



Advanced imaging of disease unrelated to the coronavirus disease 2019 (COVID-19) during the pandemic: effect of patient demographics in a pediatric emergency department

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Abstract

Background Coronavirus disease 2019 (COVID-19) disproportionately affected children from underrepresented minorities and marginalized populations, but little is understood regarding the pandemic's effect on non-COVID-19-related illnesses.

Objective To examine the effect of the COVID-19 pandemic and related stay-at-home orders on pediatric emergency department (ED) imaging of non-COVID-19-related diseases across patient demographic groups.

Materials and methods We retrospectively reviewed radiology reports from advanced imaging (US, CT, MRI and fluoroscopy) on children in the ED during the month of April for the years 2017, 2018, 2019 and 2020, excluding imaging for respiratory illness and trauma. We used imaging results and the electronic medical record to identify children with positive diagnoses on advanced imaging, and whether these children were admitted to the hospital. Demographic variables included age, gender, race/ethnicity and insurance type. We used multivariable Poisson regression models to report rate ratio (RR) and binomial logistic regression models to report odds ratio (OR) with 95% confidence interval (CI).

Results We included 1,418 ED encounters for analysis. Compared to pre-2020, fewer children underwent ED imaging in April 2020 (RR 0.63, 95% CI 0.52, 0.76). The odds of positive imaging results increased (OR 2.18, 95% CI 1.59, 3.00) overall, and for all racial/ethnic groups except Hispanic patients (OR 0.83, 95% CI 0.34, 2.03). No differences occurred in admission rates for positive imaging results in 2020 compared to pre-2020.

Conclusion In April 2020 compared to pre-2020, there were decreased imaging and increased positivity rates for imaging for non-respiratory and non-trauma ED visits. COVID-19 stay-at-home advisories might have resulted in triaging for urgent health care by families or referring clinicians during this month of the pandemic.

Keywords Children · Coronavirus disease 2019 · Emergency department · Health care disparity · Pediatrics · Race · Radiology

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Introduction

On March 11, 2020, the World Health Organization (WHO) declared the coronavirus disease 2019 (COVID-19) a worldwide pandemic [1]. To slow infection rates, many parts of the United States subsequently implemented varying restrictions on citizens' activities. These restrictions included mandatory closures of some businesses and schools, and orders or advisories that people stay at home [2].

In the early months of the pandemic in the United States, it became apparent that underlying health care and socioeconomic disparities were being reflected in disproportionately higher rates of infection, morbidity and mortality for COVID-19 among Black/African American, Hispanic and lower-income populations [3–6]. Concerns arose during this

time about the indirect health effects of the pandemic. With stay-at-home restrictions in effect, awareness emerged that some individuals were avoiding timely care for illnesses not related to COVID-19, which was exacerbating disproportionately worse health outcomes for already marginalized populations [7].

Previous literature supports that children from underrepresented minorities and socioeconomically disadvantaged populations are generally subjected to similar health care disparities, as in adults. Disproportionately higher rates of COVID-19 infection have correspondingly been demonstrated in these groups [8–10]. It is less well understood whether pandemic-related effects, such as government-imposed lockdowns, have altered health care access or health care seeking behaviors, potentially exacerbating health care inequities in marginalized communities. In this study, we explored such indirect pandemic-related health effects in children as related to the use of advanced imaging for pediatric emergency department (ED) patients. We compared one institution's advanced imaging use in ED patients during 1 month of the stay-at-home advisories during the pandemic (i.e. April 2020) to advanced imaging use in the same month in prior years. The objective of this study was to examine the association of patient demographic factors with the number and positive diagnosis rate of pediatric ED imaging studies performed and hospital admission rates that were unrelated to respiratory illnesses or trauma. Our hypothesis was that sociodemographic factors had no effect on use of advanced imaging for pediatric ED patients presenting for non-respiratory, non-traumatic illnesses in April 2020 as compared to prior years.

Materials and methods

This retrospective study was exempted from review by our institutional review board and informed consent was not needed. We conducted this retrospective medical record review at a single urban academic tertiary-care children's hospital with more than 400 inpatient beds and an annual ED patient volume of >60,000 children. Using Montage Search and Analytics (Montage Healthcare Solutions, Philadelphia, PA), we obtained reports from advanced imaging (defined as US, CT, MRI and fluoroscopy) examinations on ED patients younger than 19 years during the month of April for the years 2017, 2018, 2019 and 2020.

April was selected because it was the first full calendar month of our state's stay-at-home advisory, and likely the period of greatest lifestyle adjustment for the population. We included reports for advanced imaging studies on ED patients performed at our hospital, as well as internally generated consultation reports for advanced imaging studies performed at outside institutions when a second opinion

report was requested by our ED staff, because these are included in the electronic medical record (EMR).

For each radiology report, we reviewed the indication for the exam. To focus on children other than those who were undergoing radiology evaluation for respiratory symptoms, which could have been caused by COVID-19, we excluded imaging studies requested to assess for airway or pulmonary pathology. We could not exclude all children with potential COVID-19 infection because it can also present with gastrointestinal symptoms. We also excluded trauma-related imaging to avoid the confounding effect of altered trauma rates associated with stay-at-home restrictions [11]. We excluded radiography reports because of the relatively low yield of this modality for the study aims; the most common indications for chest and extremity radiographs are for respiratory symptoms and trauma, respectively, and these exam indications had been excluded, and symptomatic children receiving abdominal radiographs are often subsequently assessed with advanced imaging.

For studies meeting inclusion criteria, we reviewed the individual radiology reports for each child. Based on the imaging results, we designated the children as having either a positive or negative diagnosis. A positive diagnosis was defined as an abnormal imaging finding that was not incidental and could explain the child's presenting symptoms. Children with multiple imaging studies in the same month were considered negative for diagnosis only if all study results were negative. All studies performed in the same month were considered one encounter; studies performed in different years were considered different encounters. For children with a positive imaging diagnosis, we reviewed the EMR to determine disposition, and these children were further characterized as admitted to the hospital or discharged without admission.

Patient demographic data

We recorded the following patient characteristics: age, gender, race, ethnicity and insurance type (public versus private or self-pay/other). In addition, we included the child's ED acuity level, as measured by the Emergency Severity Index (ESI), which ranges from 1, the highest acuity, to 5, or non-urgent [12].

Statistical analysis

The data in this study comprised 1,418 ED patient encounters. Thirty (2%) of these encounters came from 15 patients. Given this small percentage, and the models involved, encounters were treated independently. The study contained three outcome variables: imaging frequency, diagnosis (1=positive, 0=negative) and admission (1=admitted, 0 = not admitted). The denominator for positive diagnosis

was the number imaged, while the denominator for admission was the number of positive diagnoses. These outcomes potentially depended on year (pre-2020, 2020), four sociodemographic factors, acuity level at triage and the interactions of these factors with the year.

For imaging outcomes, the factor for “year” comprised just 2020 and 2019. We used the single year 2019 to compare the imaging rate in 2020 to avoid confounding the 2020 vs. pre-2020 effect, given the trend toward increasing imaging over the years 2017–2019. For the outcomes of diagnosis and admission, the factor for “year” had two levels: 2020 vs. the three preceding years (2017, 2018, 2019).

The sociodemographic factors (number of levels in parentheses) were gender (2), age (5), race/ethnicity (5), insurance (2) and acuity level (3). Based on clinical similarities for analysis as a predictor, each child’s acuity level was categorized into three levels based on the 5-level Triage Acuity ESI scale assessed upon arrival at the ED: acuity level 1 (low acuity) included ESI 4 or 5; acuity level 2 (moderate acuity) included ESI 3; and acuity level 3 (high acuity) included ESI 1 or 2. P -value <0.05 was considered significant.

We analyzed imaging frequencies using a Poisson exponential model [13] in which the rate (mean frequency per year) depended on the predictors of gender, age, race/ethnicity, insurance and acuity level. We analyzed diagnosis and admission using binomial logistic models [13] in which the odds of a positive diagnosis or the odds of admission depended on the same predictors as imaging.

All models outlined above were estimated using SAS/STAT v. 14.1 (SAS Institute, Cary, NC). The generalized linear model (GENMOD) procedure was used for the Poisson model, while the LOGISTIC procedure was used for binomial and proportional odds models. The method of estimation was quasi-maximum likelihood for imaging (to

accommodate overdispersion), penalized maximum likelihood for diagnosis and admission (to accommodate sparse data) and maximum likelihood for acuity. We calculated Wald-based 95% confidence intervals for odds and rates via exponentiation of confidence intervals on the log rate and log odds scales. Rates, odds, cumulative odds and their ratios (rate ratio [RR], odds ratio [OR] and cumulative OR) were based on models with predictors in addition to year. Accordingly, they were interpreted as being “adjusted” for these additional parameters.

Results

We identified 1,680 ED encounters involving advanced imaging for indications not related to trauma or respiratory illness during the month of April in the years 2017, 2018, 2019 and 2020. Of these, we excluded 262 encounters: 47 with missing demographic data, 27 who indicated race/ethnicity of “other,” 8 with self-pay insurance, 160 who were adults (older than 18 years), and 20 with missing acuity information. This yielded 1,418 ED patient encounters for analysis. In the 3 years preceding 2020, the use of advanced imaging for ED patients during April for non-respiratory, non-trauma disorders increased significantly ($P<0.001$), rising from 310 in 2017 to 437 in 2019 (Fig. 1); during this same time period no change was demonstrated for positive diagnosis ($P=0.48$) or hospital admission ($P=0.40$).

All patients

Compared to 2019, the rate of ED patients imaged in 2020 for non-respiratory illness and non-trauma significantly decreased (RR 0.63, 95% CI 0.52, 0.76) (Table 1). Compared

Fig. 1 Number of emergency department patient imaging encounters, positive exams and admissions during the month of April in the years 2017 through 2020. Children with imaging indications related to respiratory illness or trauma were excluded. ED emergency department

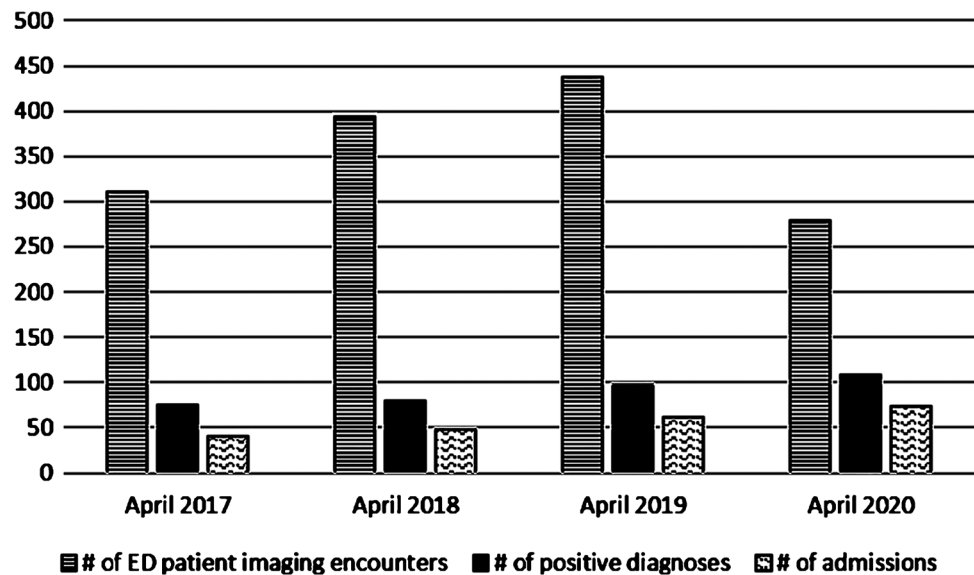


Table 1 Frequencies of imaging, positive diagnosis and hospital admission

	April 2020	April 2019	Rate ratio	95% CI	<i>P</i> -value ^a
Patients with advanced imaging ^b	278	437	0.63	0.52, 0.76	<0.001
	April 2020 <i>n/N</i> (%)	Pre-2020 ^e <i>n/N</i> (%)	Odds ratio	95% CI	<i>P</i> -value ^a
Positive diagnoses on imaging ^c	108/278 (39)	251/1,140 (22)	2.18	1.59, 3.00	<0.001
Positive imaging diagnoses admitted ^d	74/108 (69)	149/251 (59)	1.23	0.71, 2.12	0.46

CI confidence interval, *N* total number, *n* subset number

^a*P*-value <0.05 is significant (bold)

^bNon-respiratory and non-trauma advanced imaging (fluoroscopy, US, CT, MRI)

^cThe denominator (*N*) for positive diagnosis was the number imaged

^dThe denominator (*N*) for hospital admission was the number of positive diagnoses

^eApril of 2017, 2018 and 2019

to pre-2020 (April of 2017, 2018 and 2019), children were more likely to have a positive diagnosis in 2020 (OR 2.18, 95% CI 1.59, 3.00). Compared to pre-2020, in 2020 no significant change was demonstrated in the likelihood of admission given a positive imaging diagnosis (OR 1.23, 95% CI 0.71, 2.12) (Table 1).

There were no significant interactions between year and acuity for the rate of imaging (*P*=0.11), the odds of positive diagnosis (*P*=0.21) or the odds of admission (*P*=0.48). In 2020 the acuity levels of patient encounters at time of ED triage were: acuity 1 (lowest acuity) = 6/278 (2%), acuity 2 (moderate acuity) = 194/278 (70%) and acuity 3 (highest acuity) = 78/278 (28%). This compared to pre-2020, when acuity 1 included 41/1,140 (4%), acuity 2 included

762/1,140 (67%) and acuity 3 included 337/1,140 (30%) ED patients.

Gender and age group

Both boys and girls were more likely to have a positive diagnosis on imaging in 2020 compared to 2017–2019, though the likelihood of admission for positive imaging diagnoses did not change (Table 2).

Results among age groups were variable (Table 3). Lower imaging rates were demonstrated for children ages 1–4 years (RR 0.50, 95% CI 0.32, 0.78), 5–10 years (RR 0.43, 95% CI 0.27, 0.68) and 15–18 years (RR 0.62, 95% CI 0.42, 0.98), but not in children younger than 1 year or age 11–14 years.

Table 2 Imaging frequency, positive diagnosis and hospital admission according to gender

Number of imaging studies		April 2020	April 2019	Adjusted rate ratio ^d	95% CI	<i>P</i> -value ^e
Gender ^a		<i>N</i> =278	<i>N</i> =437			
Female, <i>n</i> (%)		132 (47)	211 (48)	0.62	0.47, 0.81	<0.001
Male, <i>n</i> (%)		146 (53)	226 (52)	0.64	0.49, 0.83	<0.001
Positive diagnosis on imaging						
Gender ^b		April 2020 <i>n/N</i> (%)	Pre-2020 ^f <i>n/N</i> (%)	Adjusted odds ratio ^d	95% CI	<i>P</i> -value ^e
Female		43/132 (33)	98/560 (17)	2.14	1.33, 3.45	0.001
Male		65/146 (45)	153/570 (27)	2.23	1.47, 3.37	0.0002
Positive imaging diagnoses admitted to hospital						
Gender ^c		April 2020 <i>n/N</i> (%)	Pre-2020 ^f <i>n/N</i> (%)	Adjusted odds ratio ^d	95% CI	<i>P</i> -value ^e
Female		29/43 (67)	59/98 (60)	1.13	0.48, 2.64	0.78
Male		45/65 (69)	90/153 (59)	1.33	0.67, 2.63	0.42

CI confidence interval, *N* total number, *n* subset number

^aInteraction term for year and gender, *P*=0.87

^bInteraction term for year and gender, *P*=0.90

^cInteraction term for year and gender, *P*=0.77

^dAdjusted for gender, insurance, race, age, acuity level, year, and year and gender interaction term

^e*P*-value <0.05 is significant (bold)

^fApril of 2017, 2018 and 2019

Table 3 Imaging frequency, positive diagnosis and hospital admission according to age group

Number of imaging studies					
Age group ^a	April 2020 N=278 N (%)	April 2019 N=437 N (%)	Adjusted rate ratio ^d	95% CI	P-value ^e
<1 year	38 (14)	50 (11)	0.76	0.44, 1.28	0.30
1–4 years	47 (17)	93 (21)	0.50	0.32, 0.78	0.002
5–10 years	39 (14)	91 (21)	0.43	0.27, 0.68	<0.001
11–14 years	89 (32)	99 (23)	0.89	0.61, 1.28	0.54
15–18 years	65 (24)	104 (24)	0.62	0.42, 0.98	0.02
Positive diagnosis on imaging					
Age group ^b	April 2020 n/N (%)	Pre-2020 ^f n/N (%)	Adjusted odds ratio ^d	95% CI	P-value ^e
<1 year	13/38 (34)	14/122 (11)	3.23	1.29, 8.05	0.01
1–4 years	13/47 (28)	51/209 (24)	1.05	0.49, 2.24	0.90
5–10 years	20/39 (51)	55/261 (21)	3.53	1.68, 7.44	<0.001
11–14 years	42/89 (47)	71/283 (25)	2.65	1.56, 4.49	<0.001
15–18 years	20/65 (31)	60/265 (23)	1.66	0.89, 3.10	0.11
Positive imaging diagnoses admitted to hospital					
Age group ^c	April 2020 n/N (%)	Pre-2020 ^f n/N (%)	Adjusted odds ratio ^d	95% CI	P-value ^e
<1 year	11/13 (85)	11/14 (79)	1.28	0.19, 8.59	0.80
1–4 years	6/13 (46)	34/51 (67)	0.45	0.11, 1.78	0.25
5–10 years	13/20 (65)	29/55 (53)	1.72	0.54, 5.52	0.36
11–14 years	32/42 (76)	39/71 (55)	2.14	0.89, 5.30	0.09
15–18 years	12/20 (60)	36/60 (60)	1.01	0.34, 2.99	0.98

CI confidence interval, N total number, n subset number

^aInteraction term for year and age, $P=0.10$

^bInteraction term for year and age, $P=0.12$

^cInteraction term for year and age, $P=0.40$

^dAdjusted for gender, insurance, race, age, acuity level, year, and year and age group interaction term

^e P -value <0.05 is significant (bold)

^fApril of 2017, 2018 and 2019

Compared to 2017–2019, rates of positive diagnosis on imaging in 2020 were significantly higher for children <1 year (OR 3.23, 95% CI 1.29, 8.05), 5–10 years (OR 3.53, 95% CI 1.68, 7.44) and 11–14 years (OR 2.65, 95% CI 1.56, 4.49), but not for the other age groups. No significant differences were demonstrated in 2020 for any age group with positive imaging diagnoses admitted to the hospital.

Race and ethnicity

Compared to 2019, imaging rates in 2020 were significantly decreased for all groups except non-Hispanic Black children (RR 0.73, 95% CI 0.39, 1.34) and non-Hispanic Asian children (RR 0.47, 95% CI 0.18, 1.21) (Table 4). Increased rates of a positive diagnosis on imaging were demonstrated in all groups except for Hispanic children (OR 0.83, 95% CI 0.34, 2.03). No differences among racial and ethnic groups were found in hospital admission rates for those with positive imaging diagnoses.

Insurance type

Imaging rates were decreased for children with private insurance (RR 0.63, 95% CI 0.49, 0.80) and public insurance (RR 0.63, 95% CI 0.47, 0.84) in 2020 compared to 2019 (Table 5). Children with both types of insurance were more likely to have positive imaging diagnoses in 2020. Likelihoods of hospital admission for the different insurance types did not change for children with positive imaging diagnoses.

Discussion

We found that, compared to 2019, fewer children underwent advanced imaging for non-respiratory- and non-trauma-related indications in our large urban pediatric ED in April 2020, during a statewide COVID-19 stay-at-home advisory, compared to April 2019. Concurrently, the likelihood of a positive imaging exam was comparatively higher in 2020 for

Table 4 Imaging frequency, positive diagnosis, and admission, by race/ethnicity

Number of imaging studies						
Race and ethnicity ^a	April 2020 N=278 N (%)	April 2019 N=437 N (%)	Adjusted rate ratio ^d	95% CI	P-value ^e	
Non-Hispanic White	159 (57)	245 (56)	0.64	0.50, 0.82	<0.001	
Non-Hispanic Black	28 (10)	38 (9)	0.73	0.39, 1.34	0.31	
Non-Hispanic Asian	10 (4)	21 (5)	0.47	0.18, 1.21	0.12	
Hispanic	44 (16)	70 (16)	0.62	0.39, 1.00	0.05	
Unknown	37 (13)	63 (14)	0.58	0.35, 0.96	0.04	
Positive diagnosis on imaging						
Race and ethnicity ^b	April 2020 n/N (%)	Pre-2020 ^f n/N (%)	Adjusted odds ratio ^d	95% CI	P-value ^e	
Non-Hispanic White	62/159 (39)	143/607 (24)	2.04	1.34, 3.09	<0.001	
Non-Hispanic Black	13/28 (46)	25/118 (21)	3.51	1.40, 8.83	0.008	
Non-Hispanic Asian	8/10 (80)	13/60 (22)	10.11	1.96, 52.01	0.006	
Hispanic	9/44 (20)	37/180 (21)	0.83	0.34, 2.03	0.69	
Unknown	16/37 (43)	33/175 (19)	3.40	1.52, 7.62	0.003	
Positive imaging diagnoses admitted to hospital						
Race and ethnicity ^c	April 2020 n/N (%)	Pre-2020 ^f n/N (%)	Adjusted odds ratio ^d	95% CI	P-value ^e	
Non-Hispanic White	42/62 (68)	93/143 (65)	0.88	0.44, 1.79	0.73	
Non-Hispanic Black	6/13 (46)	11/25 (44)	1.18	0.27, 5.18	0.83	
Non-Hispanic Asian	6/8 (75)	7/13 (54)	2.15	0.30, 15.62	0.45	
Hispanic	7/9 (78)	17/37 (46)	2.66	0.43, 16.60	0.30	
Unknown	13/16 (81)	21/33 (64)	1.52	0.35, 6.55	0.58	

CI confidence interval, N total number, n subset number

^aInteraction term for year and age, P=0.95

^bInteraction term for year and age, P=0.03

^cInteraction term for year and age, P=0.78

^dAdjusted for gender, insurance, race, age, acuity level, year, and year and race/ethnicity interaction term

^eP-value <0.05 is significant (bold)

^fApril of 2017, 2018 and 2019

children from all racial and ethnic groups studied, except for Hispanic children, even after adjusting for other variables. Despite the decreased imaging volume in 2020, similar numbers of children with positive exams were admitted compared to 2017–2019. This suggests that during this period of the pandemic, the decrease in imaging occurred mostly in less ill patients.

The decrease in advanced imaging for ED patients in April 2020 is to be expected given the dramatic decrease in overall ED volumes during the time in which the most restrictive stay-at-home advisory was in place in our state. During this same period, compared to baseline, overall ED patient volume decreased 66% at our hospital [14]. Numerous other reports have described decreased ED visits for both adults and children nationally and internationally during the pandemic [15–22]. Although the year-to-year differences are undoubtedly related to the pandemic, the specific reasons for this difference in health care utilization are unclear. Possible factors include concerns about exposure to

COVID-19 at health care centers [23], interpretation of stay-at-home restrictions, and fear or perception of decreased hospital resources. Regardless, the potential consequences are concerning. Multiple studies in adults have suggested that many individuals delayed or were unable to seek attention for important medical conditions during the COVID-19 pandemic and stay-at-home orders [16, 24–26]. One French study found that ED chest CT utilization for non-COVID-related disease decreased during the first 2 weeks of the stay-at-home advisory compared to the prior year, but that the positivity rate was unchanged. This supports concerns regarding missed or delayed diagnoses, and weighs against the idea that the decreased volumes are related to a decrease in presentation of less ill patients [27]. One study of Israeli children showed higher rates of complicated appendicitis during the pandemic, which suggests delays in seeking care [28]. In contrast, the children in our study were more likely to have advanced imaging exams that yielded a positive diagnosis, with no change in admission rates for such

Table 5 Imaging frequency, positive diagnosis and hospital admission rates according to insurance type

Number of imaging studies					
Insurance type ^a	April 2020 N=278 n (%)	April 2019 N=437 n (%)	Adjusted rate ratio ^d	95% CI	P-value ^e
Private	160 (58)	252 (58)	0.63	0.49, 0.80	<0.001
Public	118 (42)	185 (42)	0.63	0.47, 0.84	0.002
Positive diagnosis on imaging					
Insurance type ^b	April 2020 n/N (%)	Pre-2020 ^f n/N (%)	Adjusted odds ratio ^d	95% CI	P-value ^e
Private	64/160 (40)	152/677 (22)	2.09	1.34, 3.26	0.001
Public	44/118 (37)	99/463 (21)	2.33	1.42, 3.82	<0.001
Positive imaging diagnoses admitted to hospital					
Insurance type ^c	April 2020 n/N (%)	Pre-2020 ^f n/N (%)	Adjusted odds ratio ^d	95% CI	P-value ^e
Private	44/64 (69)	92/152 (61)	1.24	0.58, 2.65	0.59
Public	30/44 (68)	57/99 (58)	1.21	0.51, 2.87	0.66

CI confidence interval, N total number, n subset number

^aInteraction term for year and insurance type, $P=0.98$

^bInteraction term for year and insurance type, $P=0.76$

^cInteraction term for year and insurance type, $P=0.98$

^dAdjusted for gender, insurance, race, age, acuity level, year, and year and insurance interaction term

^e P -value <0.05 is significant (bold)

^fApril of 2017, 2018 and 2019

diagnoses. Therefore, it seems less likely that substantially more missed or delayed diagnoses occurred during the study period at our institution.

The decreased frequency of advanced imaging that we demonstrated in 2020 was associated with an overall increase in positive diagnosis rate, when adjusting for variables, including ED triage acuity level. Given the dramatic decrease in ED volume during the stay-at-home advisory, it seems likely there was a change in the types of patients and acuity levels who presented to the ED during April 2020, which might account for this finding [14]. Another possible explanation is altered imaging utilization patterns by ED physicians, with more selective use leading to higher positivity rates. Our results do not necessarily support this possibility, and to our knowledge no published reports have suggested this possibility. The unchanged admission rate for children with positive imaging findings, adjusting for ED triage acuity level, during our comparative time periods suggests that admission patterns did not change during the pandemic.

It is notable that Hispanic children were the only demographic group in our study who did not demonstrate increased exam positivity rates for advanced imaging related to non-respiratory and non-trauma conditions in 2020 compared to prior years. However, the sample size for this population was small ($n=44$), thus overarching conclusions are limited. The overall imaging frequency decrease was comparable to those for non-Hispanic children, although a smaller

proportion of advanced imaging studies was obtained in non-Hispanic Black and Asian children compared to Hispanic and non-Hispanic White children.

Numerous reports have demonstrated COVID-19-related health outcome differences particularly within Hispanic, non-Hispanic Black and non-Hispanic Native American populations, including in children [6, 29–33]. Recent Centers for Disease Control and Prevention (CDC) data show that Hispanic individuals nationally are far more likely than non-Hispanic Asian and non-Hispanic White people to contract, be hospitalized for, and die from COVID-19, and Hispanic people are slightly more likely than non-Hispanic Black people to contract and be hospitalized for the disease [34]. Data from Boston, MA, specifically have shown considerable and disproportionately higher rates of COVID-19 among Hispanic versus non-Hispanic people living in the city [35].

Little data exist to date regarding disparities in non-COVID-related health care in children during the pandemic. Given our primary presumption that the frequency of non-COVID-related illness should not have decreased disproportionately for any given group during the pandemic, the lack of increased positivity rates in Hispanic children, despite decreased imaging numbers, is concerning for conditions that went undiagnosed. Evidence has emerged that disparities in non-COVID-related health care, including care associated with diagnostic imaging, have occurred for minority populations during the pandemic [36]. Such disparities have been demonstrated to be reflective of health care disparities

existing prior to COVID-19 [37, 38] and exacerbated by the disproportionate burdens that the pandemic exerted on these populations [39–41].

This study has multiple limitations, with numerous potential confounders. The purpose was to focus on the radiology experience during 1 month of the pandemic. We assessed only children who had advanced imaging studies for non-respiratory and non-trauma conditions; therefore, we cannot place our data within the context of the numbers, demographics or clinical acuity levels of all children arriving to the ED during the study period. This focused population served as a proxy for non-COVID-19 indications, although it is possible that some of the children with gastrointestinal symptoms had COVID-19. Besides trauma, other common pediatric illnesses, such as gastroenteritis, might have decreased in incidence because of stay-at-home restrictions. This could affect ordering patterns and imaging positivity rates for children presenting to the ED. Recently published data from our ED show decreased visits during the time period we examined, as expected [15]. It remains nonetheless possible that factors separate from ED access might have changed imaging utilization, and more important, once imaged, the rate of positive diagnoses. Also, although we might not have addressed all confounders, we did conduct multivariable analyses for our primary outcomes.

This is a retrospective electronic medical record review, with the risks for misclassification in the clinical information. This includes the variables of gender, race and ethnicity, which are designed to be self-reported at the time of ED registration. All children were categorized as male or female, without a non-binary option. Also, sample sizes for race and ethnicity categories in 2020 were very small, especially for non-Hispanic Asians, and for some of the age groups; therefore, conclusions for certain groups are limited.

We did not include preferred language or limited English proficiency in our models. Patient language has been associated with both increased and decreased ED diagnostic test utilization [42, 43]. We also did not specifically adjust for patients transferred to the ED for care or for those with an unscheduled return visit to the ED within 72 h (bounce-back visit), which could influence acuity level and admission patterns. The study did not address all potential differences in our ED provider practices and the types of patients presenting for ED care during the pandemic. Although there might have been changes in ED protocols that led to decreased imaging for certain clinical indications, it seems unlikely that these would confound findings related to race/ethnicity. It further seems likely that any non-COVID-era factors that might contribute to disparities in access to care and treatment would have remained unchanged across the 4-year study period, and that differences seen in April 2020 compared to other years were primarily related to pandemic and stay-at-home conditions.

Conclusion

In April 2020, at the height of the statewide stay-at-home advisory, there was a decrease in advanced imaging obtained for ED patients with non-respiratory and non-trauma conditions. Except for Hispanic patients, the likelihood of positive imaging diagnoses during this month increased in 2020 compared to recent pre-pandemic years. To inform interventions that advance equitable care in children, further work is needed to better understand potential underlying causes of advanced imaging utilization differences across diverse populations.

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Declarations

Conflicts of interest None

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