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Racial/Ethnic and Socioeconomic Disparities of SARS-CoV-2 Infection Among Children

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Abbreviations:

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)

Non-Hispanic (NH)

Median family income (MFI)

Odds ratio (OR)

Confidence interval (CI)

What's Known on This Subject: Racial/ethnic and socioeconomic disparities in SARS-CoV-2 infection have been reported among adults, but are understudied in relation to infection risk in children.

What this Study Adds: In this cross-sectional study of a large cohort of children tested in the United States for SARS-CoV-2 through an exclusively pediatric drive-through/walk-up testing site, rates of SARS-CoV-2 infection were disproportionately higher among minority and socioeconomically disadvantaged youth.

Contributors' Statement Page:

Dr. Goyal conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript.

Dr. Simpson conceptualized and designed the study, designed the data collection instruments, coordinated and supervised data collection, and reviewed and revised the manuscript.

Ms. Boyle and Ms. Badolato collected data, carried out the initial analyses, and reviewed and revised the manuscript.

Dr. Delaney coordinated and supervised data collection, and reviewed and revised the manuscript.

Dr. McCarter supervised and conducted the analyses, and reviewed and revised the manuscript.

Dr. Cora-Bramble conceptualized and designed the study, and reviewed and revised the manuscript.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

ABSTRACT

Objective: To evaluate racial/ethnic and socioeconomic differences in rates of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection among children.

Methods: We performed a cross-sectional study of children tested for SARS-CoV-2 at an exclusively pediatric drive-through/walk-up SARS-CoV-2 testing site from March 21-April 28, 2020. We performed bivariable and multivariable logistic regression to measure the association between patient race/ethnicity and estimated median family income (MFI) based on census block group estimates with: 1) SARS-CoV-2 infection and 2) reported exposure to SARS-CoV-2.

Results: Of 1000 children tested for SARS-CoV-2 infection, 20.7% tested positive. In comparison to non-Hispanic (NH)-whites (7.3%), minority children had higher rates of infection (NH-black: 30.0%; adjusted OR 2.3 [95% CI 1.2, 4.4]; Hispanic: 46.4%; adjusted OR 6.3 [95% CI 3.3, 11.9]). In comparison to children in the highest MFI quartile (8.7%), infection rates were higher among children in quartile 3 (23.7%; adjusted OR 2.6 [95% CI 1.4, 4.9]; quartile 2 (27.1%; adjusted OR 2.3 [95% CI 1.2, 4.3], and quartile 1 (37.7%; adjusted OR 2.4 [95% CI 1.3, 4.6]). Rates of reported exposure to SARS-CoV-2 also differed by race/ethnicity and socioeconomic status.

Conclusions: In this large cohort of children tested for SARS-CoV-2 through a community-based testing site, racial/ethnic minorities and socioeconomically disadvantaged children carry the highest burden of infection. Understanding and addressing the causes of these differences are needed to mitigate disparities and limit the spread of infection.

INTRODUCTION

Racial/ethnic and socioeconomic-related disparities in health outcomes have been reported for years, across multiple clinical conditions.¹ The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic has served to shine a spotlight on and amplify such disparities, as reports indicate that racial/ethnic minorities and socioeconomically disadvantaged populations are the most severely impacted.

More than 1.5 million cases of SARS-CoV-2 infection have been diagnosed in the United States, and children are estimated to comprise approximately 50,000 of those cases.² Recent data highlight the disproportionate burden of SARS-CoV-2-related illness and death on racial/ethnic

minorities among adults.³⁻⁵ Additional data further suggest that low socioeconomic status may further exacerbate health outcomes for racial and ethnic minorities.⁴

Data regarding disparities in SARS-CoV-2 infection and outcomes have been, thus far, mostly limited to adults. It is unknown whether such disparities extend to children as well. The primary objective of this study was to investigate the presence of racial/ethnic and socioeconomic disparities in rates of SARS-CoV-2 infection in a large sample of non-acutely ill children who were tested at an exclusively pediatric drive-through/walk-up SARS-CoV-2 testing site.

METHODS

Study Design

This was a planned cross-sectional analysis of a registry of children tested for SARS-CoV-2 at an exclusively pediatric drive-through/walk-up urban SARS-CoV-2 testing site from March 21, 2020 through April 28, 2020. This SARS-CoV-2 specimen collection site is affiliated with a tertiary care urban children's hospital. This service was funded through philanthropic support; therefore, patients seeking this service did not incur any out of pocket charges. To broaden access to those without motor vehicles, the testing site also allowed for walk-up testing. Targeted outreach to non-English speaking communities was also conducted in order to advertise this service to all communities. Furthermore, interpreters proficient in Spanish and Ahmaric were present at the testing site daily to assist non-English speaking families, and translated information material was made available to all. The institutional review board approved this study and provided a waiver of informed consent as this was a post hoc analysis of previously collected data.

Study Population

Children between the ages of 0-22 years with mild symptoms not requiring acute medical care were eligible to be tested at this site with a physician referral. Age criteria for access to the testing site were consistent with the policies of the affiliated children's hospital and primary care practices. Physicians could refer patients through the use of an electronic portal available on the hospital website if they met age criteria, reported mild symptoms, and had at least one of the following: known exposure, high risk status, family member with high risk status, required testing for work. The online referral form included patient demographics (name, age, sex, race/ethnicity, and address), reported symptoms, and reason for referral.

The testing site, located within one mile of the hospital at an outdoor enclosed parking lot of a local university, offered testing two to three times per week, including weekends, between the hours of 10am and 2pm. Because the testing site was not equipped to provide any medical management, patients who appeared ill were immediately rerouted to the hospital prior to receipt of SARS-CoV-2 testing.

Outcomes and Exposures

The primary outcome was rate of SARS-CoV-2 positivity. Trained staff collected nasopharyngeal or throat swabs which were refrigerated and sent to an offsite commercial laboratory (Quest Diagnostics, Inc) for PCR testing. Quest Diagnostics publishes that they use four different United States Food and Drug Administration granted Emergency Use Authorization molecular tests including a laboratory-developed test (LDT), COBAS Roche Diagnostics test, Hologic Panther Fusion test, and Hologic Panther Covid-19 molecular assay. The published limits of detection of these tests are the following: Quest LDT 136 copies/mL; Roche 0.009 TCID₅₀/mL (TCID₅₀ is defined as median tissue culture infectious dose) and both

Hologic tests are 0.01 TCID₅₀/mL. The secondary outcome included patient/family reported SARS-CoV-2 exposure status based on data from the standardized online referral form.

Exposure variables were race/ethnicity and socioeconomic status. Consistent with other studies, race/ethnicity was categorized as non-Hispanic (NH) black, NH-white, Hispanic, and other.⁶⁻⁸ We used median family income (MFI) by census block group from the American Communities Survey 2014-2018 as a proxy for socioeconomic status. The American Communities Survey uses 5-year estimates derived from home address to estimate median family income.⁹ MFI was then categorized into quartiles. Potential confounding variables included age and sex.

Statistical Analysis

We used means and frequency analyses to describe the study population and calculate unadjusted SARS-CoV-2 positivity rates. Home addresses were geocoded using ArcGIS Pro (Version 2.5.1) to create a point layer for all patients. The point layer was spatially joined with a census block group polygon layer and then merged with ACS population level data by census block group to derive median family income.

Bivariable and multivariable logistic regression analyses were developed to estimate unadjusted and adjusted odds ratios (OR) to assess the strength of association of race/ethnicity and socioeconomic status with the outcome measures. We tested for an interaction between race/ethnicity and SES but only retained interactions that were statistically significant, and thus the interaction was excluded from the final models. Linear regression analysis was used to assess trends in rates of SARS-CoV-2 infection over the study period among each racial/ethnic group. Estimates derived from the multivariable models included adjusted odds ratios with 95%

confidence intervals (CI) and adjusted probabilities. All analyses were conducted using Stata 16.0 (College Station, TX).

RESULTS

Characteristics of Study Population:

During the study period, 1000 children were tested for SARS-CoV-2 at the drive-through/walk-up specimen collection site. The median age was 8.0 (IQR 2.0, 14.0) years and 52.3% were male.

Of the children tested, approximately one-third were of NH-black and one-quarter were of Hispanic race/ethnicity. Median family income ranged from \$11,667 to more than \$250,000. Approximately one-third (29.1%) had a median family income below the national median family income of \$78,500. (**Table 1, Figure 1a**). Median family income differed by race/ethnicity, with significantly lower median family income for minority youth (MFI NH-white: \$161,250; NH-black: \$92,188, $p<0.001$; Hispanic: \$75,114, $p<0.001$; other: \$139,568, $p=0.001$).

Disparities in SARS-CoV-2 Positivity Rates

Of the 1000 children tested, 207 (20.7%) tested positive for SARS-CoV-2. The median age of those testing positive was 11.0 (IQR 5.0, 16.0) years and 47.8% were male.

Positivity rates for SARS-CoV-2 differed by race/ethnicity. In comparison to NH-white children (7.3%), NH-black (30.0%, OR 3.3 [95% CI 1.8, 5.9]), and Hispanic (46.4%, OR 9.1 [95% CI 5.1, 16.4]), children had higher rates of SARS-CoV-2 infection. (**Figure 2, Table 2**) After adjustment for age, sex, and MFI, minority children had a greater likelihood of SARS-CoV-2 infection compared to NH-white children (NH-black (aOR: 2.3 [95% CI: 1.2, 4.4]; Hispanic (aOR: 6.3 [95% CI: 3.3, 11.9]. (**Table 2**) Furthermore, positivity rates among Hispanic

children increased over time (p -trend=0.002), but not among other racial/ethnic groups. (**Figure 3**)

Positivity rates for SARS-CoV-2 infection also differed by MFI (**Figure 1b**). Children residing in households of lower MFI had higher rates of positivity compared to those residing in households with the highest MFI. In comparison to children in the highest MFI quartile (8.7%), SARS-CoV-2 infection rates were higher among children in quartile 3 (23.7%, OR 3.2 [95% CI: 1.8, 5.6]); quartile 2 (27.1%; OR 3.8 [95% CI: 2.1, 6.6]), and quartile 1 (37.7%, OR 5.9 [95% CI: 3.4, 10.3]). (**Figure 2, Table 2**) In the fully-adjusted model, rates of SARS-CoV-2 positivity were higher among children within the lowest MFI quartiles compared to quartile 4 (Quartile 3: aOR: 2.6 [95% CI: 1.4, 4.9]; Quartile 2: aOR: 2.3 [95% CI: 1.2, 4.3]; Quartile 1: 2.4 [95% CI: 1.3, 4.6]). (**Table 2**)

Disparities in Exposure Status

Of the 1000 children tested, 106 (10.6%) reported exposure to SARS-CoV-2. Reports of exposure to SARS-CoV-2 infected people differed by race/ethnicity. In comparison to NH-white children (11.3%), NH-black children (34.9%; aOR 2.3 [95% CI 1.0, 5.1]) and children of other racial/ethnic groups (19.8%; aOR 2.5 [95% CI 1.1, 5.8]) reported higher rates of a known exposure. Furthermore, patient/family reported exposure also differed by MFI, with higher rates of exposure in less socioeconomically advantaged households (quartile 4: 12.3%; quartile 2: 29.3%, aOR 2.4 [95% CI 1.1, 5.2]). (**Table 3**)

DISCUSSION

In this large cohort of children tested for SARS-CoV-2 virus through community-based testing, we found evidence of both racial/ethnic- and socioeconomic-related disparities in SARS-

CoV-2 infection. Specifically, minority and socioeconomically disadvantaged children had a higher likelihood of SARS-CoV-2 infection. Furthermore, these observed racial/ethnic disparities in infection rates only slightly attenuated after adjustment for socioeconomic status.

Our findings of disproportionately higher rates of SARS-CoV-2 infection among minority youth mirror that found in recent adult literature. For instance, Millet and colleagues found that US counties with higher populations of black residents had disproportionately higher rates of SARS-CoV-2 related infection and deaths, beyond adjustment for sociodemographics, comorbidities, and socioeconomic determinants.³ Similarly, through an analysis using health system data in California, Azar and colleagues found higher rates of SARS-CoV-2 infection among black adults compared to white patients after adjustment for median household income.⁵

Although it was beyond the scope of this study to understand the causes for these differential rates of infection, the causes may be multifactorial, and include, but are not limited to structural factors, poorer access to health care, limited resources, as well as bias and discrimination. For instance, structural factors may prevent minorities from practicing social distancing, and thus, limiting exposure. Minorities are disproportionately over-represented in ‘essential’ service industries that require travel and face-to-face interactions.^{10, 11} When working in the food service industry, health care, and transportation, teleworking and ‘sheltering in place’ may not be feasible. Additionally, minorities have higher reliance on public transportation and are more likely to live in crowded settings, such as public housing, compared to NH-whites.^{12, 13} Furthermore, minorities have higher rates of living in multigenerational households, thus, increasing opportunities for exposure to older adults who may be more vulnerable to infection.¹⁴ In fact, our data indicate that minority youth had higher likelihood of reporting exposure to SARS-CoV-2 compared to NH-white youth. Another explanation for the disproportionately

higher rates of SARS-CoV-2 infection among minority youth may be due to prior experiences of bias and discrimination, which can lead to distrust of the healthcare system and delays in seeking care,¹⁵ and thus, spread of infection to household members.

Rates of SARS-CoV-2 infection were higher among Hispanic than NH-black or NH-white children. This finding is similar to that recently reported by Martinez and colleagues.¹⁶ A study on differences in measures of exposure to H1N1 by race/ethnicity demonstrated that when compared to NH-whites and NH-blacks, Hispanics had the highest rates of living in metropolitan areas, in apartment buildings, and with a larger household size. Hispanics also reported the highest rates of difficulty in avoiding public transportation, lowest rates in ability to telework, and the highest rates of difficulty obtaining childcare that was not with a group of children.¹⁷ Along with the aforementioned reasons for these disparities, Hispanic children may have experienced the most pronounced burden of infection due to compounding additional factors such as immigration status and language barriers. Furthermore, symptomatic adults may avoid testing due to fears of deportation.^{17, 18} Future work to ensure equitable allocation of testing and culturally appropriate prevention education may help improve early identification, quarantine, and distribution of resources to reduce community spread of disease.

The findings of this study should be considered in the context of several potential limitations. Race and ethnicity data were provided by the clinician at time of referral, not self-reported, and thus may be subject to misclassification bias. We used MFI from the American Communities Survey as a proxy for SES status, which may be another source of misclassification bias. However, to provide greater precision, estimates on MFI were based on census block group rather than zip code. Recent adult data demonstrate higher rates of morbidity and mortality among racial/ethnic minorities and socioeconomically disadvantaged groups. As

our study was conducted outside a clinical care setting, we could not assess disparities in morbidity and mortality. Access to the testing site required physician referral. Therefore, our findings of racial/ethnic and socioeconomic disparities in positivity rates may be an underestimate, as racial/ethnic and socioeconomically disadvantaged groups have less access to primary care physicians.¹⁹⁻²¹ In addition, referral to the testing site by clinicians may have been differentially provided, and advertisement of the testing site may not have been uniformly distributed among all potential referring clinicians. Furthermore, the testing site was available a few days per week and during the hours of 10am and 2pm which may not have been convenient for all. The testing site was located in a relatively low income neighborhood with a large proportion of minority residents. However, our data illustrate children of various socioeconomic backgrounds travelled across state lines to access the testing site. In addition, four different diagnostic tests were used for SARS-CoV-2 testing which was standard laboratory approach to keep up with test demand during this pandemic. It is unlikely that these polymerase chain reaction amplification-based tests were differentially distributed by patient race/ethnicity and/or MFI. Furthermore, we were unable to adjust for unmeasured confounding variables, including, but not limited to housing conditions or occupancy. Finally, as this was a single center study, these results may not be generalizable to other geographic locations with different racial/ethnic and socioeconomic compositions of their communities.

In conclusion, we found higher rates of SARS-CoV-2 infection among minority and socioeconomically disadvantaged children. Future research should confirm and extend this work by focusing on the modifiable reasons for these observed disparities as well as their differential impact in terms of SARS-CoV-2-related morbidity and mortality outcomes to mitigate the spread of infection and its health effects.

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Table 1. Demographics of Study Population

Demographic Characteristic	SARS-CoV-2 Tested n=1000 (%)
Age	
<1 year	89 (8.9)
1-4 years	282 (28.2)
5-11 years	279 (27.9)
12-17 years	222 (22.2)
≥18 years	128 (12.8)
Sex	
Male	523 (52.3)
Female	477 (47.7)
Race/Ethnicity	
NH-white	203 (20.3)
NH-black	304 (30.4)
Hispanic	229 (22.9)
Other	171 (17.1)
Unknown	93 (9.3)
Median Family Income (quartiles)	
Q4 [\$157,679->\$250,000]	236 (23.6)
Q3 [\$107,321-\$157,308]	237 (23.7)
Q2 [\$70,341-\$107,292]	236 (23.6)
Q1 [\$11,667-\$70,300]	237 (23.7)
Unknown	54 (5.4)

Figure 1. SARS-CoV-2 Testing and Positivity by Median Family Income

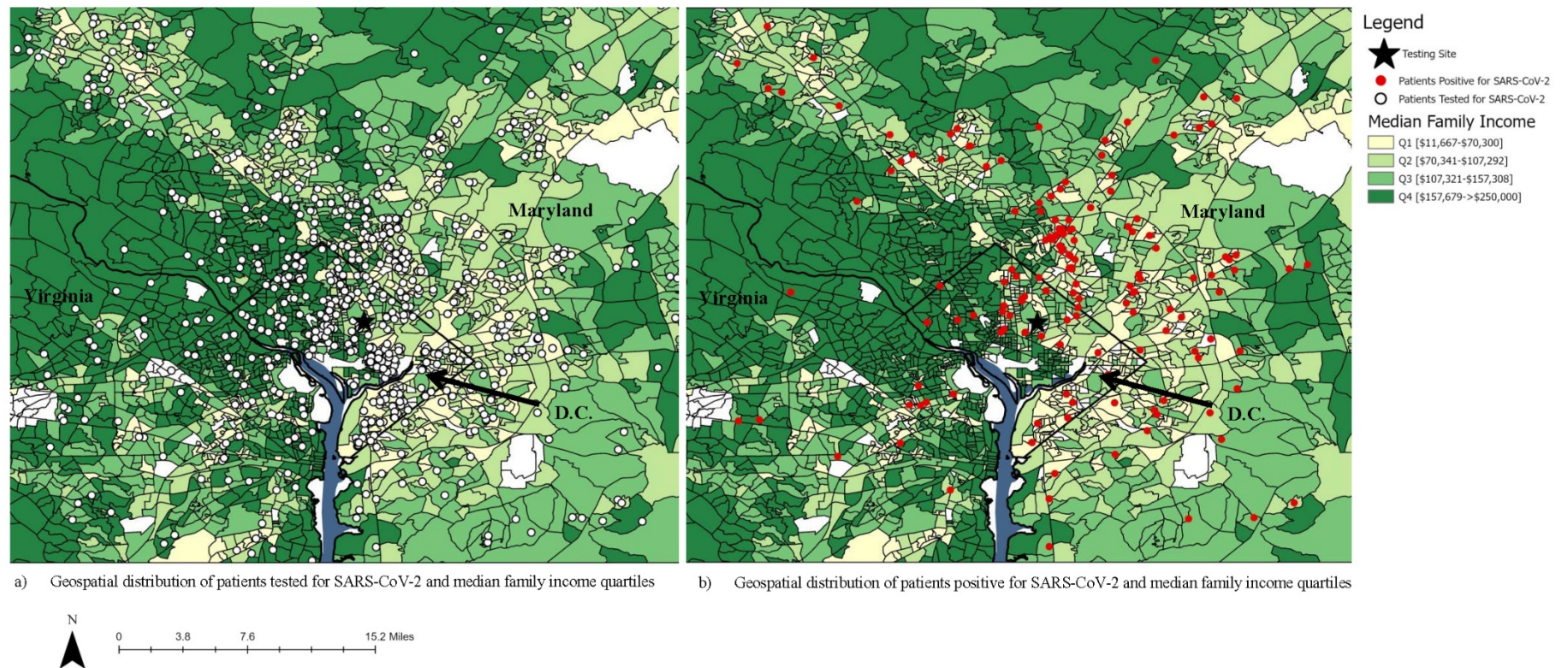


Figure 2. Rates of SARS-CoV-2 Infection by Race/Ethnicity and Socioeconomic Status

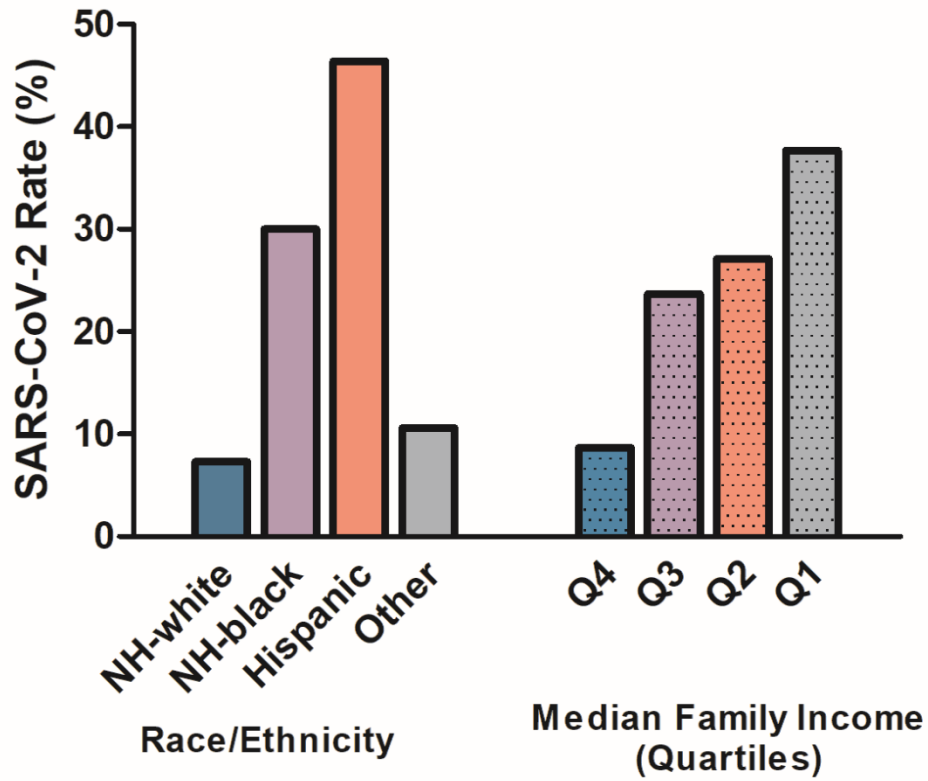


Table 2: Racial/Ethnic and Socioeconomic Factors Associated with SARS-CoV-2 Virus Positivity

Demographic Characteristic	OR (95% CI)	aOR (95% CI)^a
Race/Ethnicity		
NH-white	Reference	Reference
NH-black	3.3 (1.8, 5.9)	2.3 (1.2, 4.4)
Hispanic	9.1 (5.1, 16.4)	6.3 (3.3, 11.9)
Other	1.9 (0.9, 3.8)	1.8 (0.9, 3.7)
Median Family Income (quartiles)		
Q4: \$157,679->\$250,000	Reference	Reference
Q3: \$107,321-\$157,308	3.2 (1.8, 5.6)	2.6 (1.4, 4.9)
Q2: \$70,341-\$107,292	3.8 (2.1, 6.6)	2.3 (1.2, 4.3)
Q1: \$11,667-\$70,300	5.9 (3.4, 10.3)	2.4 (1.3, 4.6)

^a Adjusted for age, sex, race/ethnicity, and median family income.

Figure 3. Trends in Rates of SARS-CoV-2 Positivity over Study Period, by Race/Ethnicity

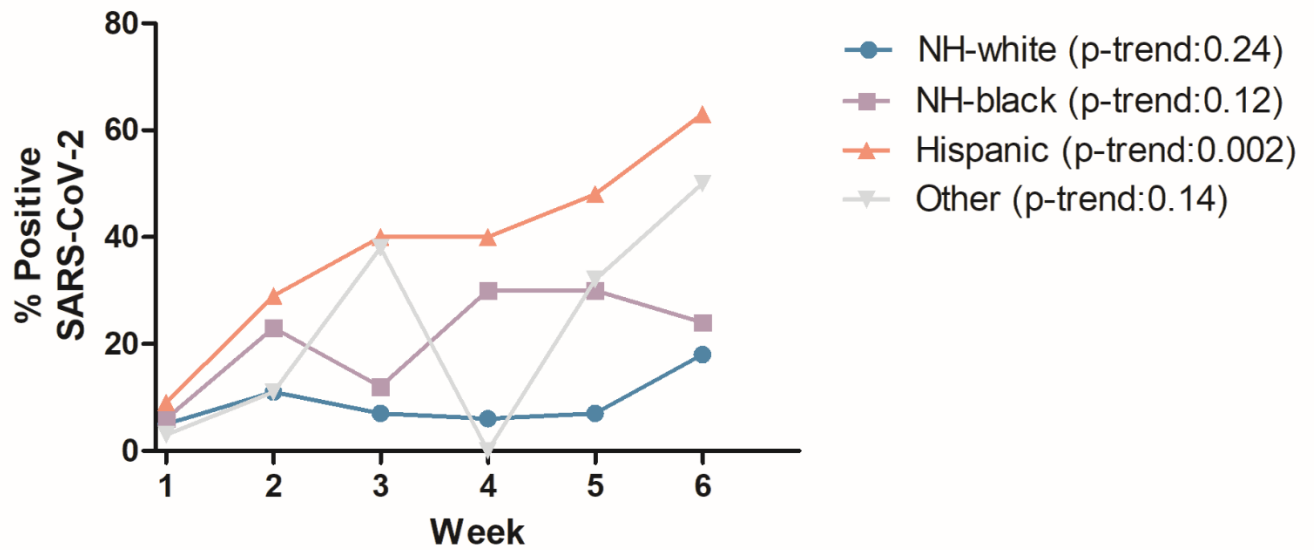


Table 3. Racial/Ethnic and Socioeconomic Factors Associated with Reported SARS-CoV-2 Virus Exposure

Demographic Characteristic	OR (95% CI)	aOR (95% CI)^a
Race/Ethnicity		
NH-white	Reference	Reference
NH-black	2.2 (1.1, 4.4)	2.3 (1.0, 5.1)
Hispanic	2.2 (1.1, 4.5)	1.9 (0.8, 4.4)
Other	2.0 (1.0, 4.5)	2.5 (1.1, 5.8)
Median Family Income (quartiles)		
Q4 [\$157,679->\$250,000]	Reference	Reference
Q3 [\$107,321-\$157,308]	2.0 (1.0, 4.1)	1.9 (0.9, 4.1)
Q2 [\$70,341-\$107,292]	2.6 (1.3, 5.1)	2.4 (1.1, 5.2)
Q1 [\$11,667-\$70,300]	2.5 (1.3, 4.9)	2.1 (0.9, 4.6)

^a Models adjusted for age, sex, race/ethnicity, and median family income.

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