- [15] Abrams D, Watson T, Doleac J et al. Crime in the Time of COVID | Econofact. Econofact | Key facts and incisive analysis to the national debate on economic and social policies. <https://econofact.org/crime-in-the-time-of-covid>. Published 2022. Accessed February 24, 2022.
- [16] Popal Z, Berkeveld E, Ponsen KJ, Goei H, Bloemers FW, Zuidema WP, et al. The effect of socioeconomic status on severe traumatic injury: a statistical analysis. *Eur J Trauma Emerg Surg* 2021;47(1):195–200 Feb.
- [17] “Operational Strategy for K-12 Schools through Phased Prevention.” *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, [https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/operation-strategy.html?CDC\\_AA\\_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fcommunity%2Fschools-childcare%2Fschools.html](https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/operation-strategy.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fcommunity%2Fschools-childcare%2Fschools.html).