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Effectiveness of Preoperative Symptom Screening in Identifying Pediatric SARS-CoV-2 Infections: A Retrospective Cohort Analysis

Catherine T. McNamara, BS
Laura C. Nuzzi, BA
Ava G. White, BA
Gabrielle G. Massey, BA
Stephanie D. Miller, MHA
Amir H. Taghinia, MD, MPH, MBA
Brian I. Labow, MD, FACS, FAAP

Introduction: Evidence-based protocols identifying COVID-19 cases in pediatric preoperative settings are lacking. With COVID-19 positioned to remain a threat to children, this study examines effectiveness of preoperative COVID-19 symptom screening in pediatric patients.

Methods: This retrospective cohort study included hospital billing/medical record queries of (1) procedures performed under conscious sedation/general anesthesia and (2) laboratory-confirmed COVID-19 (+) cases from April 6, 2020, to June 15, 2020. Descriptive analyses were performed for demographic, procedural, symptom, and COVID-19 test result data obtained from medical records. Bivariate analyses examined associations between SARS-CoV-2 test results and symptom, demographic, and procedural data.

Results: Among 2900 surgical cases, median (interquartile range) age was 8.1 (12.8) years. The majority were male (n = 1609, 55.5%), white (n = 1614, 55.7%), and not Hispanic/Latino (n = 1658, 57.2%). Additionally, 85.4% (n = 2412) of cases were non-emergent. Fifteen COVID-19 (+) cases were identified, for a 0.5% positivity rate. COVID-19 positivity was not associated with sex, American Society of Anesthesiologists physical status, or preoperative symptom status. Notably, 92.9% (n = 13) of COVID-19 (+) cases were asymptomatic. COVID-19 (+) patients were significantly older (15.6 years) than COVID-19 (−) patients (8.0 years). Patients who were not white, were Hispanic/Latino, or had a relatively lower economic status, were more likely to test positive.

Conclusions: Preoperative symptom screenings insufficiently identified COVID-19 (+) patients. During outbreaks, testing protocols should be implemented to identify COVID-19 (+) patients. Future research should examine if observations are similar for other variants, and how health disparities associate with COVID-19.
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INTRODUCTION

The COVID-19 pandemic has become one of the defining moments in healthcare. SARS-CoV-2 infected over 50 million Americans between January 2020 and mid-December 2021, and has disproportionately impacted marginalized communities.[1–7] Throughout the majority of the pandemic, adults have experienced the brunt of infections. However, recent data indicate that SARS-CoV-2 infections are starting to trend younger.[8] As of late September 2021, children have contributed to 16.2% of all positive cases in the United States, compared to just 2.7% in April 2020.[9] Based on current data, this is due in part to vaccination availability, reintroduction of in-person learning, and a variety of other social factors.[10–15]

Although children can present with similar symptoms of COVID-19 as adults (fever, cough, shortness of breath, fatigue, diarrhea, and rhinorrhea), pediatric patients are

From the Department of Plastic and Oral Surgery, Boston Children's Hospital and Harvard Medical School, Boston, Mass.

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frequently asymptomatic and experience milder disease courses.[3,13,16–25] In rare cases, children have developed multiorgan inflammatory syndrome (MIS-C) or thrombotic microangiopathy (TMA) as a result of SARS-CoV-2 infection; however, the pathogenesis is currently unclear.[26,27]

During the initial 2020 shutdowns, elective health services, including surgery, were largely suspended.[28,29] A study including 26 pediatric hospitals reported a 77% drop in surgeries during this time compared to 2019, with an estimated $276.3 million lost from inpatient and outpatient services.[28] Given the health-related downsides and economic costs, a shutdown of this magnitude is unlikely to be repeated. It is critical that we become educated on how to exist with COVID-19 in healthcare, and determine the most effective ways of screening for the virus in children.

To date, there have been few studies examining this smaller segment of the COVID-19 population. One recent letter reported that COVID-19 (+) pediatric surgical patients were largely older, and symptomatic, but that those who tested positive did not vary by race, or Hispanic ethnicity.[30] However, this study was limited to a small sample size and short time period.

The present study aims to evaluate the effectiveness of preoperative COVID-19 symptom screening relative to SARS-CoV-2 testing in pediatric patients, using a larger sample size and broader time period than the earlier report. Using these data, we aim to propose an evidence-based approach to preoperative COVID-19 screening for children. Our secondary goal is to explore patient characteristics and demographics which may associate with positivity rates within the preoperative pediatric population.

Takeaways

Question: Do preoperative symptom screenings accurately identify incidental COVID-19 cases among pediatric patients undergoing surgery?

Findings: COVID-19 positivity was 0.5% among the 2900 total procedures included in our retrospective cohort series. The presence of any COVID-19 symptom was not significantly associated with a positive SARS-CoV-2 test result, and approximately 93% of COVID-19 (+) cases were asymptomatic.

Meaning: Preoperative screening based on symptoms was insufficient in identifying COVID-19 (+) cases in our sample, highlighting the importance of preoperative SARS-CoV-2 testing in pediatric surgical patients.

METHODS

After receiving institutional review board approval with a waiver of informed consent, we performed a retrospective review examining COVID-19 symptoms and SARS-CoV-2 test results in preoperative patients at a single pediatric tertiary care medical center. Demographics, clinical presentation, operative procedures, and SARS-CoV-2 test results were all obtained from the medical record. All data were stored and managed in password protected documents within our institution's security firewall. Nearly all SARS-CoV-2 testing was performed using polymerase chain reaction (PCR) methodology at our institutional core laboratory, and only a small number of tests were performed at an outside institution before patient transfer to our hospital.

Patient Eligibility and Case Selection

Two distinct hospital billing and medical record queries were performed to identify eligible patients (Fig. 1). During the study period, preoperative SARS-CoV-2 testing and COVID-19 symptom screening were both required by our institution for all non-emergent procedures performed under general anesthesia or conscious sedation. The first query identified all patients undergoing procedures under general anesthesia or conscious sedation at our institution from April 6, 2020, through June 15, 2020. This list was then screened to identify laboratory confirmed COVID-19 (+) cases and COVID-19 (−) cases. Patients whose results were unavailable were excluded from all analyses. Upon report of a preoperative positive SARS-CoV-2 test, non-emergent procedures were rescheduled. As the above query only captured completed procedures, rescheduling a procedure due to a positive SARS-CoV-2 test result would exclude it from query results. Thus, to avoid selection bias towards COVID-19 (−) cases, and to ensure all COVID-19 (+) cases reported during preoperative screening were captured, a second query was performed.

In the second query, laboratory-confirmed COVID-19 (+) cases at our institution were identified using the associated *International Classification of Diseases, Tenth Revision* (ICD-10), code U07.1 during the same time period. This list was screened for patients who were COVID-19 (+) as a result of preoperative testing, and who did not overlap with the previous procedure query. Patients who tested positive during a clinical or emergency department visit unrelated to an upcoming surgical procedure were excluded from our final sample of COVID-19 (+) cases.

To achieve our final cohort, the total number of COVID-19 (+) cases included a combination of both queries, whereas the total number of COVID-19 (−) cases were identified during the initial procedure query.

Statistical Analyses

Analyses were performed using IBM SPSS Version 27 (IBM Corp., Armonk, N.Y.). Frequency distributions were reported for demographics; COVID-19 clinical presentation; procedural data; and test source, type, and results. Unless otherwise stated, variables were dichotomized as follows: race (white versus non-white), ethnicity (Hispanic or Latino versus not Hispanic or Latino) and COVID-19 symptom status (at least one COVID-19 symptom versus asymptomatic). The Mann–Whitney U test was used to compare the difference in median age between COVID-19 (+) and COVID-19 (−) groups. The Fisher exact and Pearson chi-squared tests were used to assess associations of sex, race, ethnicity, American Society of Anesthesiologists (ASA) physical status, and COVID-19 symptom status with SARS-CoV-2 test results, as appropriate. An independent samples t-test was used to evaluate differences in median

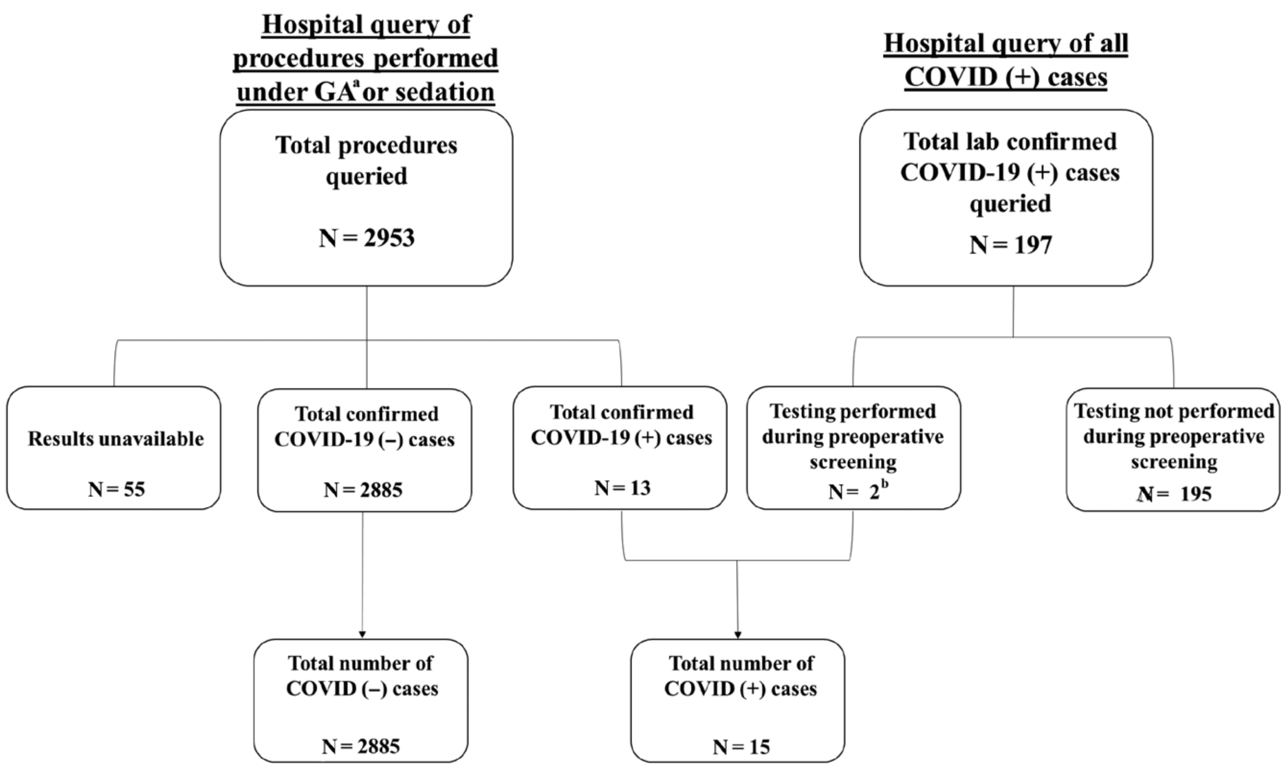

Fig. 1. Schematic of hospital billing and medical record queries. [a]General anesthesia. [b]Additional cases that did not overlap with procedure query.

household income by the SARS-CoV-2 test result. Median household income data were obtained from the US Census Bureau using patient zipcode.[31] Cases with missing data were excluded from analyses. A *P* value less than 0.05 was considered statistically significant. (**See appendix, Supplemental Digital Content 1**, which displays the STROBE statement, **http://links.lww.com/PRSGO/C76**.)

RESULTS

Cohort Demographics

A total of 2900 cases were obtained from both queries. The procedure query resulted in 2953 cases, of which 2885 were COVID-19 (–), 13 were COVID-19 (+), and 55 were excluded due to absent testing data. The COVID-19 (+) case query resulted in 197 cases, of which two additional cases were identified during preoperative screening, and did not overlap with the original query. In total, these queries yielded 15 COVID-19 (+) cases and 2885 COVID-19 (–) cases, with a resulting positivity rate of 0.5% (Table 1). Of note, 99.4% (n = 2882) of test results were obtained using PCR testing, all performed at our institution. All remaining test results (n = 18) were obtained from outside medical records following patient transfer to our institution.

The median age of the entire cohort was 8.1 years [minimum: <1.2 months; maximum: 59.8 years; interquartile range (IQR): 12.8 years; 5th percentile: 3.5 months, 95th percentile: 21.2 years], and the majority of the sample was male (n = 1609, 55.5%), white (n = 1614, 55.7%), and not Hispanic or Latino (n = 1658, 57.2%). Approximately 85% of all cases were non-emergent (n = 2412), with the greatest number of cases (n = 1203, 42.6%) classified as ASA 2. Orthopedics was the most common surgical service (n = 522, 18.0%).

Symptoms and Cohort Demographics

There was no significant difference in presence of symptoms between COVID-19 (+) and COVID-19 (–) cases ($P > 0.99$; Table 2). Roughly 93% (n = 13; symptom data unavailable for one case) of COVID-19 (+) cases were asymptomatic. The only presenting symptom in COVID-19 (+) cases was dermatologic (cellulitis), occurring in one case (7.1%), while fever was the most common presenting symptom in COVID-19 (–) cases (n = 72, 2.5%). Additionally, sex and ASA physical status distribution did not significantly vary between COVID-19 (+) and COVID-19 (–) cases ($P > 0.05$, both; Table 3).

COVID-19 (+) patients were significantly older (median age: 15.6 years, minimum: 6 months, maximum: 25.4 years, IQR: 7.0 years) than COVID-19 (–) patients (median age: 8.0 years, minimum: <1.2 months, maximum: 59.8 years, IQR: 12.8 years) ($P = 0.04$). Furthermore, patients who were non-white had 6.7 times the odds of testing positive for SARS-CoV-2 compared to white patients [OR: 6.66, 95% confidence interval (CI): 2.04–21.71, $P = 0.001$]. Additionally, patients who were Hispanic or Latino had 4.5 times the odds of testing positive for SARS-CoV-2 compared to non-Hispanic or Latino patients (OR: 4.45, 95% CI: 1.40–14.12, $P = 0.006$). Last, COVID-19

Table 1. Demographic and Clinical Data

	n = 2900 Cases
Median (IQR) age at preoperative screening, y	8.1 (12.8)
COVID-19 positivity rate, n (%)	15 (0.5)
Sex, n (%)	
Male	1609 (55.5)
Female	1291(44.5)
Race, n (%)	
Asian	71 (2.4)
Black or African American	148 (5.1)
Other	334 (11.5)
Unknown	733 (25.3)
White	1614 (55.7)
Ethnicity, n (%)	
Hispanic or Latino	270 (9.3)
Not Hispanic or Latino	1658 (57.2)
Unknown	972 (33.5)
ASA class, n (%)	
1	698 (24.7)
2	1203 (42.6)
3	725 (25.7)
4	188 (6.7)
5	10 (0.4)
ASA physical status, n (%)	
Non-emergent	2412 (85.4)
Emergent	413 (14.6)
Surgical service, n (%)	
Orthopedics	522 (18.0)
Otolaryngology	509 (17.6)
General	495 (17.1)
Gastrointestinal	274 (9.4)
Genitourinary	201 (6.9)
Cardiology	174 (6.0)
Plastic and oral	163 (5.6)
Neurology	162 (5.6)
Eye	117 (4.0)
Oncology	111 (3.8)
Dental	50 (1.7)
Pain	50 (1.7)
Gynecology	36 (1.2)
Medical	14 (0.5)
Pulmonary	13 (0.4)
Dermatology	9 (0.3)

(+) patients lived in regions with significantly lower median household incomes (mean income = $73,761.07 ± $32,388.63) compared to COVID-19 (−) patients (mean income = $93,781.18 ± $36,540.20; P = 0.03). Of note, median household income data were unavailable for 43 patients.

Additional review of COVID-19 (+) cases showed that one patient tested positive for SARS-CoV-2 before two separate surgical procedures, contributing two COVID-19 (+) cases. As a result, six patients (n = 7/15 cases, 46.7%) had comorbidities before surgery, the most common being obesity (n = 4/7 cases, 57.1%). Postoperative complications data were available for 40.0% (n = 6/15) of COVID-19 (+) patients, with none experiencing surgical complications. There were no unexpected readmissions or reoperations. One patient with COVID-19 died on postoperative day zero; however, the cause of death was attributed to sepsis, pneumonia, and intestinal obstruction within the setting of chronic lung disease and COVID-19.

DISCUSSION

The COVID-19 pandemic has presented one of the greatest healthcare challenges in modern history. A lack of knowledge in the early stages resulted in a catastrophic loss of life, suspension of elective surgical and medical care, and questions regarding the long-term impact on healthcare. Thus, it is essential that we continue to expand our knowledge based on the past two years of experience to facilitate decision-making going forward. In our study, we explored the effectiveness of preoperative COVID-19 screening protocols (routine testing and symptom screening) to provide supportive data for an evidence-based approach for preoperative COVID-19 screening in the pediatric population. We also investigated how patient demographics associated with preoperative COVID-19 status. Although our study sample was not limited to plastic surgery cases alone, plastic surgeons often perform surgeries in conjunction with other specialties. Thus, a diverse sample of surgical specialties provides added relevance and generalizability to our study.

The COVID-19 positivity rate in our cohort was 0.5%, similar to other pediatric studies.[3,30,32–35] It has been suggested that lower positivity rates in children are in part a result of less frequent testing, as a consequence of asymptomatic presentation.[22] However, in the present study, all non-emergent cases (approximately 85% of the entire cohort) were tested preoperatively for SARS-CoV-2, regardless of symptom status. This suggests additional causes for lower positivity rates among children, such as inherent or behavioral protection against infection. From a biological

Table 2. COVID-19-related Symptoms Stratified by SARS-CoV-2 Test Result

Reported COVID-19 Symptoms, n (%)	Negative SARS-CoV-2 Test Result, n = 2885 Cases*	Positive SARS-CoV-2 Test Result, n = 15 Cases*	P
Cough	22 (0.8)	0 (0.0)	
Fever	72 (2.5)	0 (0.0)	
Diarrhea	61 (2.1)	0 (0.0)	
Rhinorrhea	17 (0.6)	0 (0.0)	
Conjunctivitis	1 (<0.1)	0 (0.0)	
Skin symptoms†	11 (0.4)	1 (7.1)	
Muscle aches	2 (0.1)	0 (0.0)	—‡
Fatigue	27 (0.9)	0 (0.0)	
Loss of taste and/or smell	0 (0.0)	0 (0.0)	
Shortness of breath	59 (2.1)	0 (0.0)	
Other§	1 (<0.1)	0 (0.0)	
Any symptom	220 (7.6)	1 (7.1)	>0.99

*Symptom percentages do not total 100% as cases could present with multiple symptoms.
†Inclusive of rash or red pigmentation to skin.
‡Analyses not conducted.
§Lung congestion.

Table 3. Demographic and Clinical Data Stratified by SARS-CoV-2 Test Result

	Negative SARS-CoV-2 Test Result, n = 2885 Cases	Positive SARS-CoV-2 Test Result, n = 15 Cases	*P*
Median (IQR) age at preoperative screening, y	8.0 (12.8)	15.6 (7.0)	**0.04**
Sex, n (%)			
Male	1603 (55.6)	6 (40.0)	0.23
Female	1282 (44.4)	9 (60.0)	
Race, n (%)			
Non-white*	544 (25.3)	9 (69.2)	**0.001**
White	1610 (74.7)	4 (30.8)	
Ethnicity, n (%)†			
Hispanic or Latino	265 (13.8)	5 (41.7)	**0.006**
Not Hispanic or Latino	1651 (86.2)	7 (58.3)	
ASA class, n (%)			
1	698 (24.8)	0 (0.0)	—‡
2	1197 (42.6)	6 (46.2)	
3	719 (25.6)	6 (46.2)	
4	187 (6.7)	1 (7.7)	
5	10 (0.4)	0 (0.0)	
ASA physical status, n (%)			
Non-emergent	2400 (85.4)	12 (85.7)	>0.99
Emergent	411 (14.6)	2 (14.3)	
Surgical service, n (%)			
Orthopedics	521 (18.1)	1 (6.7)	—‡
Otolaryngology	507 (17.6)	2 (13.3)	
General	489 (16.9)	6 (40.0)	
Gastrointestinal	274 (9.5)	0 (0.0)	
Genitourinary	201 (7.0)	0 (0.0)	
Cardiology	173 (6.0)	1 (6.7)	
Plastic and oral	163 (5.6)	0 (0.0)	
Neurology	161 (5.6)	1 (6.7)	
Eye	117 (4.1)	0 (0.0)	
Oncology	108 (3.7)	3 (20.0)	
Dental	50 (1.7)	0 (0.0)	
Pain	50 (1.7)	0 (0.0)	
Gynecology	35 (1.2)	1 (6.7)	
Medical	14 (0.5)	0 (0.0)	
Pulmonary	13 (0.5)	0 (0.0)	
Dermatology	9 (0.3)	0 (0.0)	

*Includes Asian, American Indian or Alaska Native, Black or African American and other. Cases with undisclosed race were excluded from analysis.
†Cases with undisclosed ethnicities were excluded from this analysis.
‡Analysis not conducted.

standpoint, differential ACE2 receptor expression, fewer risk factors, and differences in innate and adaptive immunity have been postulated as potential justifications for low pediatric infection rates.[13,36,37] On the social-behavioral level, others have suggested lack of travel, school closures, and fewer activities outside the home as possible explanations.[11,13] Of note, the majority of data from this study, similar to other pediatric surgical studies, were collected in the latter part of the 2019–2020 academic year and into the early summer (March–July). In the regions where data were collected for the present (Massachusetts) and previous studies (Texas, Pennsylvania, and Washington), state mandated school closures were instituted during these periods, preventing in-person learning and after-school activities.[3,30,38]

Lower morbidity and mortality figures have contributed to the misconception that children are not significantly impacted by COVID-19, especially early in the pandemic.[7,16] Review of COVID-19 (+) surgical cases in our study similarly revealed only one death, and no postoperative complications, or unexpected readmissions or reoperations, analogous to another pediatric study.[39] More recently, however, there was a 10-fold increase in weekly hospitalizations due to COVID-19 from June 2021 to August 2021 in children 0–4 years of age, which coincided with emergence of the Delta variant.[40] These data emphasize the previously overlooked vulnerability of children to this virus, and highlight an immediate need to establish COVID-19 testing protocols for children in the operative setting.

In an effort to control COVID-19 transmission in the operative setting, including patient to patient, and patient to provider, it is of primary importance to identify COVID-19 (+) patients. Standard screening questions for COVID-19-related symptoms have become ubiquitous. However, the effectiveness of this symptom-based approach remains unclear in the pediatric preoperative setting. Our study found no significant difference in the presence of symptoms by SARS-CoV-2 test status. These data contrast a previous letter which showed that preoperative COVID-19 (+) pediatric patients were more likely to be symptomatic.[30] The difference may reflect a larger sample size or longer study period relative to the mentioned study. In addition, approximately 93% of COVID-19 (+) cases in our cohort were asymptomatic, considerably higher than several other pediatric studies in which testing was conducted primarily due to exposure and/or presence of symptoms (asymptomatic range: 14.2%–28%), rather than routine screening.[18,22–24] This difference may be due to the underlying reason for testing in associating symptoms to positivity rates. Our data suggest that rigorous preoperative testing rather than screening questions is essential to identify COVID-19 positive children preoperatively. In emergent instances when patients cannot be tested preoperatively, we suggest they be treated as COVID-19 (+) (even when asymptomatic), and established precautions should be exercised.

We also found that patients in our study who tested positive for SARS-CoV-2 were significantly older than those who tested negative (median 15.6 versus 8.0 years), mirroring a prior study.[30] The behavioral independence and increased social interaction in older children may account for this finding. However, with the lifting of school closure mandates for the 2021–2022 academic year, schools have largely returned to in-person learning and after-school activities despite transmission of the Delta variant, and appearance of the Omicron variant.[41,42] As a result, the above age difference is likely to be diminished with this return over time.

With the opening of schools, emergence of the Omicron variant, and younger students only now becoming eligible for vaccination, a reliance on behavioral protections (masking, handwashing, and social distancing), is still critical to preventing infection.[14,15] However, even in parts of the country with school mask mandates, there have still been outbreaks among children.[12] Given the published effectiveness of masks when donned correctly, these outbreaks suggest that difficulty in managing protective behavioral habits (such as consistent masking) is, and will likely continue to be, a strong contributor to rising infections in children.[43] Although it is important to acknowledge that interactions at school and during school-related activities are not necessarily the only sources of pediatric transmission, a recent study showed that there were significantly greater increases in pediatric SARS-CoV-2 infections in areas of the United States without school mask mandates, relative to those with them.[10] This further supports the importance of masking and other behavioral mitigation strategies.

Racial, socioeconomic, and other demographic disparities have been well-documented throughout the pandemic.[2,3,6,44,45] We found that children from racially marginalized families had 570% increased odds of testing positive for SARS-CoV-2 relative to white patients. A similar trend was seen for children who were Hispanic or Latino (350% increase), compared to those who were not. These findings align with those of previous adult and pediatric series, but contrast a recent letter.[3,6,30,44,46] Although a comprehensive analysis of the determinants underlying these trends is beyond the scope of this study, there are several potential contributing factors to be noted. Those who are racially/ethnically marginalized often live in multigenerational homes and crowded areas that do not lend to efficient social distancing, propagating viral spread.[5] Additionally, inequities related to access to healthcare predispose racially/ethnically marginalized families to underlying conditions (asthma, diabetes, etc.), which are all risk factors for severe COVID-19.[47–50]

Median household income analyses produced equally interesting results. Analogous to other pediatric and adult data publications, we found that patients testing positive for SARS-CoV-2 resided in areas with significantly lower median household incomes relative to patients testing negative.[44,45] Similar to trends seen for racially/ethnically marginalized individuals, barriers such as the ability to access insurance, quality education and healthcare, and adequate diets for low-income families may result in increased risks for underlying conditions and COVID-19.[47,50–53] These data, in combination with the observed racial/ethnic disparities, further highlight the need to address underlying social determinants of health both within and outside of the context of COVID-19.

Limitations of our study should be acknowledged. This study was performed at a single, tertiary pediatric care facility in the Northeastern United States, and thus results may not be generalizable to other institutions. Additionally, conclusions could change based on the circulating variant. The study was conducted over a relatively short period, with a small COVID-19 (+) sample on which to base conclusions. Furthermore, approximately 25% and 33% of patients did not report their race and ethnicity, respectively. Thus, analyses using these data may be over- or underestimated.

The hospital query used to identify COVID-19 (+) cases relied on the correct ICD-10 coding. COVID-19 (+) cases incorrectly defined by a code other than U07.1 would not have been captured in our query. Similarly, symptoms were determined based on documentation in the medical record. Incomplete documentation of symptoms could also have underestimated overall COVID-19 symptoms in our pediatric cohort.

Moreover, it is important to acknowledge that our institution's preoperative SARS-CoV-2 testing requirement, irrespective of symptom status, may have biased this study toward asymptomatic patients. It is possible that symptomatic patients scheduled for non-emergent procedures may have elected to cancel their surgery without undergoing testing. As a result, the relative percentage of asymptomatic to symptomatic patients may be overestimated.

CONCLUSIONS AND RECOMMENDATIONS

Accurate and universal preoperative testing is essential to identify pediatric patients infected with SARS-CoV-2 before surgery. Furthermore, screening practices reliant on symptoms alone are ineffective. In light of only newly expanded vaccination eligibility by age, and continued prevalence and emergence of the Delta and Omicron variants respectively, we strongly recommend that all nonemergent patients undergo preoperative SARS-CoV-2 testing, regardless of symptom status. When COVID-19 reaches an endemic stage, we would suggest testing only during local/regional surges. However, as we continue to navigate emerging variants/surges at present, preoperative testing of all non-emergent pediatric patients is recommended.[54]

In our sample, patients from racially/ethnically marginalized communities, and those of lower relative economic status were more likely to test positive for SARS-CoV-2. Additional investigation is necessary to address the underlying health determinants responsible for these inequities.

Brian I. Labow, MD, FACS, FAAP
Department of Plastic and Oral Surgery
Boston Children's Hospital and Harvard Medical School
300 Longwood Avenue
Hunnewell 1
Boston, MA 02115
E-mail: brian.labow@childrens.harvard.edu

REFERENCES

1. Inagaki K, Garg P, Hobbs CV. SARS-CoV-2 positivity rates among children of racial and ethnic minority groups in Mississippi. *Pediatrics.* 2021;147:e2020024349.
2. Shah M, Sachdeva M, Dodiuk-Gad RP. COVID-19 and racial disparities. *J Am Acad Dermatol.* 2020;83:e35.
3. Adler AC, Shah AS, Blumberg TJ, et al. Symptomatology and racial disparities among children undergoing universal preoperative COVID-19 screening at three US children's hospitals: early pandemic through resurgence. *Paediatr Anaesth.* 2021;31:368–371.
4. Karmakar M, Lantz PM, Tipirneni R. Association of social and demographic factors with COVID-19 incidence and death rates in the US. *JAMA Netw Open.* 2021;4:e2036462.
5. Webb Hooper M, Nápoles AM, Pérez-Stable EJ. COVID-19 and racial/ethnic disparities. *JAMA.* 2020;323:2466–2467.
6. Boserup B, McKenney M, Elkbuli A. Disproportionate impact of COVID-19 pandemic on racial and ethnic minorities. *Am Surg.* 2020;86:1615–1622.
7. Centers for Disease Control and Prevention (CDC). COVID data tracker. Available at https://covid.cdc.gov/covid-data-tracker/#demographics. Published 2021. Accessed May 27, 2021.
8. Boehmer TK, DeVies J, Caruso E, et al. Changing age distribution of the COVID-19 pandemic—United States, May-August 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69:1404–1409.
9. American Academy of Pediatrics. Children and COVID-19: state-level data report, version 9/30/2021. Available at https://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/children-and-covid-19-state-level-data-report/. Published 2021. Accessed November 24, 2021.
10. Budzyn SE, Panaggio MJ, Parks SE, et al. Pediatric COVID-19 cases in counties with and without school mask requirements—United States, July 1-September 4, 2021. *MMWR Morb Mortal Wkly Rep.* 2021;70:1377–1378.
11. Dattner I, Goldberg Y, Katriel G, et al. The role of children in the spread of COVID-19: Using household data from Bnei Brak, Israel, to estimate the relative susceptibility and infectivity of children. *PLoS Comput Biol.* 2021;17:e1008559.
12. Jehn M, McCullough JM, Dale AP, et al. Association between K-12 school mask policies and school-associated COVID-19 outbreaks—Maricopa and Pima Counties, Arizona, July-August 2021. *MMWR Morb Mortal Wkly Rep.* 2021;70:1372–1373.
13. Sinaei R, Pezeshki S, Parvaresh S, et al. Why COVID-19 is less frequent and severe in children: a narrative review. *World J Pediatr.* 2021;17:10–20.
14. Centers for Disease Control and Prevention (CDC). Guidance for COVID-19 prevention in K-12 schools. Available at https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/k-12-guidance.html. Published 2022. Accessed March 3, 2022.
15. Centers for Disease Control and Prevention (CDC). COVID-19 vaccines for children and teens. Available at https://www.cdc.gov/coronavirus/2019-ncov/vaccines/recommendations/children-teens.html. Published 2022. Accessed March 3, 2022.
16. Ludvigsson JF. Systematic review of COVID-19 in children shows milder cases and a better prognosis than adults. *Acta Paediatr.* 2020;109:1088–1095.
17. Balasubramanian S, Rao NM, Goenka A, et al. Coronavirus disease 2019 (COVID-19) in children - what we know so far and what we do not. *Indian Pediatr.* 2020;57:435–442.
18. Cui X, Zhao Z, Zhang T, et al. A systematic review and meta-analysis of children with coronavirus disease 2019 (COVID-19). *J Med Virol.* 2021;93:1057–1069.
19. Colson P, Tissot-Dupont H, Morand A, et al. Children account for a small proportion of diagnoses of SARS-CoV-2 infection and do not exhibit greater viral loads than adults. *Eur J Clin Microbiol Infect Dis.* 2020;39:1983–1987.
20. Dhochak N, Singhal T, Kabra SK, et al. Pathophysiology of COVID-19: why children fare better than adults? *Indian J Pediatr.* 2020;87:537–546.
21. Centers for Disease Control (CDC) Response Team. Coronavirus disease 2019 in children—United States, February 12-April 2, 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69:422-426.
22. de Souza TH, Nadal JA, Nogueira RJN, et al. Clinical manifestations of children with COVID-19: a systematic review. *Pediatr Pulmonol.* 2020;55:1892–1899.
23. Lu X, Zhang L, Du H, et al; Chinese Pediatric Novel Coronavirus Study Team. SARS-CoV-2 infection in children. *N Engl J Med.* 2020;382:1663–1665.
24. Qiu H, Wu J, Hong L, et al. Clinical and epidemiological features of 36 children with coronavirus disease 2019 (COVID-19) in Zhejiang, China: an observational cohort study. *Lancet Infect Dis.* 2020;20:689–696.
25. Xie J, Ding C, Li J, et al. Characteristics of patients with coronavirus disease (COVID-19) confirmed using an IgM-IgG antibody test. *J Med Virol.* 2020;92:2004–2010.
26. Diorio C, McNerney KO, Lambert M, et al. Evidence of thrombotic microangiopathy in children with SARS-CoV-2 across the spectrum of clinical presentations. *Blood Adv.* 2020;4:6051–6063.
27. Lee EH, Kepler KL, Geevarughese A, et al. Race/ethnicity among children with COVID-19-associated multisystem inflammatory syndrome. *JAMA Netw Open.* 2020;3:e2030280.
28. Synhorst DC, Bettenhausen JL, Hall M, et al. Healthcare encounter and financial impact of COVID-19 on children's hospitals. *J Hosp Med.* 2021;16:223–226.
29. Farid Y, Schettino M, Kapila AK, et al. Decrease in surgical activity in the COVID-19 pandemic: an economic crisis. *Br J Surg.* 2020;107:e300.
30. Lin EE, Blumberg TJ, Adler AC, et al. Incidence of COVID-19 in pediatric surgical patients among 3 US children's hospitals. *JAMA Surg.* 2020;155:775–777.
31. United States Census Bureau. Income in the past 12 months (In 2019 inflation-adjusted dollars). Available at https://data.census.gov/cedsci/table?q=United%20States&t=Income%20%28Households,%20Families,%20Individuals%29%3AIncome%20and%20Poverty&tid=ACSST5Y2019.S1901&hidePreview=false. Published 2019. Accessed April 1, 2021.
32. Ladhani SN, Amin-Chowdhury Z, Davies HG, et al. COVID-19 in children: analysis of the first pandemic peak in England. *Arch Dis Child.* 2020;105:1180–1185.
33. Livingston E, Bucher K. Coronavirus disease 2019 (COVID-19) in Italy. *JAMA.* 2020;323:1335.
34. The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) - China, 2020. *China CDC Wkly.* 2020;2:113-122.
35. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. *JAMA.* 2020;323:1239–1242.
36. Steinman JB, Lum FM, Ho PP, et al. Reduced development of COVID-19 in children reveals molecular checkpoints gating

pathogenesis illuminating potential therapeutics. *Proc Natl Acad Sci USA*. 2020;117:24620–24626.
37. Williams PCM, Howard-Jones AR, Hsu P, et al. SARS-CoV-2 in children: spectrum of disease, transmission and immunopathological underpinnings. *Pathology*. 2020;52:801–808.
38. Eduction Week. Map: coronavirus and school closures in 2019-2020. Available at https://www.edweek.org/leadership/map-coronavirus-and-school-closures-in-2019-2020/2020/03. Published 2020. Accessed July 15, 2021.
39. Mehl SC, Loera JM, Shah SR, et al. Favorable postoperative outcomes for children with COVID-19 infection undergoing surgical intervention: experience at a free-standing children's hospital. *J Pediatr Surg*. 2021;56:2078–2085.
40. Delahoy MJ, Ujamaa D, Whitaker M, et al; COVID-NET Surveillance Team; COVID-NET Surveillance Team. Hospitalizations associated with COVID-19 among children and adolescents—COVID-NET, 14 States, March 1, 2020-August 14, 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70:1255–1260.
41. Centers for Disease Control and Prevention (CDC). Delta variant: what we know about the science. Available at https://www.cdc.gov/coronavirus/2019-ncov/variants/delta-variant.html. Published 2021. Accessed November 24, 2021.
42. Centers for Disease Control and Prevention (CDC). Omicron variant: what you need to know. Available at https://www.cdc.gov/coronavirus/2019-ncov/variants/omicron-variant.html. 2021. Accessed December 17, 2021.
43. Hendrix MJ, Walde C, Findley K, et al. Absence of apparent transmission of SARS-CoV-2 from two stylists after exposure at a hair salon with a universal face covering policy—Springfield, Missouri, May 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69:930–932.
44. Goyal MK, Simpson JN, Boyle MD, et al. Racial and/or ethnic and socioeconomic disparities of SARS-CoV-2 infection among children. *Pediatrics*. 2020;146:e2020009951.
45. Baena-Díez JM, Barroso M, Cordeiro-Coelho SI, et al. Impact of COVID-19 outbreak by income: hitting hardest the most deprived. *J Public Health (Oxf)*. 2020;42:698–703.
46. Abedi V, Olulana O, Avula V, et al. Racial, economic, and health inequality and COVID-19 infection in the United States. *J Racial Ethn Health Disparities*. 2021;8:732–742.
47. Sharma SV, Chuang RJ, Rushing M, et al. Social determinants of health-related needs during COVID-19 among low-income households with children. *Prev Chronic Dis*. 2020;17:E119.
48. Artiga S, Garfield R, Orgera K. Communities of color at higher risk for health and economic challenges due to COVID-19. Available at https://www.kff.org/coronavirus-covid-19/issue-brief/communities-of-color-at-higher-risk-for-health-and-economic-challenges-due-to-covid-19/. Published 2020. Accessed May 25, 2021.
49. Mayo Clinic. COVID-19: who's at higher risk of serious symptoms? Available at https://www.mayoclinic.org/diseases-conditions/coronavirus/in-depth/coronavirus-who-is-at-risk/art-20483301. Published 2021. Accessed May 25, 2021.
50. Fiscella K, Franks P, Gold MR, et al. Inequality in quality: addressing socioeconomic, racial, and ethnic disparities in health care. *JAMA*. 2000;283:2579–2584.
51. Devoe JE, Baez A, Angier H, et al. Insurance + access not equal to health care: typology of barriers to health care access for low-income families. *Ann Fam Med*. 2007;5:511–518.
52. Fiscella K, Williams DR. Health disparities based on socioeconomic inequities: implications for urban health care. *Acad Med*. 2004;79:1139–1147.
53. Lazar M, Davenport L. Barriers to health care access for low income families: a review of literature. *J Community Health Nurs*. 2018;35:28–37.
54. Anesthesia Patient Safety Foundation, American Society of Anesthesiologists. American Society of Anesthesiologists and the Anesthesia Patient Safety Foundation statement on perioperative testing for the COVID-19 virus. Available at https://www.apsf.org/news-updates/asa-and-apsf-joint-statement-on-perioperative-testing-for-the-covid-19-virus/. Published 2021. Accessed April 14, 2022.