COVID-19 in Pediatric Patients: Observations from the Initial Phase of the Global Pandemic in Rhode Island

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ABSTRACT

OBJECTIVE: To describe characteristics of children undergoing SARS-CoV-2 testing during the initial wave of infections in Rhode Island.

METHODS: This is a descriptive study of 729 children tested for SARS-CoV-2 at four emergency departments April 9 to May 7, 2020 in Rhode Island. Demographic information and symptoms were cataloged for those tested.

RESULTS: 81 (11%) children tested positive for SARS-CoV-2. 94% of positive children were symptomatic. 74% of positive cases had constitutional symptoms and 72% had upper respiratory symptoms. While only 34% of those tested were Hispanic, 68% of the SARS-CoV-2-positive cases occurred in Hispanic children.

CONCLUSION: This study details the pediatric population's experience during the first wave of the pandemic in Rhode Island. It could inform testing allocation strategies in healthcare settings. It also highlights vulnerable populations in need of further public health support in our state.

KEYWORDS: pediatric, COVID-19, SARS-CoV-2, public health, symptoms

INTRODUCTION

During the initial wave of the SARS-CoV-2 pandemic in Rhode Island, the peak of new cases was on April 23, 2020 with 419 new SARS-CoV-2-positive cases, or approximately 40 cases per 100,000.[1] A total of 2953 daily tests were performed on April 23, 2020 and 13.4% were positive.[2]

We aimed to provide a thorough depiction of the pediatric population undergoing SARS-CoV-2 testing in Rhode Island during the initial peak of the pandemic. Rhode Island had relatively broad testing capability of both symptomatic and asymptomatic patients during this time, enabling us to perform a thorough assessment of symptomatology among SARS-CoV-2-positive and negative children.[3] Research suggests that children with SARS-CoV-2 infection generally experience mild disease courses or are asymptomatic.[4]

Initially, pediatric COVID-19 testing in Rhode Island predominantly occurred in the emergency department (ED) setting. Using ED data from the healthcare network that cares for the majority of inpatient pediatric patients in the state, we aimed to assess how demographic characteristics and clinical symptoms differed among SARS-CoV-2-positive and negative children in Rhode Island during the initial peak of the pandemic.[5]

METHODS

A retrospective chart review of ED encounters for patients less than or equal to 21-years-old who received a SARS-CoV-2 test between April 9 and May 7, 2020 was performed. These patients presented to one of four EDs that are part of an integrated statewide health system including a level one pediatric trauma center at a tertiary care children's hospital, an adult level one trauma center and two community EDs. This healthcare network cares for over 90% of inpatient pediatric patients in Rhode Island.[5] The study timeframe included the two-week period preceding and following the peak in SARS-CoV-2 cases on April 23, 2020 in Rhode Island.[1] Given the limited data regarding SARS-CoV-2 reinfection rates and the difficulty in distinguishing symptoms from a new infection compared to residual symptoms from a prior infection, our study only included the first ED visit during the study timeframe for patients who had repeat visits. Institutional review board approval was obtained.

Data was recorded with a standardized REDCap data collection form.[6] Patient data collected included patient age, sex, preferred language, ethnicity, race, SARS-CoV-2 test results, presenting symptoms, pulmonary examination abnormalities, contact with a confirmed SARS-CoV-2 positive person, concurrent medical diagnoses, concurrent respiratory pathogen infections and disposition from the ED (discharge to home, group home, psychiatric hospital or admission to a hospital unit). Patients 21 years and younger were included, as pediatric EDs commonly treat patients up to 21 years of age if the patient has not yet transitioned their medical care to an adult provider.

Patients with pre-existing medical or psychiatric conditions were defined as having a positive past medical history. Patients who had a medical diagnosis that did not consist of an unspecified viral syndrome or COVID-19 were defined as having a positive concurrent medical diagnosis. Consistent with prior studies, an abnormal pulmonary examination included any auscultatory abnormalities such as rhonchi, crackles/rales or wheeze.[7]

17 presenting symptoms were grouped into four categories: constitutional (fever of 38 degrees Celsius or higher, subjective fever, chills or body aches), upper respiratory (sore throat, congestion/runny nose, cough or shortness of breath), gastrointestinal (abdominal pain, nausea/vomiting or diarrhea) and other symptoms (headache, loss of smell, loss of taste, seizure, chest pain or rash). This symptom list was developed from COVID-19 symptoms described at the time of study in recent adult and pediatric literature as well as those delineated by the Centers for Disease Control and Prevention (CDC).[7,8] Some patients had multiple symptoms in the same or different categories. Asymptomatic patients were defined as those without any of these symptoms.

Patients who had symptoms suspicious for COVID-19, required hospital admission, or were to be transferred to group home settings or psychiatric facilities were tested for SARS-CoV-2 in the EDs included in this report.[3]

SARS-CoV-2 testing consisted of a reverse-transcription polymerase chain reaction (RT-PCR) run on patient nasopharyngeal swabs. Four RT-PCR Sars-CoV-2 tests were utilized with the following published limits of detection: GenMark Dx ePlex (1x10^5 copies/mL),[9] Cepheid Infinity/Genexpert (0.0100 plaque forming units/mL),[10] BD Max System (40 genome equivalents/mL)[11] and Roche Diagnostics Cobas 6800 (0.007 $TCID_{50}$/mL – $TCID_{50}$ is the median tissue culture infectious dose).[12]

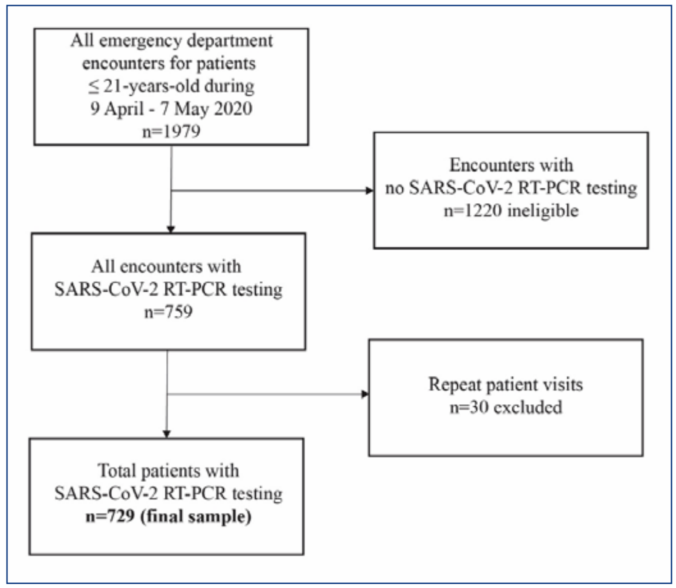
A subset of patients had a respiratory pathogen panel nasopharyngeal swab (RPP) and Group A Streptococcus pharyngeal swab performed. The RPP tested for adenovirus, coronavirus (types 229E, HKU1, NL63, OC43), human metapneumovirus, influenza A and B, rhinovirus/enterovirus, parainfluenza virus 1 to 4, respiratory syncytial virus A and B, Bordetella pertussis, Chlamydia pneumoniae and Mycoplasma pneumoniae. The Group A Streptococcus pharyngitis test was performed using a posterior oropharyngeal swab by rapid bedside testing (Sekisui Diagnostics 141 Osom® Strep A test)[13] or RT-PCR if the rapid test was negative.

Two researchers completed the standardized chart review. Five percent of charts were reviewed by both researchers. The kappa statistic and percent agreement score for manually abstracted data were 0.92 and 98%, respectively. Statistical analyses were performed using STATA/SE version 16.0.[14] χ^2-squared tests and Fisher's exact tests were used for categorical variables. The Mann-Whitney *U* test was used for comparing median values for the age variable. Logistic regression was performed to better understand how various factors may have been related to a SARS-CoV-2 positive test and controlled for presenting symptoms, age and race/ethnicity. These controls were based on covariates previously reported to impact SARS-CoV-2 positivity or complication rates including age, preferred language and race/ethnicity.[7,15] As preferred language was found to be highly correlated with race/ethnicity, it was not included in the final adjusted model.

RESULTS

Of the 1,979 ED visits during the study period (eligible sample), a SARS-CoV-2 test was sent for 759 patients. 30 repeat patient visits (0.04% of SARS-CoV-2-tested patients) were excluded to form the final analytic sample of 729 patients (**Figure 1**). Of the 729 children tested for SARS-CoV-2, 81 (11%) tested positive. 546 of the 729 (75%) patients were classified as having symptoms at the time of testing. 14% of symptomatic patients tested positive while only 3% of asymptomatic patients were positive. 94% of SARS-CoV-2 cases occurred in symptomatic patients.

Figure 1. Flowchart of Study Participants



Of those who tested positive for SARS-CoV-2, there was an unequal distribution between age groups, with the most positive tests occurring among the less than one-year-old (22%) and 18- to 21-year-old (33%) groups (**Table 1**). 15% of those tested were less than one-year-old and 22% were 18- to 21-years-old. There was no statistically significant difference between males and females in the SARS-CoV-2-positive and negative groups. There were substantial racial and ethnic differences among SARS-CoV-2-tested patients. Among Hispanic patients, one in five tested positive for SARS-CoV-2. In contrast, one in 20 non-Hispanic patients tested positive. A greater percentage of positive patients preferred Spanish as their primary language (42%) compared to SARS-CoV-2-negative patients (13%).

The number of patients presenting with each of the individual 17 symptoms in both groups is outlined in **Figure 2** and consolidated into symptom categories in **Figure 3**. Among SARS-CoV-2-positive patients, 94% of patients had at least one symptom, 74% had a constitutional symptom and 72% had an upper respiratory symptom. In comparison, among SARS-CoV-2 negative patients, there was a lower prevalence of patients with at least one symptom (73%), constitutional symptoms (34%), or upper respiratory symptoms (32%). There was no significant difference in gastrointestinal symptoms between the two groups. 56% of SARS-CoV-2-positive patients had a known SARS-CoV-2-positive contact compared to only six percent of negative patients.

There was a broad array of concurrent medical diagnoses among SARS-CoV-2-positive patients. These included but were not limited to seizures (three patients, of which one had a history of a prior seizure disorder), pneumonia (three patients, of which one had new-onset diabetes), asthma exacerbation (one patient), acute otitis media (one patient), milk protein allergy (one patient), *E. coli* urinary tract infection (one patient) and dental infection (one patient). Six SARS-CoV-2-positive patients received pharyngeal Group A streptococcus testing, of which three were positive. 20 SARS-CoV-2-positive patients received RPPs and all were negative. There were 108 RPPs sent among SARS-CoV-2-negative patients, of which 15 (14%) were positive for a respiratory pathogen. The majority of SARS-CoV-2-positive patients (82%) were discharged home. 15% were admitted to the hospital, and none required an intensive care unit admission (**Table 2**). 67% of non-Hispanic white SARS-CoV-2-positive patients were discharged home from the ED compared to 85% of Hispanic and 75% of non-Hispanic black patients.

Consistent with the descriptive statistics, several characteristics were found to be associated with increased SARS-CoV-2 positivity (**Table 3**). Children with constitutional (aOR=5.4; 95% CI 3.1–9.5) or upper respiratory

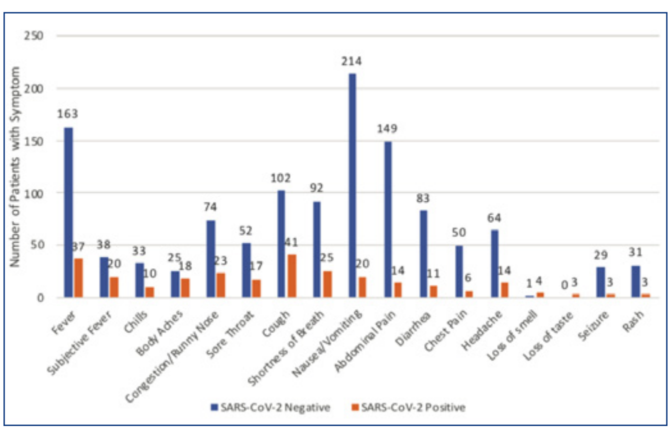
Table 1. Demographics of the Study Population

Characteristics	Total Tested (n=729)	SARS-CoV-2 Negative (n=648)	SARS-CoV-2 Positive (n=81)	P value
Age, median (IQR)	13 (2-17)	13 (2-17)	10 (1-19)	0.14
Age Group in Years, n (%)				
<1	107 (15)	89 (14)	18 (22)	0.001
1–5	117 (16)	107 (17)	10 (12)	
6–11	113 (16)	98 (15)	15 (19)	
12–17	232 (32)	221 (34)	11 (14)	
18–21	160 (22)	133 (21)	27 (33)	
Sex, n (%)				
Male	359 (49)	313 (48)	46 (57)	0.15
Female	370 (51)	335 (52)	35 (43)	
Race and Ethnicity, n (%)				
NH White	337 (46)	322 (50)	15 (19)	<0.001
NH Black or African American	73 (10)	65 (10)	8 (10)	
NH Other	64 (9)	61 (9)	3 (4)	
Hispanic	248 (34)	193 (30)	55 (68)	
Not Reported	7 (1)	7 (1)	0 (0)	
Preferred Language, n (%)				
English	596 (82)	551 (85)	45 (56)	<0.001
Spanish	120 (17)	86 (13)	34 (42)	
Other	13 (2)	11 (2)	2 (3)	

IQR = interquartile range, NH = non-Hispanic
Percentages may not equal 100% due to rounding.

Figure 2. Presenting Symptoms Among 729 Children Tested for SARS-CoV-2

Patients could have multiple symptoms. Symptoms were grouped into categories: constitutional (temperature of at least 38 degrees Celsius, subjective fever, chills, body aches), upper respiratory (sore throat, congestion/runny nose, cough, shortness of breath), gastrointestinal (abdominal pain, nausea/vomiting, diarrhea) and other (headache, loss of smell or taste, seizure, chest pain, rash).



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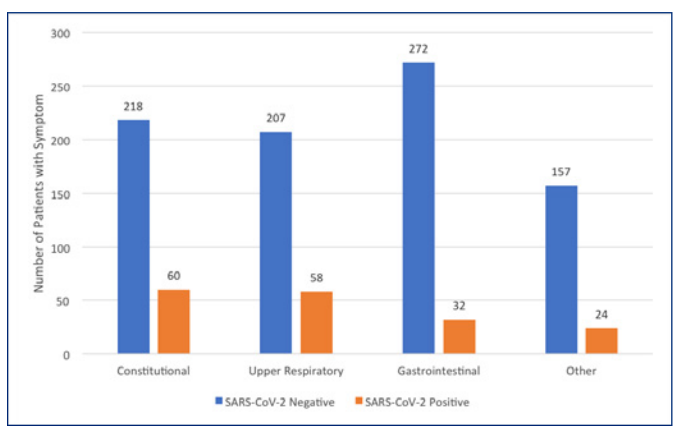

Table 2. Clinical Characteristics of the Study Population

Characteristics	Total Tested (n=729)	SARS-CoV-2 Negative (n=648)	SARS-CoV-2 Positive (n=81)	P value
Symptomatology, n (%)				
Asymptomatic	183 (25)	178 (28)	5 (6)	<0.001
Symptomatic	546 (75)	470 (73)	76 (94)	
[a]Constitutional	278 (38)	218 (34)	60 (74)	<0.001
[a]Upper Respiratory	265 (36)	207 (32)	58 (72)	<0.001
[a]Gastrointestinal	304 (42)	272 (42)	32 (40)	0.67
[a]Other	181 (25)	157 (24)	24 (30)	0.29
SARS-CoV-2 Positive Contact, n (%)				
Yes	84 (12)	39 (6)	45 (56)	<0.001
No	645 (89)	609 (94)	36 (44)	
Pulmonary Examination, n (%)				
Abnormal	73 (10)	58 (9)	15 (19)	0.007
Normal	656 (90)	590 (91)	66 (82)	
Past Medical History, n (%)				
Yes	398 (55)	368 (57)	30 (37)	0.001
No	331 (45)	280 (43)	51 (63)	
Concurrent Medical Diagnosis, n (%)				
Yes	466 (64)	446 (69)	20 (25)	<0.001
No	263 (36)	202 (31)	61 (75)	
Disposition from the ED, n (%)				
Home	386 (53)	320 (49)	66 (82)	<0.001
Group Home	21 (3)	20 (3)	1 (1)	
Medical Floor Admission	202 (28)	190 (29)	12 (15)	
Intensive Care Unit Admission	35 (5)	35 (5)	0 (0)	
Psychiatric Admission	79 (11)	77 (12)	2 (3)	
Other	6 (1)	6 (1)	0 (0%)	

[a]Patients could have multiple symptoms in the same or different categories.
Percentages may not equal 100% due to rounding.

Table 3. Odds Ratios of SARS-CoV-2 Positive Test by Presenting Symptoms

	OR (95% CI)	aOR (95% CI)[a]
Symptomatic	5.8 (2.3-14.5)	3.9 (1.5-10.1)
[b]Constitutional	5.6 (3.3-9.5)	5.4 (3.1-9.5)
[b]Upper Respiratory	5.4 (3.2-9.0)	3.9 (2.3-6.6)
[b]Gastrointestinal	0.9 (0.6-1.5)	0.8 (0.5-1.4)
[b]Other	1.3 (0.8-2.2)	1.0 (0.6-1.8)

OR=odds ratio, aOR = adjusted odds ratio, CI = confidence interval
[a]Models adjusted for age and race/ethnicity.
[b]Patients could have multiple symptoms in the same or different categories.

symptoms (aOR=3.9; 95% CI 2.3–6.6) had increased odds of testing positive for SARS-CoV-2. Children with gastrointestinal (aOR=0.8; 95% CI 0.5–1.4) or other symptoms (aOR=0.68; 95% CI 0.41–1.14) had no significant change in the odds of testing positive. Hispanic children had increased odds of testing positive compared to non-Hispanic white children (aOR=4.9; 95% CI 2.6-8.9). Non-Hispanic Black or African American children also had increased odds of testing positive for SARS-CoV-2 compared to non-Hispanic white children, though this result was not statistically significant (aOR=2.0; 95% CI 0.8–4.9). When compared to 18- to 21-year-olds, children who were 1- to 5-years-old (aOR=0.2; 95% CI 0.1–0.5) and 12- to 17-years-old (aOR=0.3; 95% CI 0.1–0.7) had decreased odds of testing positive.

DISCUSSION

The strength of this study was its ability to provide a detailed description of the demographic and clinical characteristics of pediatric patients in relation to their test results during the initial COVID-19 wave in Rhode Island. The study sample had a positivity rate of 11%, which is consistent with statewide data comprising both adult and pediatric patients that reported a positivity rate of 13.4% at the peak of infections.

We detail the presence or absence of 17 clinical symptoms among SARS-CoV-2-positive and negative pediatric patients. Children with constitutional or upper respiratory symptoms had the highest odds of being SARS-CoV-2-positive. Our findings also reinforce the differences in SARS-CoV-2 infection between adults and children. For example, highly specific COVID-19 symptoms in adults (i.e., loss of taste or smell) were uncommon among SARS-CoV-2-positive children, and few children required admission to the hospital.[16] This information could inform strategies in various healthcare settings for managing patient flow or determining priority to receive rapid testing versus testing that returns within days.

While 40% of SARS-CoV-2-positive patients had gastrointestinal symptoms, 42% of negative patients did as well. Interestingly, it has been reported that patients can have SARS-CoV-2-positive rectal swabs and negative pharyngeal swabs, suggesting that patients with gastrointestinal symptoms in our study might have had false negative tests.[17]

Greater than half the SARS-CoV-2-positive patients in this study reported a SARS-CoV-2-positive close contact. Though we could not ascertain patients' degrees of exposure to individuals known to be SARS-CoV-2-positive, this was consistent with prior literature showing 65% of patients who tested positive had close contact with a family member known to be COVID-19 positive.[18] This highlights the easy spread of infection through close personal contacts. It underscores the need for statewide resources, public campaigns, and provider counseling to have infected patients appropriately quarantine from others if possible, or alternatively, wear masks within households when a family member is exhibiting symptoms.

The prevalence of coinfections was low during the initial peak. None of the SARS-CoV-2-positive patients who had an RPP performed had a concurrent respiratory infection detected. Among SARS-CoV-2-negative patients who had an RPP, 14% tested positive for an infection. This may have been partially due to the fact that this initial peak in coronavirus cases occurred in the respiratory "off-season," when rates of respiratory illness are relatively low. In the next phase of the pandemic, the hospital system has transitioned to obtaining an expanded RPP that now includes SARS-CoV-2 in addition to the other pathogens listed previously for all symptomatic patients. Beyond its clinical utility, this broader panel will allow researchers to evaluate rates of coinfection with more rigor in the upcoming winter months.

In addition to providing clinical data on SARS-CoV-2 infections in children, our study highlights the unequal burden of COVID-19 among children of different ethnicities and emphasizes the need for targeted advocacy and public health efforts for our minority communities. Hispanic children had over four times increased odds of testing positive for SARS-CoV-2 compared to non-Hispanic white children.

It is difficult to disentangle the complex relationships of race/ethnicity and SARS-CoV-2-positivity with associated confounders and mediators such as socioeconomic status and living conditions. In Rhode Island in 2018, 12.9% of the population and 17.5% of children lived below the poverty line. Hispanics comprised the largest ethnic group (29.3%) that lived below the poverty line.[19] Low socioeconomic status households may be more likely to have additional people living in the same room with limited space to adequately quarantine, have fewer resources to mitigate adverse health events, and may thus be at higher risk for SARS-CoV-2 transmission.[20] Low socioeconomic status may therefore be contributing to higher odds of SARS-CoV-2-positivity among Hispanic children. Prior studies have shown that in addition to Hispanic children, non-Hispanic black or African-American children have increased odds of testing positive for SARS-CoV-2 compared to non-Hispanic white children.[15] While we found a similar pattern, inadequate power likely contributed to our inability to detect this finding with statistical significance.

A limitation is the need to interpret our results in a landscape of evolving SARS-CoV-2 testing capabilities and stages of reopening. These factors lead to constant change in the incidence and prevalence of SARS-CoV-2 in different communities, which also affect the pre-test probability of SARS-CoV-2-positivity. While a large amount of pediatric testing at this time was occurring in the ED setting, our data from a population seeking ED level care may not perfectly reflect COVID-19 symptomatology or prevalence in the community as a whole. If certain populations such as the Hispanic community utilized the ED disproportionately more than others during the initial phase of the pandemic, this might skew our findings regarding incidence of infection in specific communities. In addition, by testing all admitted patients for SARS-CoV-2, our SARS-CoV-2-negative patients represent a sicker sample than the general population. A higher proportion of SARS-CoV-2-negative patients were admitted to the medical floor and intensive care unit compared to SARS-CoV-2-positive patients in our study. With increased testing availability, the results of future studies may be more generalizable to the broader pediatric population.

CONCLUSION

Our study provides a thorough description of the children who underwent SARS-CoV-2 testing during the initial peak of the pandemic. Our data are also consistent with prior analyses demonstrating the disproportionately large COVID-19 burden among minority communities during that time. This growing body of literature highlights the systemic inequities that lead to increased disease burden among vulnerable communities and is further evidence that our country must implement public health policies to combat these inequities. These findings could inform allocation of rapid SARS-CoV-2 testing and management of patient flow in various healthcare settings, and highlight populations in need of further public health support in our state.

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