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## Pediatric emergency care in New York City during the COVID-19 pandemic shutdown and reopening periods

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### ABSTRACT

**Objective:** New York City (NYC) is home to the largest public healthcare system in the United States and was an early epicenter of coronavirus disease 2019 (COVID-19) infections. This system serves as the safety net for underserved and marginalized communities disproportionately affected by the pandemic. Prior studies reported substantial declines in pediatric emergency department (ED) volume during the initial pandemic surge, but few describe the ongoing impact of COVID-19 throughout the year. We evaluated the characteristics of pediatric ED visits to NYC public hospitals during the pandemic lockdown and reopening periods of 2020 compared to the prior year.

**Methods:** Retrospective cross-sectional analysis of pediatric ED visits from 11 NYC public hospitals from January 2019–December 2020. Visit demographics, throughput times, and diagnosis information during the early (3/7/20–6/7/20) and late (6/8/20–12/31/20) pandemic periods coinciding with the New York State of emergency declaration (3/7/20) and the first reopening date (6/7/20) were compared to similar time periods in 2019. Findings were correlated with key pandemic shutdown and reopening events.

**Results:** There was a 47% decrease in ED volume in 2020 compared to 2019 (125,649 versus 238,024 visits). After reopening orders began in June 2020, volumes increased but peaked at <60% of 2019 volumes. Admission rates, triage acuity, and risk of presenting with a serious medical illness were significantly higher in 2020 versus 2019 ( $P < 0.001$ ). Time-to-provider times decreased however provider-to-disposition times increased during the pandemic ( $P < 0.001$ ). Infectious and asthma diagnoses declined >70% during the pandemic in contrast to the year prior. After reopening periods began, penetrating traumatic injuries significantly increased compared to 2019 [+34%, Relative Risk: 3.2 (2.6, 3.8)].

**Conclusions:** NYC public hospitals experienced a sharp decrease in pediatric volume but an increase in patient acuity during both the initial pandemic surge and through the reopening periods. As COVID-19 variants emerge, the threat of the current pandemic expanding remains. Understanding its influence on pediatric ED utilization can optimize resource allocation and ensure equitable care for future surge events.

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## 1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic has led governments worldwide to institute lockdown measures to slow the spread of infection [1]. During the height of the pandemic, stay-at-home orders, social distancing, school and business closures, and mask mandates were instituted [1,2]. These safety measures substantially altered the landscape of healthcare utilization during this period [3–9]. Many emergency departments (ED) throughout the United States experienced a reduction in patient volumes but increased patient acuity [3–10].

New York City (NYC) is home to the largest public healthcare system in the United States and was an early epicenter of COVID-19 infections [1,11]. NYC Health + Hospitals (H + H) operates 11 acute care hospitals and serves as the medical safety net for over one million patients including poor and underserved minority populations [11]. During the pandemic, these groups suffered disproportionately worse infection rates, hospitalizations, and medical outcomes compared to other patients [12,13]. Though children often experience milder COVID-19 infections than adults, nearly one-third of pediatric patients admitted with COVID-19 had severe disease [14]. As children continue to make up an increasing percentage of new cases [15], knowledge on how pandemics affect pediatric healthcare resource utilization is essential in planning for future catastrophic events.

Prior studies have described pediatric ED utilization characteristics during the COVID-19 pandemic either within a single hospital perspective or focused on trends across the country [3–9]. The objective of this study was to report pediatric ED volumes and demographics in a large health system located within the most severely affected communities in the city at the forefront of the COVID-19 pandemic. To this point, one hospital in the NYC H + H system, Elmhurst Hospital, was described as the “epicenter within the epicenter” by Mayor Bill DeBlasio for receiving the highest volume and severity of COVID-19 patients [16]. This study also aims to describe pediatric ED utilization during the subsequent recovery and reopening period, as most previous studies focus on the initial months of the COVID-19 surge [3–9].

## 2. Materials and methods

### 2.1. Study design and setting

This was a retrospective study of patient visits to all 11 NYC H + H EDs located in four of the five NYC boroughs from January 2019 through December 2020 [17]. Pediatric services at each hospital vary and range from community EDs to tertiary care centers. Six hospitals within the system are designated pediatric or adult trauma centers. Five also offer pediatric intensive care services.

Data was collected for the years 2019–2020. During 2020, time periods representing the early pandemic (March 7th, 2020 - June 7th, 2020) and late pandemic (June 8th, 2020 - December 31st, 2020) were further examined. These divisions aimed to capture trends during the COVID-19 pandemic using two important cut points: the State of Emergency announcement for New York State on March 7th, 2020, and the Phase 1 reopening on June 8th, 2020 [1,2]. Data from the same time intervals in the year 2019 were also collected for comparison. This study was reviewed as exempt by the Biomedical Research Alliance of New York Institutional Review Board.

### 2.2. Study population

All visits of patients <21 years old to NYC H + H EDs during the study period were included. Patient visits to dedicated psychiatric EDs, and labor and delivery units within the health system were excluded. However, psychiatric and pregnancy related complaints were included if the patient presented to the general ED.

### 2.3. Data collection and analysis

Demographic data, visit types, emergency severity index (ESI) levels, dispositions, diagnoses, and throughput times were collected from the electronic medical record (EMR) (QuadraMed, Reston, VA and Epic Systems, Verona, WI). Raw data was obtained through programmed extraction of the EMR by one of the study authors (HOT), a Senior Business Intelligence Developer within the NYC H + H Central Office Department of Data and Analytics, with additional support from developers from the Office of Quality and Safety and Data Sciences (CC, VN - Acknowledgements). All data abstractors had multiple years of experience extracting clinical data for research studies and were aware of the study objectives. Extracted data was compared to EMR records for accuracy and weekly quality assurance was performed during the data abstraction process. ESI levels were graded from 1 to 5, with 1–2 being most severe and emergent [18]. Missing demographic data was sorted as “unknown” or “not listed” in each category and included in analysis.

Weekly visit volumes and admission rates for the entire health system were collected. The dataset was grouped and analyzed in seven broad diagnostic categories: serious illness, minor medical problems, traumatic injuries, infections and communicable illness, asthma exacerbations, psychiatric/psychosocial, and pregnancy-related problems. These were chosen in order to describe the vast majority of complaints seen in a typical pediatric ED.

Categories were assigned to ED diagnoses through key word searching using STATA version 16.1 (StataCorp LLC, College Station, TX). Search terms and exclusion terms were selected by study authors (TL, HSC, JAM) and are listed in Supplemental Table 1. Subcategories within each major category were also reported. Surgical emergencies other than appendicitis, ovarian/testicular torsion, or intussusception were combined into one subcategory (“Other Surgical Emergencies”), which included small bowel obstruction, pyloric stenosis, volvulus, and hernias. Trauma visits that were not fractures, lacerations, or penetrating injuries were also combined into one trauma subcategory (“Other Trauma”), which included contusions, sprains, strains, concussion, traumatic pain, and other wounds and injuries. Any ESI 1/2 or any admitted patient that was not part of another diagnosis category was combined into one subcategory (“Other ESI 1/2 or Admitted”). Similarly, any patient visit that was ESI 3/4/5 and discharged, and not part of another diagnosis category was also combined into one subcategory (“Other ESI 3/4/5 and Discharged”).

### 2.4. Statistical analysis

Continuous variables were described using medians (interquartile range [IQR]), and categorical variables were described with frequencies (percentages). Group differences were compared using Mann-Whitney and Chi-Square tests, when appropriate. A *p*-value of <0.05 was designated as statistically significant. STATA version 16.1 was also used for all statistical analyses.

## 3. Results

There were a total of 363,673 visits of patients <21 years old in 2019 and 2020. The 125,649 ED visits in 2020 represented a 47% decrease in overall volume compared to the 238,024 ED visits in 2019 (Fig. 1). The greatest decrease in weekly volumes was 83.5% between March 2020 and April 2020 (14,570 visits versus 2410 visits, respectively). This period coincided with the first wave of COVID-19 infections and the start of lockdown orders in NYC (Fig. 1) [2]. After NYC reopening orders started on June 8th, 2020, pediatric ED volumes increased throughout 2020 but peaked at less than 60% of 2019 volumes in August 2020.

Table 1 demonstrates the clinical characteristics of the early and late pandemic periods in 2020 compared to 2019. While most differences were statistically significant, few were clinically meaningful. Children

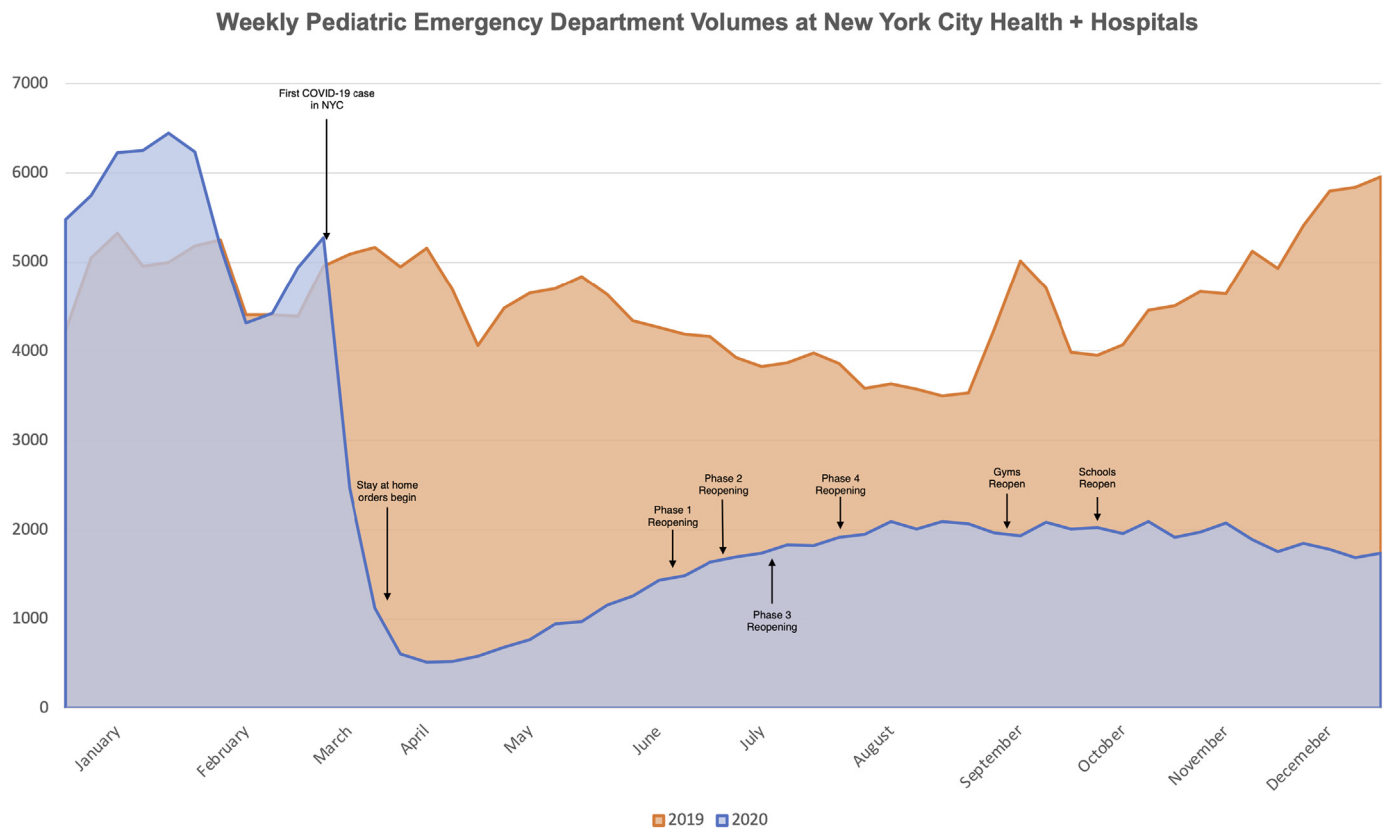


Fig. 1. New York City public hospital weekly pediatric emergency department visits.

presenting to the ED in 2020 had a higher median age compared to 2019. Most patients identified as Black or Hispanic, though racial distribution did not differ substantially between the two years. Although a higher proportion of patients arrived via EMS in 2020 compared to 2019, most patients came to the ED as walk-ins.

Patient acuity was higher in 2020 compared to 2019, as evidenced by a higher proportion of ESI 1 or 2 visits, increased admission rates, higher transfer rates to other facilities, and increased risk of presenting with a serious medical illness (Tables 1 and 2). These differences were consistent in both the early and late pandemic periods. As Fig. 2 demonstrates, once the COVID-19 pandemic began, the weekly percentage of patients admitted to the hospital increased substantially and remained high for the remainder of 2020. For throughput metrics during the pandemic, the time to provider was significantly shorter compared to the year prior, but the disposition and dwell times were significantly longer (Table 1).

In 2020, declines in volume were seen for nearly all diagnosis categories and subcategories compared to 2019 (Table 2). The largest decreases were in the early pandemic period, particularly in those with minor medical complaints, trauma, infections, and asthma (all >70% decrease) (Table 2). However, the percentage of patients with a serious medical illness, trauma, psychiatric/psychosocial, and pregnancy-related complaints was substantially higher in the early pandemic period of 2020 versus the same period of 2019 (Table 2). The volume of patients diagnosed with testicular torsion, ovarian torsion, Kawasaki Disease, septicemia, penetrating injury, and ectopic pregnancy were unchanged in the early pandemic period compared to the prior year (Table 2).

There was also a greater than 70% decrease in infectious and asthma complaints during the late pandemic compared to 2019. Though more children with traumatic and minor medical diagnoses started to return to the ED in the late pandemic, they came at a lower rate than the prior

year (Table 2). Similar to the early pandemic, the risk of serious medical illness, trauma, psychiatric/psychosocial, and pregnancy complaints continued to be higher in the late pandemic period compared to the same period in 2019 (Table 2). By the late pandemic, there was a substantial increase in the number of patients presenting with diabetic complications, cardiac arrest/death, and penetrating injury despite decreases in overall patient volume (Table 2).

#### 4. Discussion

This study described the pediatric ED volume and demographic information of patients 0–21 years from the largest public safety net hospital network in the United States during the COVID-19 pandemic [11]. Similar to other reports [3,6–8,19,20], there was a decrease in overall pediatric ED volume but an increase in visit acuity. This finding is consistent with the effect of prior natural disaster and contagion events (Hurricane Sandy, Severe Acute Respiratory Syndrome) on emergency care utilization [21–24]. There was an overall decline in the volume of seven common ED diagnosis categories. The most dramatic changes were increases in the risk of serious medical illness and trauma, and decreases in the risk of infectious illness and asthma exacerbations.

The reasons for these trends are likely multifactorial. During the initial shutdown in early March 2020, people were encouraged to socially distance, stay indoors, and only leave their homes for essential purposes [1]. Fewer face-to-face interactions and school closures likely reduced the spread of contagious infections [8,25]. The fear of contracting COVID-19 from other patients likely contributed to decreased emergency department utilization [26]. In addition, the rise of telehealth as a means to provide distanced medical care probably contributed to decreased pediatric ED volumes as children who did not need an in-person visit could avoid the hospital altogether [27].

**Table 1**  
Clinical characteristics of patient visits <21 years to New York City public hospitals during the early and late COVID-19 pandemic periods in 2020 compared to 2019.<sup>a</sup>

Characteristics	Early pandemic period 2019 vs 2020			Late pandemic period 2019 vs 2020		
	3/7/19–6/7/19 (n = 62,846)	3/7/20–6/7/20 (n = 18,001)	P-Value	6/8/19–12/31/19 (n = 129,465)	6/8/20–12/31/20 (n = 55,215)	P-Value
Male	32,917 (52.4)	9287 (51.6)	0.06	66,811 (51.6)	27,489 (49.8)	<0.001
Age in Years, Median [IQR]	7.2 [2.8–14.1]	8.7 [3.0–17.1]	<0.001	7.0 [2.5–14.8]	10.1 [2.9–17.7]	<0.001
Race						
- Black	17,159 (27.3)	6306 (35.0)	<0.001	41,896 (32.4)	20,007 (36.2)	<0.001
- Hispanic	18,729 (29.8)	7230 (40.2)		49,110 (37.9)	21,148 (38.3)	
- Asian/Pacific Islander	4756 (7.6)	1055 (5.9)		10,863 (8.4)	3592 (6.5)	
- White	2632 (4.2)	955 (5.3)		6331 (4.9)	3107 (5.6)	
- American Indian	209 (0.3)	49 (0.3)		476 (0.4)	139 (0.3)	
- Other/Unknown	19,361 (30.8)	2406 (13.4)		20,789 (16.1)	7222 (13.1)	
Mode of Arrival						
- Walk In	42,029 (66.9)	13,102 (72.8)	<0.001	100,093 (77.3)	41,258 (74.7)	<0.001
- Ambulance	7471 (11.9)	4133 (23.0)		18,203 (14.1)	11,889 (21.5)	
- Other	13,346 (21.2)	766 (4.3)		11,169 (8.6)	2068 (3.8)	
Emergency Severity Index (ESI)						
- 1	90 (0.1)	77 (0.4)	<0.001	222 (0.2)	259 (0.5)	<0.001
- 2	2708 (4.3)	1075 (6.0)		5748 (4.4)	3098 (5.6)	
- 3	22,990 (36.6)	7626 (42.4)		50,289 (38.8)	24,749 (44.8)	
- 4	26,911 (42.8)	7811 (43.4)		60,123 (46.4)	23,195 (42.0)	
- 5	9696 (15.4)	1064 (5.9)		11,670 (9.0)	3228 (5.9)	
- Not Listed	451 (0.7)	348 (1.9)		1413 (1.1)	686 (1.2)	
Emergency Disposition						
- Admitted	2279 (3.6)	974 (5.4)	<0.001	5386 (4.2)	3109 (5.6)	<0.001
- Discharged	56,245 (89.5)	15,961 (88.7)		117,839 (91.0)	49,619 (89.9)	
- Left During Evaluation	3384 (5.4)	567 (3.2)		4252 (3.3)	1019 (1.9)	
- Expired	13 (0.0)	9 (0.1)		25 (0.0)	40 (0.1)	
- Transfer to Another Facility	876 (1.4)	489 (2.7)		1931 (1.5)	1419 (2.6)	
- Unknown	49 (0.1)	1 (0.0)		32 (0.0)	9 (0.0)	
Throughput Times in Minutes, Median [IQR]						
- Time to Triage	13 [7–23]	12 [7–20]	<0.001	13 [7–23]	11 [7–18]	<0.001
- Triage to Provider	20 [8–45]	12 [5–28]	<0.001	17 [7–40]	9 [4–19]	<0.001
- Provider to Disposition	68 [27–133]	72 [31–142]	<0.001	72 [30–140]	82 [41–153]	<0.001
- Disposition to Exit	15 [3–38]	27 [13–56]	<0.001	21 [10–44]	26 [14–51]	<0.001
- Total Length of Stay	146 [92–225]	146 [88–239]	0.29	149 [93–236]	137 [85–225]	<0.001

<sup>a</sup> All values represent frequency (percentage) unless otherwise indicated.

NYC H + H is the municipal safety net health system serving a marginalized, economically challenged, and minority population of New York City [11]. These patient groups regularly experienced difficulties accessing healthcare prior to COVID-19, and these challenges only increased during pandemic shutdowns [3]. This study was neither a single hospital [4,6,7] nor a group of geographically diverse medical centers [3,8] allowing us to present pediatric emergency utilization during the COVID-19 pandemic from a unique perspective. Unlike many prior reports which focused on the first few months of the pandemic [4–10], we also reported trends and demographics through the duration of 2020, providing additional insight into the effect of reopening periods on ED care.

#### 4.1. Serious medical conditions

During the pandemic, fewer children sought emergency care for minor complaints, but those seriously ill still went to the ED. While most disease categories saw smaller volumes once the pandemic began, there was a slight increase in the number of children with sepsis, bacteremia, or meningitis during the early pandemic period. Delays in seeking care is a well-known consequence of the COVID-19 pandemic, which likely resulted in these more severe outcomes [28]. In contrast, there was a substantial decrease in sepsis, bacteremia, and meningitis cases during the late pandemic period. Relaxed stay-at-home orders and decreased COVID-19 rates in the summer of 2020 [29] likely increased comfort in seeking care in the early course of an illness before it became life-threatening. Additionally, there was an increase in children presenting with Kawasaki Disease and Multisystem Inflammatory Syndrome in Children (MIS-C) in 2020 compared to 2019. MIS-C arose

as a complication of recent COVID-19 infection and shares many signs and symptoms with both Kawasaki Disease and sepsis, including fever, irritability, laboratory derangements, and end-organ damage [30,31]. Thus, diagnosis coding between these conditions may have overlapped.

There was a significant increase in the relative risk of diabetic ketoacidosis, status epilepticus, and sickle cell disease complications during both the early and late COVID-19 pandemic. These conditions require close treatment plan adherence to maintain control. Patients with epilepsy have reported increased seizure frequency and barriers to accessing medications during the COVID-19 pandemic [32,33]. Decreased access to chronic medications during shutdowns may have increased the risk of serious complications [34].

There was not a major difference in absolute numbers for non-contagious serious illnesses, including testicular torsion, ovarian torsion, and surgical emergencies other than appendicitis. A decrease in children presenting with intussusception was also seen in 2020 compared to 2019, consistent with other pandemic literature [8]. Mesenteric lymphadenopathy and Peyer patch hypertrophy from viral illnesses acting as intussusception lead points may have been less common during the pandemic secondary to social distancing and lockdown orders [35]. There was a significant decrease in diagnosis of appendicitis during the early pandemic period compared to 2019. This finding is consistent with national pediatric ED reports [8] but differs from research in other NYC Hospitals. Levene et al. and Sokoloff et al. reported a slight increase in appendicitis cases at NYC children's hospitals during the early pandemic period [6,7]. NYC H + H does not have its own children's hospitals, and perhaps these emergencies were being directed to specialized centers during the pandemic when operating room availability was limited [36].



**Table 2**  
Clinical diagnoses of patient visits <21 years to New York City public hospitals during the early and late COVID-19 pandemic periods in 2020 compared to 2019<sup>a, b, c</sup>

Diagnosis	Early pandemic period 2019 vs 2020					Late pandemic period 2019 vs 2020				
	3/7/19–6/7/19 (n = 62,846)	3/7/20–6/7/20 (n = 18,001)	Percent Change	Absolute Risk Difference, % (95% CI)	Relative Risk (95% CI)	6/8/19–12/31/19 (n = 129,465)	6/8/20–12/31/20 (n = 55,215)	Percent Change	Absolute Risk Difference, % (95% CI)	Relative Risk (95% CI)
<b>Serious Medical Illness</b>	<b>3411 (5.4)</b>	<b>1476 (8.2)</b>	<b>−57</b>	<b>2.8 (2.3, 3.2)</b>	<b>1.5 (1.4, 1.6)</b>	<b>7612 (5.9)</b>	<b>4635 (8.4)</b>	<b>−39</b>	<b>2.5 (2.3, 2.8)</b>	<b>1.4 (1.4, 1.5)</b>
- DKA/DM Requiring Admission	36 (0.1)	28 (0.2)	−22	0.1 (0.0, 0.1)	2.7 (1.7, 4.5)	61 (0.1)	101 (0.2)	+66	0.1 (0.1, 0.2)	3.9 (2.8, 5.3)
- Status Asthmaticus	433 (0.7)	103 (0.6)	−76	−0.1 (−0.2, 0.0)	0.8 (0.7, 1.0)	822 (0.6)	255 (0.5)	−69	−0.2 (−0.2, −0.1)	0.7 (0.6, 0.8)
- Status Epilepticus	85 (0.1)	65 (0.4)	−23	0.2 (0.1, 0.3)	2.7 (1.9, 3.7)	216 (1.9)	176 (2.7)	−19	0.2 (0.1, 0.2)	1.9 (1.6, 2.3)
- Testicular Torsion	11 (0.0)	12 (0.1)	+10	0.1 (0.0, 0.1)	3.8 (1.7, 8.6)	27 (0.0)	16 (0.0)	−41	0.0 (0.0, 0.0)	1.4 (0.8, 2.6)
- Ovarian Torsion	2 (0.0)	1 (0.0)	−50	0.0 (0.0, 0.0)	1.8 (0.2, 19.3)	3 (0.0)	4 (0.0)	+33	0.0 (0.0, 0.0)	3.1 (0.7, 14.0)
- Intussusception	11 (0.0)	1 (0.0)	−90	0.0 (0.0, 0.0)	0.3 (0.0, 2.5)	22 (0.0)	12 (0.0)	−45	0.0 (0.0, 0.0)	1.3 (0.6, 2.6)
- Kawasaki Disease	2 (0.0)	5 (0.0)	+150	0.0 (0.0, 0.0)	8.7 (1.7, 45.0)	10 (0.0)	3 (0.0)	−70	0.0 (0.0, 0.0)	0.7 (0.2, 2.6)
- MIS-C	N/A	21 (0.1)	N/A	N/A	N/A	N/A	40 (0.1)	N/A	N/A	N/A
- Appendicitis	150 (0.2)	63 (0.4)	−58	0.1 (0.0, 0.2)	1.5 (1.1, 2.0)	316 (0.2)	225 (0.4)	−29	0.2 (0.1, 0.2)	1.7 (1.4, 2.0)
- Other Surgical Emergencies	8 (0.0)	3 (0.0)	−63	0.0 (0.0, 0.0)	1.3 (0.4, 4.9)	22 (0.0)	19 (0.0)	−14	0.0 (0.0, 0.0)	2.0 (1.1, 3.7)
- Sickle Cell Disease Complications	94 (0.2)	53 (0.3)	−43	0.1 (0.1, 0.2)	2.0 (1.4, 2.8)	266 (0.2)	120 (0.2)	−55	0.1 (−0.0, 0.1)	1.1 (0.9, 1.3)
- Sepsis/Bacteremia/Meningitis	20 (0.0)	21 (0.1)	+5	0.1 (0.0, 0.1)	3.7 (2.0, 6.8)	70 (0.1)	45 (0.1)	−36	0.0 (0.0, 0.1)	1.5 (1.0, 2.2)
- Cardiac Arrest/Death	16 (0.0)	10 (0.1)	−38	0.0 (0.0, 0.1)	2.2 (1.0, 4.8)	31 (0.0)	45 (0.1)	+45	0.1 (0.0, 0.1)	3.4 (2.2, 5.4)
- Other ESI 1/2 or Admitted	2543 (4.1)	1090 (6.1)	−57	2.0 (1.6, 2.4)	1.5 (1.4, 1.6)	5746 (4.4)	3574 (6.5)	−38	2.0 (1.8, 2.3)	1.5 (1.4, 1.5)
<b>Minor Complaint and Discharged</b>	<b>27679 (44.0)</b>	<b>7867 (43.7)</b>	<b>−72</b>	<b>−0.3 (−1.2, 0.5)</b>	<b>1.0 (1.0, 1.0)</b>	<b>57987 (44.8)</b>	<b>30987 (56.1)</b>	<b>−47</b>	<b>11.3 (10.8, 11.8)</b>	<b>1.3 (1.0, 1.0)</b>
- Chest Pain	661 (1.1)	240 (1.3)	−64	0.3 (0.1, 0.5)	1.3 (1.1, 1.5)	1296 (1.0)	724 (1.3)	−44	0.3 (0.2, 0.4)	1.3 (1.2, 1.3)
- Abdominal Pain	1276 (2.0)	250 (1.4)	−80	−0.6 (−0.8, −0.4)	0.7 (0.6, 0.8)	1941 (1.5)	1027 (1.9)	−47	0.4 (0.2, 0.5)	1.2 (1.2, 1.3)
- Headache	764 (1.2)	176 (1.0)	−77	−0.2 (−0.4, −0.1)	0.8 (0.7, 1.0)	1387 (1.1)	537 (1.0)	−61	−0.1 (−0.2, 0.0)	0.9 (0.8, 1.0)
- Other ESI 3/4/5 and Discharged	25,011 (39.8)	7172 (40.0)	−71	0.2 (−0.5, 1.0)	1.0 (1.0, 1.0)	53,384 (41.2)	28,707 (52.0)	−46	10.8 (10.3, 11.3)	1.3 (1.2, 1.3)
<b>Trauma</b>	<b>6337 (10.1)</b>	<b>1915 (10.6)</b>	<b>−70</b>	<b>0.6 (0.1, 1.1)</b>	<b>1.1 (1.0, 1.1)</b>	<b>14038 (10.8)</b>	<b>7593 (13.8)</b>	<b>−46</b>	<b>2.9 (2.6, 3.2)</b>	<b>1.3 (1.2, 1.3)</b>
- Fractures	1015 (1.6)	340 (1.9)	−67	0.3 (0.1, 0.5)	1.2 (1.0, 1.3)	2359 (1.8)	1433 (2.6)	−39	0.8 (0.6, 0.9)	1.4 (1.3, 1.5)
- Lacerations	1602 (2.6)	717 (4.0)	−55	1.4 (1.1, 1.8)	1.6 (1.4, 1.7)	3739 (2.9)	2381 (4.3)	−36	1.4 (1.2, 1.6)	1.5 (1.4, 1.6)
- Penetrating Injury	48 (0.1)	48 (0.3)	0	0.2 (0.1, 0.3)	3.5 (2.3, 5.2)	167 (0.1)	224 (0.4)	+34	0.3 (0.2, 0.3)	3.2 (2.6, 3.8)
- Other Trauma	3691 (5.9)	810 (4.5)	−78	−1.4 (−1.7, −1.0)	0.8 (0.7, 0.8)	7799 (6.0)	3556 (6.4)	−54	0.4 (0.2, 0.7)	1.1 (1.0, 1.1)
<b>Infections</b>	<b>20326 (32.3)</b>	<b>5176 (28.8)</b>	<b>−75</b>	<b>−3.6 (−4.3, −2.8)</b>	<b>0.9 (0.9, 0.9)</b>	<b>39275 (30.3)</b>	<b>8475 (15.4)</b>	<b>−78</b>	<b>−15.0 (−15.4, −14.6)</b>	<b>0.5 (0.5, 0.5)</b>
- Cough/Viral Respiratory Infection	6743 (10.7)	1892 (10.5)	−72	−0.2 (−0.7, −0.3)	1.0 (0.9, 1.0)	13,802 (10.7)	2144 (3.9)	−85	−6.8 (−7.0, −6.5)	0.4 (0.4, 0.4)
- Gastroenteritis	4676 (7.4)	963 (5.4)	−79	−2.1 (−2.5, −1.7)	0.7 (0.7, 0.8)	7320 (5.7)	1947 (3.5)	−73	−2.1 (−2.3, −1.9)	0.6 (0.6, 0.7)
- Otitis Media	2387 (3.8)	360 (2.0)	−85	−1.8 (−2.1, −1.5)	0.5 (0.5, 0.6)	4658 (3.6)	740 (1.3)	−84	−2.4 (−2.4, −2.1)	0.4 (0.3, 0.4)
- Influenza	674 (1.1)	126 (0.7)	−81	−0.4 (−0.5, −0.2)	0.6 (0.5, 0.8)	1454 (1.1)	6 (0.0)	−99	−1.1 (−1.2, −1.1)	0.0 (0.0, 0.0)
- RSV	37 (0.1)	12 (0.1)	−68	0.0 (0.0, 0.1)	1.1 (0.6, 2.2)	324 (0.3)	4 (0.0)	−99	−0.2 (−0.3, −0.2)	0.0 (0.0, 0.1)
- COVID-19	N/A	166 (0.9)	N/A	N/A	N/A	N/A	199 (2.4)	N/A	N/A	N/A
- Fever/Other Viral Infection	6285 (10.0)	1673 (9.3)	73	−0.7 (−1.2, −0.2)	0.9 (0.9, 1.0)	12,079 (9.3)	3438 (6.2)	−72	−3.1 (−3.4, −2.8)	0.7 (0.6, 0.7)
<b>Asthma and Discharged</b>	<b>2881 (4.6)</b>	<b>676 (3.8)</b>	<b>−76</b>	<b>−0.8 (−1.2, −0.5)</b>	<b>0.8 (0.8, 0.9)</b>	<b>5788 (4.5)</b>	<b>1337 (2.4)</b>	<b>−77</b>	<b>−2.1 (−2.2, −1.9)</b>	<b>0.5 (0.5, 0.6)</b>
<b>Psychiatric/Psychosocial</b>	<b>568 (0.9)</b>	<b>277 (1.5)</b>	<b>−51</b>	<b>0.6 (0.4, 0.8)</b>	<b>1.7 (1.5, 2.0)</b>	<b>1052 (0.8)</b>	<b>851 (1.5)</b>	<b>−19</b>	<b>0.7 (0.6, 0.8)</b>	<b>1.9 (1.7, 2.1)</b>

(continued on next page)

Table 2 (continued)

Diagnosis	Early pandemic period 2019 vs 2020					Late pandemic period 2019 vs 2020				
	3/7/19–6/7/19 (n = 62,846)	3/7/20–6/7/20 (n = 18,001)	Percent Change	Absolute Risk Difference, % (95% CI)	Relative Risk (95% CI)	6/8/19–12/31/19 (n = 129,465)	6/8/20–12/31/20 (n = 55,215)	Percent Change	Absolute Risk Difference, % (95% CI)	Relative Risk (95% CI)
- Abuse/Neglect/ Sexual Assault	182 (0.3)	90 (0.5)	-51	0.2 (0.1, 0.3)	1.7 (1.3, 2.2)	373 (0.3)	309 (0.6)	-17	0.3 (0.2, 0.3)	1.9 (1.7, 2.3)
- Self Harm/ Suicidal Ideations	229 (0.4)	86 (0.5)	-62	0.1 (0.0, 0.2)	1.3 (1.0, 1.7)	320 (0.3)	249 (0.5)	-22	0.2 (0.1, 0.3)	1.8 (1.6, 2.2)
- Stress/Anxiety	160 (0.3)	101 (0.6)	-37	0.3 (0.2, 0.4)	2.2 (1.7, 2.8)	362 (0.3)	293 (0.5)	-18	0.3 (0.2, 0.3)	1.9 (1.6, 2.2)
<b>Pregnancy Related Complaints</b>	<b>245 (0.4)</b>	<b>161 (0.9)</b>	<b>-34</b>	<b>0.5 (0.4, 0.7)</b>	<b>2.3 (1.9, 2.8)</b>	<b>715 (0.6)</b>	<b>608 (1.1)</b>	<b>-16</b>	<b>0.6 (0.5, 0.6)</b>	<b>2.0 (1.8, 2.2)</b>
- Miscarriage	74 (0.1)	46 (0.3)	-38	0.1 (0.1, 0.2)	2.2 (1.5, 3.1)	167 (0.1)	143 (0.3)	-14	0.1 (0.1, 0.2)	2.0 (1.6, 2.5)
- Ectopic	5 (0.0)	6 (0.0)	+20	0.0 (0.0, 0.1)	4.2 (1.3, 13.7)	8 (0.0)	11 (0.0)	+38	0.0 (0.0, 0.0)	3.2 (1.3, 8.0)
- Pregnancy Extramural Delivery	14 (0.0)	10 (0.1)	-54	0.0 (0.0, 0.1)	2.5 (1.1, 5.6)	25 (0.0)	20 (0.0)	-25	0.0 (0.0, 0.0)	1.9 (1.0, 3.4)
- Other Pregnancy Complaints	154 (0.3)	99 (0.6)	-36	0.3 (0.2, 0.4)	2.2 (1.7, 2.9)	515 (0.4)	434 (0.8)	-16	0.4 (0.3, 0.5)	2.0 (1.7, 2.2)

<sup>a</sup> All values represent frequency (percentage) unless otherwise indicated.  
<sup>b</sup> Some patients had more than one diagnosis coded, therefore group composites may not equal total.  
<sup>c</sup> Abbreviations: DKA, Diabetic Ketoacidosis; DM, Diabetes mellitus; ESI, Emergency Service Index; MIS-C, Multisystem Inflammatory Syndrome in Children.

4.2. Trauma

The increase in cardiac arrest and death diagnoses during the late pandemic period could be partially explained by increases in gun violence after reopening measures began. During the summer of 2020, there was a more than a two-fold increase in shooting incidents recorded in NYC compared to the summer of 2019

[37]. Among penetrating injuries during the late pandemic, volume increased 34% (RR 3.2 [95% CI: 2.6, 3.8]) (Table 2), and the mortality risk was 16 times higher in 2020 compared to 2019 (RR 16.4 [95% CI: 2.2, 133.4]). Black and Latino children make up most of the pediatric population at NYC H + H and are the racial demographic most likely to be affected by gun violence in NYC [38].

Weekly Pediatric Emergency Department Admission Rates at New York City Health + Hospitals

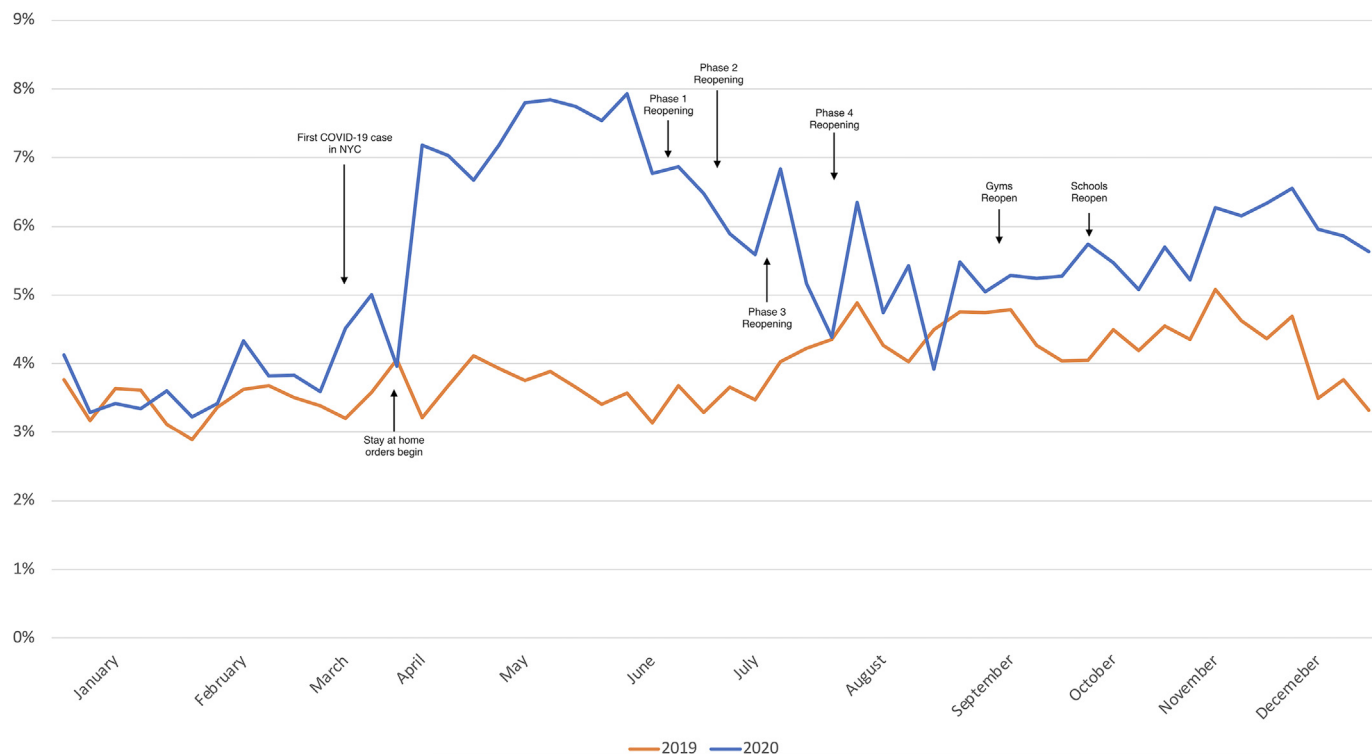


Fig. 2. Pediatric inpatient admission rates.

The overall volume of fractures, lacerations, and other traumatic injuries decreased during the pandemic. However, the relative risk for these diagnoses was higher than the previous year because these injuries often require immediate intervention rather than a watch-and-wait approach. Most other traumatic injury volumes decreased considerably during the pandemic and are consistent with other literature reported [3,8].

#### 4.3. Infections

In 2020, the diagnosis category that saw the greatest reduction compared to 2019 was infectious diseases. During the pandemic, there was a significantly smaller percentage of patients presenting to the ED with upper respiratory, gastrointestinal, otitis media, and other viral infections; these changes became more pronounced during the late pandemic period. There was a sharp decline in influenza and respiratory syncytial virus (RSV) infection diagnoses during 2020 compared to 2019. Influenza and RSV cases typically increase during the fall and winter months; however, there was only single-digit diagnoses of these viruses during the late pandemic despite schools and businesses reopening [39,40]. This suggests that social distancing and mask mandates in NYC had a substantial impact on curtailing the spread of contagious pathogens and likely altered the viral landscape even after shutdown orders were discontinued [41]. Several hundred COVID-19 discharge diagnoses were made during 2020. However, this number is likely underreported due to the lack of widespread availability of testing in the early pandemic and many COVID-19 tests resulting long after the patient had left the emergency department and the visit was assigned a diagnosis code.

#### 4.4. Asthma

During the peak pandemic period, asthma visits declined over 70% and remained low even after reopening measures began in both discharged and admitted children. Reduced spread of contagious pathogens and exposure to allergens from social distancing and mask mandates likely contributed to fewer asthma exacerbations [42]. Improved air quality from decreased carbon emissions, resulting from fewer vehicles on the road, may have also led to these decreases [6].

#### 4.5. Mental health

Pediatric ED visits for mental health issues have also substantially decreased across the NYC H + H system. These changes were more pronounced during the early pandemic compared to the late pandemic. This is similar to most existing literature describing pediatric ED mental health visits [3,8,43]. Sokoloff et al., however, described an increase in suicidal ideation and self-harm visits to an NYC children's hospital during the early pandemic period [7]. Though there was not a similar finding in our health system, many of the hospitals in NYC H + H have a separate psychiatric ED, and those visits were excluded from this study.

#### 4.6. Pregnancy

The overall volume of pregnancy-related complaints also decreased during the pandemic compared to 2019, similar to other national reports [3]. However, there was a higher proportion of these complaints during the pandemic, as early pregnancy complications are often perceived as emergency conditions [44].

#### 4.7. Throughput

Admission rates increased during the height of the early pandemic period, peaking around 7–8% in mid-May 2020. After reopening measures began, admission rates decreased during the summer months but remained higher compared to the same periods in 2019. This is

likely reflective of the increased proportion of high acuity patients seen in 2020. Decreases in overall pediatric volume likely resulted in improved time to provider metrics in both the early and late pandemic periods. However, the higher acuity and hospital staff shortages likely resulted in the increased disposition times observed due to more patients requiring extensive medical workups but fewer staff to carry out these tasks [45].

#### 4.8. Limitations

There are several study limitations. Though the sample size was large, this study examined the pediatric ED utilization in a single public safety net health system in a major northeast city. This may limit the generalizability of the findings to systems of similar size and scope. In addition, this was a retrospective study examining medical record data. Thus the accuracy of diagnosis codes and other demographics relies heavily on the inputting provider. Moreover, some hospitals in the NYC H + H transitioned to a new EMR between 2019 and 2020 and this change could have affected the available data. Some serious and pregnancy related diagnoses had low absolute numbers in both 2019 and 2020. This study was a descriptive study and as such was not powered to find a difference in all the subgroups. Lastly, visits to psychiatric EDs and labor and delivery units at NYC H + H were not examined, thus visits for mental health or maternity issues are likely underreported in this study.

### 5. Conclusion

During the COVID-19 pandemic, NYC public hospital EDs experienced a substantial decrease in pediatric volume but increased acuity and risk of serious medical conditions. Contagious infections and asthma exacerbations were significantly curtailed compared to the prior year and this finding persisted through the late pandemic periods. Coinciding with city reopening efforts, the relative risk for traumatic ED visits, especially penetrating injuries, significantly increased during the late pandemic. Our findings provide insight into pediatric ED volumes and acuity variation during public health crises, lockdown orders, and opening periods. This paper highlights the unique challenges that our population faced during the COVID-19 pandemic of 2020. As new COVID-19 variants emerge, the risk for future pandemics remain. This knowledge may help ensure efficient allocation of resources, proper planning, and quality care for all children during future catastrophic events.

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#### CRedit authorship contribution statement

**Tian Liang:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. **Haamid S. Chamdawala:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ee Tein Tay:** Conceptualization, Data curation, Formal analysis, Writing – review & editing. **Jennifer Chao:** Writing – review & editing, Formal analysis, Data curation, Conceptualization. **Muhammad Waseem:** Conceptualization, Data curation, Formal analysis, Writing – review & editing. **Horton Lee:** Writing – review & editing, Data curation, Conceptualization. **David Mortel:** Conceptualization, Data curation, Writing – review & editing. **Konstantinos Agoritsas:** Writing – review & editing, Data curation, Conceptualization. **Hugo O. Teo:** Conceptualization, Data curation, Writing – review & editing. **James A. Meltzer:** Writing –



review & editing, Writing – original draft, Supervision, Project administration, Methodology, Formal analysis, Data curation, Conceptualization.

### Declaration of Competing Interest

The authors have no conflicts of interest relevant to this article to disclose.

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### Appendix A. Supplementary data

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