


# Association Between Age and Ethnicity with Pediatric Clinical Outcomes in COVID-2019

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## Abstract

The novel coronavirus SARS-CoV-2 (COVID-19) has infected people across the world, including an increasing number of children in the United States (U.S.). The epidemiology of pediatric infection in the U.S. and how it influences clinical outcomes is still being characterized. In this study, we describe a cohort of 989 children with laboratory-confirmed SARS-CoV-2 infection. Children under age 20 in a statewide health system with SARS-CoV-2 infection, defined by positive PCR testing, between February 1 and August 30, 2020 were included in this observational cohort study. Data extracted from the medical record included age, demographic information, clinical illness severity, hospital stay, and comorbidities. Analysis included descriptive statistics and Chi-square as appropriate. Nine hundred and eighty-children met inclusion criteria for this study, ranging from 1 month to 20 years in age. Most children (62.4%) were asymptomatic at the time of diagnosis and children over the age of 2 were significantly more likely to be asymptomatic at diagnosis than younger children ( $P < .05$ ). Hispanic children were significantly more likely to be symptomatic at the time of diagnosis (56.3% asymptomatic;  $P < .05$ ). The high proportion of children with asymptomatic infection emphasizes the importance of understanding the unique role of children in the pandemic. Older children are more likely to be asymptomatic, but also more likely to experience severe or critical illness when symptoms do develop. Hispanic children were more likely to be symptomatic at diagnosis, highlighting the importance of culturally specific outreach to vulnerable communities.

## Keywords

SARS-CoV2, COVID-19, children

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## What's known on this subject?

Children are known to be less likely to experience severe COVID-19 illness than adults, but gaps remain in epidemiological features, diseases spectrum, and outcomes of SARS-CoV-2 in children of various age and racial/ethnic groups in the U.S.

## What this study adds?

Asymptomatic infection is very common (62.4%), especially in older children with COVID-19. Hispanic children were more likely to be symptomatic. These findings can inform diagnostic and screening approaches to children by highlighting the need for a high index of suspicion.

## Introduction

More than 10 million Americans have been diagnosed with the novel coronavirus SARS-CoV-2, and more than 246 000 have died.<sup>1</sup> SARS-CoV-2 is highly transmissible, with both asymptomatic and pre-symptomatic individuals capable of spreading infection.<sup>2,3</sup> Infection with the SARS-CoV-2 virus causes a clinical syndrome

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referred to as COVID-19, with a wide range of potential symptoms ranging from inapparent infection to fulminant illness with accompanying respiratory failure, coagulopathy, gastrointestinal symptoms, and cognitive impairment.<sup>4,5</sup> People in racial and ethnic minority groups, as well as those in rural areas with scarce health-care resources, are being disproportionately affected by COVID-19.<sup>4,6-10</sup> Early reports suggest that illness in children is less severe than it is in adults.<sup>11</sup> However, a serious multisystem inflammatory syndrome in children (MIS-C) has been described that causes cardiac and cardiovascular dysfunction.<sup>12-14</sup> As the pandemic evolves, the need to characterize the full extent of illness in children is paramount to inform school and community practices, as well as clinical treatment guidelines.

As a state with many people in the racial and ethnic minority groups at higher risk for SARS-CoV-2 and in rural areas, Arkansas has been significantly impacted by the COVID-19 pandemic. As of October 29, 2020, over 109 000 people have been infected with SARS-CoV-2, and almost 2000 patients have died.<sup>15</sup> Children and adolescents under 18 years of age represent almost 14 000 of those infected in the state since the start of the pandemic. The number of children infected continues to rise.<sup>15</sup> Arkansas Children's, including its primary hospital in central Arkansas and affiliate hospital in northwest Arkansas, is the only children's hospital system in the state and is among the largest pediatric hospitals in the United States.<sup>16</sup> It serves children from birth to age 21 and is largely representative of the state's pediatric population's health status. As the pandemic evolves and a larger number of children are infected, it is becoming apparent that pediatric COVID-19 experiences may be more varied and serious than previously expected. The data from continued and comprehensive surveillance is essential to predict and prepare for managing the virus over the next few months to years. The goal of this study is to characterize the epidemiology, clinical presentation, and outcomes of 989 children with SARS-CoV-2 infection from February through August 2020. The results of this study demonstrate key patterns of illness that can inform risk assessment and evaluation of children with suspected COVID-19.

## Methods

Participants were identified in the hospital system's electronic medical record using the key words "COVID-19" and "SARS-CoV-2." Patients were included in the study if they had positive SARS-CoV-2 test results, were less than 20 years of age, and received care in the Arkansas Children's system between February 1 and

August 30, 2020. During this time, all SARS-CoV-2 testing was polymerase chain reaction (PCR) qualitative testing of nasal and nasopharyngeal swab specimens. The limit of detection for this assay is 350 copies/mL. These tests are limited to laboratories certified under CLIA'88 to perform high complexity testing under the auspices of Emergency Use Authorization (EUA) by the U.S. Food and Drug Administration. The testing was performed at primary care clinics, emergency departments, outpatient areas, inpatient units, and mobile sites.

The clinical severity of COVID-19 was defined on a 1 (asymptomatic) to 5 (critical) scale, based on previously established classifications reflecting the clinical features, hospital admissions, PICU admissions, and need for artificial ventilation or oxygen therapy in patients with COVID-19.<sup>17</sup> The patients were classified based on their maximal illness severity as Asymptomatic (1), Mildly symptomatic (2; no hospitalization, managed symptomatically at home), Moderate (3; hospitalized for treatment and IV fluids but not into PICU), Severe (4; hospitalized with oxygen requirement), or Critical (5; PICU hospitalization, artificial ventilation, oxygen therapy, death). Hospitalization was defined as admission for 24 hours or more and did not include emergency room visits only or observation admissions for less than 24 hours. Comorbidities included all chronic infectious, autoimmune, and malignant diseases identified by chart review. Overweight was defined as body mass index ( $\text{kg}/\text{m}^2$ )  $\geq 85$ th percentile for age and sex based on CDC growth charts among children aged  $\geq 2$  years at the time of the most recent clinical encounter; this was not evaluated for children  $< 2$  years.

Overall, key patient characteristics were summarized using basic descriptive statistics. Means and standard deviations (SD) or median and interquartile range (IQR) while counts and proportions were used for categorical variables. Confidence intervals (95%) were calculated for each variable. Chi-square was calculated to compare disease states across age and racial/ethnic groups, as well as other categorical variables. Because of the small sample size, Asian and other racial/ethnic groups, participants were excluded from Chi-square analyses. Significance was defined as  $P < .05$ . Statistical analysis via GraphPad Prism, v9.0.0. This study was approved by the University of Arkansas for Medical Sciences Institutional Review Board (IRB #261599).

## Results

### *Patient Characteristics*

Nine hundred and eighty-nine (989) children and adolescents  $\leq 20$  years of age were diagnosed with SARS-CoV-2 infection by polymerase chain reaction (PCR) between

**Table 1.** Symptoms and Outcomes.

	n (percent of 989 total participants)	95% CI (%)
Symptomatic infection	372 (37.6)	342-402 (34.6-40.6)
Symptoms		
Fever	216 (21.8)	190-241 (19.2-24.4)
Respiratory	274 (27.7)	246-301 (24.9-30.5)
Gastrointestinal	79 (8.0)	62-96 (6.3-9.7)
Genitourinary	11 (1.1)	4-17 (0.1-1.8)
Neurologic	75 (7.6)	59-91 (5.9-9.3)
Dermatologic	15 (1.5)	7-22 (0.7-2.2)
Musculoskeletal	55 (5.6)	41-70 (4.2-7.0)
Symptom severity		
Asymptomatic	617 (62.4)	587-647 (59.4-65.4)
Mild	328 (33.2)	299-357 (30.3-36.1)
Moderate	28 (2.9)	18-39 (1.9-3.9)
Severe	8 (0.8)	2-13 (0.2-1.4)
Critical	8 (0.8)	2-13 (0.2-1.4)
Outcomes		
Hospitalized	42 (4.2)	29-54 (2.9-5.5)
Days hospitalized	1-23 days (mean 3.4 days)	2.3-4.5
Intensive care (ICU) admission	16 (1.6)	8-24 (0.8-2.4)
Intubated/ventilator support	7 (0.7)	2-12 (0.2-1.2)

Severity score based on Dong et al.<sup>17</sup>  
Abbreviation: CI, confidence interval.

February 1, 2020, and August 30, 2020 in the Arkansas Children's health system. As described in Table 1 below, the patients ranged in age from 1 month to 20 years (median 8 years; IQR 3, 14), with a slight female predominance (51.5% female). Almost two-thirds of the infected children were from minority racial and ethnic groups, including 333 non-Hispanic Black children (33.7%), 339 Hispanic children (34.3%), and 46 Asian or other racial/ethnic identification (4.7%). Importantly, the percentage of non-Hispanic Black and Hispanic children in this cohort of children with COVID-19 is significantly higher than the percentage of non-Hispanic Black (15.7%) and Hispanic (7.8%) people in Arkansas ( $P < .0001$ ).<sup>18</sup> Co-morbid conditions were common, including obesity (264 children; 26.7%) and allergies or asthma ( $n=229$ , 23.3%). Very few patients with a history of immunosuppression ( $n=20$ , 2.0%) or documented smoke exposure ( $n=87$ , 8.8%) tested positive for SARS-CoV-2 during this time frame. Most patients were diagnosed in July 2020 ( $n=464$ ; see Supplemental Figure S1), with a decrease in cases in August 2020.

### Clinical Presentation of COVID-19 in Arkansas Children

The majority of children with documented SARS-CoV-2 infection were asymptomatic ( $n=617$ ; 62.4%). Among

the 372 children with symptoms (Table 2), the most common symptoms were fever ( $n=216$ , 58.1% of symptomatic children) and respiratory symptoms, such as cough and respiratory distress ( $n=274$ ; 73.7%). Most symptomatic children were only mildly affected ( $n=329$ ; 88.7% of symptomatic children). A small number of children experienced critical or severe disease ( $n=16$ ; 4.3% of symptomatic children), requiring intensive care unit (ICU) admission and/or ventilator support. There were no patient deaths in this cohort attributed to COVID-19.

### Demographic Predictors of Illness Presentation and Severity

Age was significantly associated with illness severity in this cohort ( $\chi^2 10.8$ ,  $P .0131$ ). Children over age 10 were much more likely to have a severe or critical illness ( $n=10$ ; 62.5% of children with severe or critical illness) than younger children. Gender was not significantly associated with hospitalization; ICU admission; ventilation; likelihood of being symptomatic; type of symptoms; or presence of fever at diagnosis. Similarly, race and ethnicity were not significantly associated with hospitalization, ICU admission; or need for ventilatory support. However, race and ethnicity were significantly associated with whether a patient was symptomatic at

**Table 2.** Characteristics of the Study Population.

	n (percent of 989 total participants)	95% CI (%)
Gender		
Male	479 (48.5)	449-511 (45.4-51.6)
Female	509 (51.5)	479-540 (48.4-54.6)
Race/Ethnicity		
Non-Hispanic White	271 (27.4)	298-243 (24.6-30.2)
Non-Hispanic Black	333 (33.7)	304-362 (30.8-36.6)
Hispanic	339 (34.3)	310-368 (31.3-37.3)
Asian	5 (0.5)	1-9 (0.01-2.2)
Other	41 (4.1)	28-53 (2.9-5.3)
Co-morbid conditions		
Allergies/Asthma	229 (23.3)	204-256 (20.7-25.9)
Obesity (BMI $\geq$ 85%)	264 (26.7)	237-291 (23.9-29.5)
Smoke exposure	87 (8.8)	70-104 (7.0-10.6)
Immunosuppressed	20 (2.0)	11-28 (1.1-2.9)
Other co-morbid conditions	294 (29.7)	266-322 (26.9-32.5)

the time of testing ( $\chi^2$  11.8,  $P$ .003). Non-Hispanic white and non-Hispanic Black children were much more likely to be asymptomatic at the time of positive SARS-CoV-2 testing (Table 3). Hispanic children were significantly more likely to present with respiratory symptoms ( $n=112/339$ ; 33.0%;  $P$ .045) and with fever ( $n=96/339$ ; 28.3%;  $P$ .0004) than children from other racial/ethnic groups. Race was also significantly associated with the severity of illness (Table 4;  $\chi^2$  20.1;  $P$ .010).

Children over the age of 2 were more likely to be asymptomatic at the time of diagnosis across all race and ethnicity groups (Table 3). Children who were tested in mobile sites were much more likely to be asymptomatic ( $n=534$ ; 83.4%; CI 515-552; 80.5%-86.3%) than those tested in hospitals or clinics ( $n=84$ ; 24.1%; CI 68-100; 19.6%-28.6%) which is not surprising given the large number of patients using drive through testing locations for pre-procedural screening or post-exposure screening ( $P < .0001$ ).

## Discussion

As of November 2020, the World Health Organization (WHO) has reported over 51 million cases and 1.2 million deaths attributable to COVID-19 since declaring a public health emergency in January 2020.<sup>19</sup> The United States (U.S.) has been heavily impacted, with over 10 million cases and surging infection rates in most states.<sup>19</sup> Over 900 000 of the cases in the U.S. have occurred in children to date.<sup>20</sup> This report describes the epidemiology, clinical presentation, and outcomes of almost 1000 children in the Arkansas Childrens' system who were diagnosed with COVID-19 from February through August 2020. A large majority of children were

asymptomatic at the time of diagnosis (62.4%), emphasizing the potential for children to serve as an undetected reservoir of COVID-19 infection within the community. Among symptomatic patients, fever and respiratory symptoms were the most commonly reported, consistent with other reports of adult and pediatric illness early in the pandemic.<sup>12,17,21,22</sup> In general, outcomes were good in this population, with no deaths attributable to COVID-19 and rare hospitalization (4.2%) or ICU admission (1.4%). However, it is important to note that age was significantly associated with outcomes, with children under 2 more likely to be symptomatic at admission and children over age 10 more likely to have a critical or severe illness. Older children and adolescents should be monitored closely when experiencing COVID-19 symptoms, as they may be at higher risk of progression to ICU admission and/or ventilatory support.

Non-Hispanic Black and Hispanic children were significantly over-represented in this patient cohort, consistent with prior reports in adults and early pediatric data.<sup>1,23</sup> Race and ethnicity were also significantly associated with illness severity among the children in this study and with the symptoms at presentation. Interestingly, non-Hispanic white and non-Hispanic Black children were much more likely to be asymptomatic at the time of diagnosis than were Hispanic children, who were more likely to present with fever and respiratory symptoms. This may reflect a true increased incidence of symptomatic infection in this population or that Hispanic children have less access to healthcare and testing prior to symptom development. The SARS-CoV-2 pandemic has disproportionately impacted many racial and ethnic minority groups in the U.S., including non-Hispanic Black persons, Hispanic and Latinx

**Table 3. Number of Asymptomatic Children by Race/Ethnicity and Age.**

Race/Ethnicity	n (%; CI)			Total
	0-2 years	≥ 2-10 years	≥ 10-20 years	
Non-Hispanic White; n = 271 total positive	22 (8.1%; 13-31; 4.9%-11.3%)	68 (25.1%; 54-82; 19.9%-30.3%)	83 (30.6%; 68-98; 25.1%-36.1%)	173 (63.8%; 157-188; 58.1%-69.5%)
Non-Hispanic Black; n = 333 total positive	26 (7.8%; 16-36; 4.9%-10.7%)	97 (29.1%; 81-113; 24.2%-34.0%)	107 (32.1%; 90-124; 27.1%-37.1%)	230 (69.1%; 214-247; 64.1%-74.1%)
Hispanic; n = 339 total positive	24 (7.1%; 15-33; 4.4%-9.8%)	85 (25.1%; 69-101; 9.8%-13.9%)	82 (24.2%; 67-97; 19.6%-28.8%)	191 (56.3%; 173-209; 51.0%-61.6%)
Asian/Other; n = 5 total positive	1 (20.0%; 0-3; 0%-55%)	1 (20.0%; 0-3; 0%-55%)	0 (0%)	2 (40.0%; 0-4; 0%-82.9%)
Other; n = 41 total positive	5 (12.2%; 1-9; 2.2%-22.2%)	10 (26.8%; 5-17; 12.3%-40.4%)	6 (12.2%; 1-9; 2.2%-22.2%)	21 (51.2%; 15-27; 35.9%-66.5%)
Total; n (% of asymptomatic patients; CI)	78 (12.6%; 62-94; 10.0%-15.2%)	261 (42.3%; 237-285; 38.4%-46.2%)	278 (45.1%; 254-302; 41.2%-49.0%)	617

Six hundred seventeen total asymptomatic children in this cohort. Percentages represent the percent of total positives within the same race or ethnicity. CI = 95% Confidence Interval.

**Table 4. COVID-19 Severity across Various Race/Ethnicity Groups.**

Race/Ethnicity	Asymptomatic		Mild		Moderate		Severe		Critical		Total
	n	(%:CI)	n	(%:CI)	n	(%:CI)	n	(%:CI)	n	(%:CI)	
Non-Hispanic White	173 (63.8%; 157-188; 58.1%-69.5%)	85 (31.3%; 70-100; 25.8%-36.8%)	9 (3.3%; 3-15; 1.2%-5.4%)	0 (0%)	4 (1.5%; 0-8; 0.05%-2.9%)	271					
Non-Hispanic Black	230 (69.1%; 214-247; 64.1%-74.1%)	91 (27.3%; 75-107; 22.5%-32.1%)	5 (1.5%; 1-9; 0.2%-2.8%)	4 (1.2%; 0-8; 0.03%-2.4%)	3 (0.9%; 0-6; 0%-1.9%)	333					
Hispanic	191 (56.3%; 173-209; 51.0%-61.6%)	134 (39.5%; 116-152; 34.3%-44.7%)	9 (2.7%; 3-15; 1.0%-4.4%)	4 (1.2%; 0-8; 0%-2.4%)	1 (0.3%; 0-3; 0%-0.9%)	339					
Asian	2 (40%; 0-4; 0%-83%)	3 (60%; 1-5; 17.1%-100%)	0 (0%)	0 (0%)	0 (0%)	5					
Other	21 (51.2%; 15-27; 35.9%-66.5%)	15 (36.6%; 9-21; 21.9%-51.3%)	5 (12.2%; 1-9; 2.2%-22.2%)	0 (0%)	0 (0%)	41					
Total	617 (62.4%; 587-647; 59.4%-65.4%)	328 (33.2%; 299-357; 30.3%-36.1%)	28 (2.9%; 18-39; 1.9%-3.9%)	8 (0.8%; 2-13; 0.2%-1.4%)	8 (0.8%; 2-13; 0.2%-1.4%)	989					

Nine hundred eighty-nine total children with COVID-19 in this cohort. Percentages represent percent within the same race or ethnicity. One child was intubated and admitted to ICU. However, SARS-CoV-2 positive test was incidental and not related to ICU admission; therefore, this child is categorized as "asymptomatic." CI=95% Confidence Interval.

persons, immigrants, and indigenous populations such as American Indians and Alaskan Natives.<sup>7-9,24-26</sup> Studies are underway to identify potentially modifiable factors associated with the disproportionate impact of SARS-CoV-2 on these populations, such as biologic drivers of illness or markers of health disparity in disadvantaged populations like poverty, chronic stress, nutritional status, obesity, chronic conditions, decreased access to health care, and household crowding.<sup>27-33</sup> Our results showing disproportionate COVID-19 infection in children highlight the need for efforts to increase diagnostic testing that addresses diverse and often community-specific logistical, cultural, and language barriers to testing experienced by members of communities at the greatest risk.<sup>34,35</sup>

Our study is strengthened by its large number of children across a wide range of age groups and racial/ethnic groups and the fact that it includes data from a long period of time in a heavily impacted state. In addition, as the only children's health care system in Arkansas, the vast majority of children with significant illness associated with COVID-19 would be included in this patient sample. However, children with mild or asymptomatic infection are likely underrepresented in this cohort. It is also difficult to capture the impact of COVID-19 on Marshallese children, who have likely been disproportionately impacted by the pandemic based on adult data in this population, in this study because of limitations in race and ethnicity reporting in the medical record. Unfortunately, several questions cannot be answered with the current data set, including assessing adult and pediatric cases that were epidemiologically linked to the children with positive test results in this cohort, which is critical to understand the role of children in transmission.

## Conclusions

The results of this study highlight several key issues to inform pediatric guidelines surrounding COVID-19. First, it emphasizes the importance of children as a potential source of infection, particularly given the very high proportion of asymptomatic infection among school-age children. There are likely far more children infected with COVID-19 than we have recognized clinically. Asymptomatic and pre-symptomatic respiratory transmission plays an important role in the spread of infection.<sup>2,3</sup> Therefore, early identification of asymptomatic or pre-symptomatically infected individuals like the 617 children identified in our cohort is important to limit viral spread. Additionally, the long-term sequelae of even asymptomatic infection on children are not yet known and may not be appreciated for months to years to come. This study also identifies the significant and

disproportionate impact of COVID-19 infection on children from underrepresented racial and ethnic communities. It is critical that pediatric research and clinical efforts to address the COVID-19 pandemic include careful consideration of the biological, environmental, and cultural factors that lead to disparate COVID-19 outcomes for vulnerable children.

## Author Contributions

Dr Jessica Snowden carried out the initial analyses, drafted the initial manuscript, and reviewed and revised the manuscript. Dr Anjali Patwardhan conceptualized and designed the study, helped in drafting the initial manuscript, collected data, reviewed, and revised the manuscript.

## Declaration of Conflicting Interests

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

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## Ethics Approval

This study was approved by the University of Arkansas for Medical Sciences Institutional Review Board (IRB #261599).

## Article Summary

This study reports high rates of asymptomatic infection, as well as association between age and ethnicity on SARS-CoV-2 outcomes, in a cohort of 989 children.

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## Supplemental Material

Supplemental material for this article is available online.

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