



Mapping of Pediatric COVID-19 Cases in Miami-Dade and Broward Counties: an Analysis of Sociodemographic Disparities

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Abstract

Background Numerous studies have shown a disproportionate impact of COVID-19 infection on Black and Hispanic Americans in the adult patient population. However, few studies have been done with pediatric populations. The aim of this study is to identify the prevalence and distribution of COVID-19 cases among pediatric patients in Miami-Dade and Broward counties and identify any sociodemographic disparities.

Methods A total of 10,087 children/adolescents ages zero years-old to 20 years-old were tested from July 1, 2020, to December 31, 2020. ArcGIS was used to map cases and obtain sociodemographic data. SPSS software was used to determine significance of data trends and create a predictive model.

Results There were 1,161 pediatric COVID-19 cases detected. White Hispanics and Black Hispanics had statically significantly higher cases when compared to White non-Hispanics and Black non-Hispanics. Percentage of households on food stamps, percentage of households below the poverty line, percentage of minority populations, and percentage of Hispanic population showed a positive correlation with detected pediatric COVID-19 cases. Alternatively, areas with higher median household incomes and higher educational status were negatively correlated with COVID-19. Percentage of Hispanic population and percentage of households below the poverty line were predictive of pediatric COVID-19 cases.

Conclusion There was a disproportionate impact of pediatric COVID-19 infection on zip codes of lower socioeconomic status and increased racial/ethnic minority populations. This study demonstrates the need for public health policies that prioritize testing children/adolescents in these communities.

Keywords COVID-19 · Pediatrics · Health disparity · Sociodemographic

Background

The virus that caused the COVID-19 pandemic first emerged in Wuhan, China, in December 2019 [1]. As of May 13, 2022, in the USA, over 82 million cases have been reported with over 996,000 deaths [2]. In the early stages of the

pandemic, published studies from different countries demonstrated that pediatric patients represented less than 2% of reported cases of COVID-19 [3]. Studies also reported that pediatric COVID-19 cases remained less symptomatic and fatal [3]. As the pandemic evolved and new variants of the virus emerged, more children were impacted. As of the first week of May 2022, the American Academy of Pediatrics reported that there have been over 13 million pediatric COVID-19 cases, representing approximately 19% of all cases since the pandemic began [4].

Numerous public health studies have demonstrated a variety of health disparities related to the COVID-19 pandemic. The Centers for Disease Control and Prevention (CDC) noted disproportionate impacts on racial and ethnic minority groups in the USA. According to the CDC, Black/African American, Hispanic/Latino, American Indian, and Alaska Native people in the USA have higher rates of COVID-19 related hospitalization and death compared to non-Hispanic

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White populations [5]. These disparities are critical to areas with higher densities of racial and ethnic minorities, such as the city of Miami, where 69.4% of the population identifies as Hispanic (compared to 18.5% of the total US population [6, 7]. Other studies have shown the relationship between adverse COVID-19 health outcomes and socioeconomic status (SES). One study found that initially, higher SES was associated with increased incidence of index cases. As social distancing practices took affect that “higher SES individuals were more able to engage in,” the results inverted, and counties with lower SES demonstrated higher COVID-19 incidence and mortality [8]. While numerous studies have explored the relationship between COVID-19 infections and sociodemographic factors in adults, much less work has been done in the pediatric population.

As new variants of COVID-19 continue to have chronic and detrimental impacts on the US population, including children, it is critical to understand the impact of the pandemic across a range of diverse populations to inform decisions on testing, treatment, and resource allocation. We hope to add to this knowledge by giving insight into a unique area of the country by identifying the prevalence and distribution of COVID-19 cases among pediatric patients in Miami-Dade and Broward counties while identifying any potential sociodemographic disparities.

Methods

This is a descriptive, ecological study of COVID-19 infections of the pediatric population throughout Miami-Dade and Broward counties. A total of 10,674 children/adolescents ages zero years-old to 20 years-old were tested using the anterior nasal collection method via COVID-19 RT-PCR from July 1, 2020, to December 31, 2020. Testing was performed through the University of Miami Miller School of Medicine Pediatric Mobile Clinic, a program which travels into communities and provides health services to children, free of charge. Self-reported information obtained from those screened included age, gender, race/ethnicity, and home zip code. Cases were normalized by dividing the number of pediatric cases by the total population of each zip code. ArcGIS Pro 2.6.0 was used to geolocate and map normalized case values and obtain sociodemographic data by zip code (Supplemental Table 1). Sociodemographic factors included percentage of households on food stamps (data from 2018), median household income (data from 2020), percentage of households with those aged 25 and over having a bachelor’s degree (data from 2020), percentage of households below the poverty line (as defined by the US Census Bureau’s American Community Survey, data from 2018), percentage of minority population (data from 2020), and percentage of Hispanic ethnicity (as defined by the US

Census Bureau’s American Community Survey, data from 2020). These variables were chosen because they represent important factors that impact patient populations.

SPSS software was used for statistical analysis. Normality of sociodemographic variables was determined through visual inspection of Q-Q Plots. There were linear relationships between sociodemographic variables and normalized pediatric COVID-19 cases. Bivariate analyses were run for each sociodemographic variable and normalized pediatric COVID-19 cases using Pearson’s correlation. Multivariable linear regression was performed to identify variables predictive of pediatric COVID-19 cases. Chi-squared analysis was done to assess for differences in pediatric COVID-19 cases between racial/ethnic groups. Pediatric COVID-19 cases were not normalized for chi-squared analysis. Based on patients’ self-reported race and ethnicity, the positive cases were categorized as the following: White Hispanic, Black Hispanic, White non-Hispanic, and Black non-Hispanic. Post hoc analysis involved pairwise comparisons using the z-test of two proportions with a Bonferroni correction. This study was done with approval from the Institutional Review Board, study ID: 20,201,428 (MOD00044749).

Results

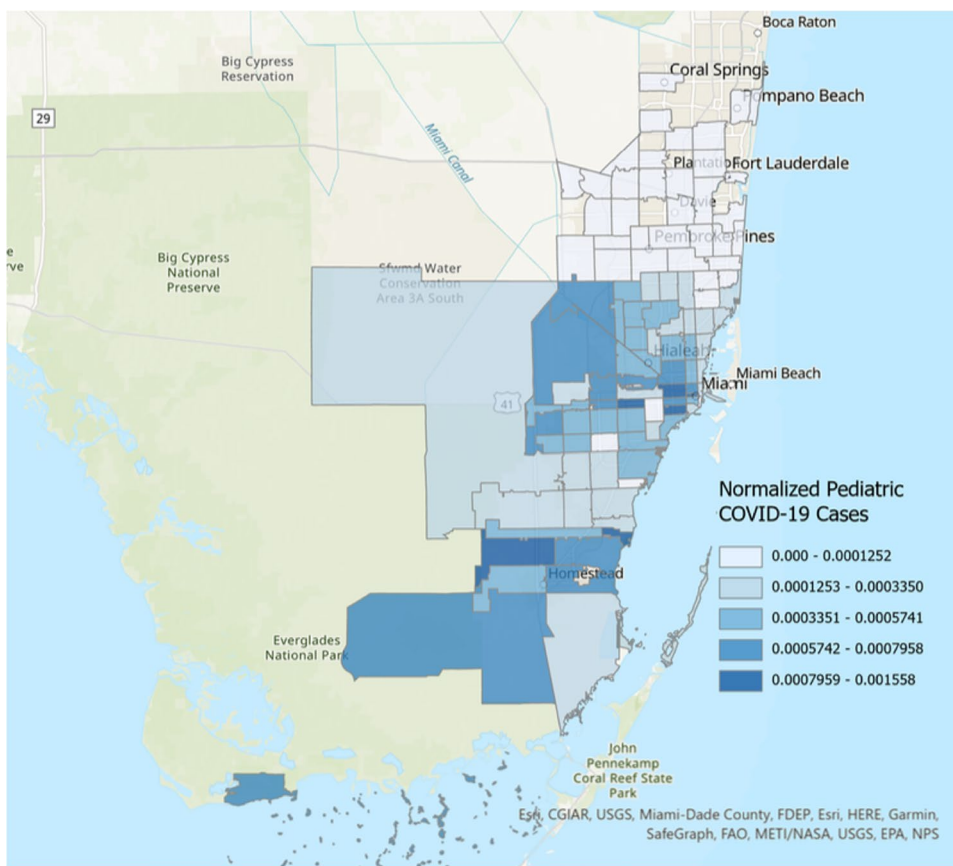
Of the 10,674 children tested, 10,087 (1,161 positive cases) cases were included in the analysis. Subjects were eliminated due to insufficient data for certain zip codes in ArcGIS or if the reported zip code was outside the boundaries of Miami-Dade or Broward counties established in ArcGIS. Additionally, one zip code was removed from analysis. This zip code was associated with an airbase and consisted of a much smaller population size and median household income than the rest of the data. Sociodemographic variables were normally distributed.

Supplemental Table 2 includes a summary of demographic data divided up among pediatric COVID-19 test results. Figure 1 shows the visual representation of the zip codes included in this study with the ratio of the number of cases to total population of the zip code area.

Bivariate analysis showed linear relationships between percentage of households on food stamps, median household income, percentage of households with those aged 25 and over having a bachelor’s degree, percentage of households below the poverty line, percentage of minority population, and percentage of Hispanic ethnicity and normalized pediatric COVID-19 cases.

There was a statistically significant, strong positive correlation between percentage of households on food stamps and normalized pediatric COVID-19 cases detected, $r(101)=0.55$, $p<0.001$. There was a statistically significant, moderately negative correlation between median household

Fig. 1 Distribution of pediatric COVID-19 cases in Miami-Dade and Broward counties. Cases normalized by zip code population



income and normalized pediatric COVID-19 cases detected, $r(101) = -0.33, p < 0.001$. There was a statistically significant, moderately negative correlation between percentage of households with adults over 25 years old possessing a bachelor's degree and normalized pediatric COVID-19 cases, $r(101) = -0.31, p < 0.001$. There was a statistically significant, moderately positive correlation between the percentage of households below the poverty line and normalized pediatric COVID-19 cases, $r(101) = 0.49, p < 0.001$. There was a statistically significant, strong positive correlation between the percentage of minority populations in the area and normalized pediatric COVID-19 cases, $r(101) = 0.55, p < 0.001$. Lastly, there was a statistically significant, strong positive correlation between the percentage of Hispanic population and normalized pediatric COVID-19 cases, $r(101) = 0.59, p < 0.001$. Results are summarized in Table 1.

The results from the bivariate analysis are depicted visually with maps in Fig. 2. There are two distinct areas in Miami-Dade County with the most extreme relationships between normalized pediatric COVID-19 cases and the sociodemographic variable of interest, with one cluster of zip codes in northern Miami-Dade County (middle of the map) and the other in southern Miami-Dade County. Broward County shows less zip codes with extreme relationships. The maps also reveal that zip codes near each other

Table 1 Correlation coefficients for relationships between sociodemographic factors and normalized pediatric COVID-19 cases

	COVID detected
% households on food stamps	.55*
Median household income	-.33*
% 25+ with bachelor's degree	-.31*
% households below poverty line	.49*
% minority population	.55*
% Hispanic population	.59*

*Statistically significant at the $p < .001$ level

Statistically, significant positive correlation between % households on food stamps, % households below the poverty line, % minority population, and % Hispanic population was shown. Statistically significant negative correlation between median household income and % households with adults over 25 years old possessing a bachelor's degree

often have more similar relationships between normalized pediatric COVID-19 cases and the sociodemographic variable. That is, zip codes in the high-high categories tend to be near other zip codes in the high-high categories. A similar spatial pattern is noted for zip codes in the low-low category.

Multiple regression was initially attempted with a model including all six independent variables. Percentage of food stamps was removed from the model due to tolerance of less

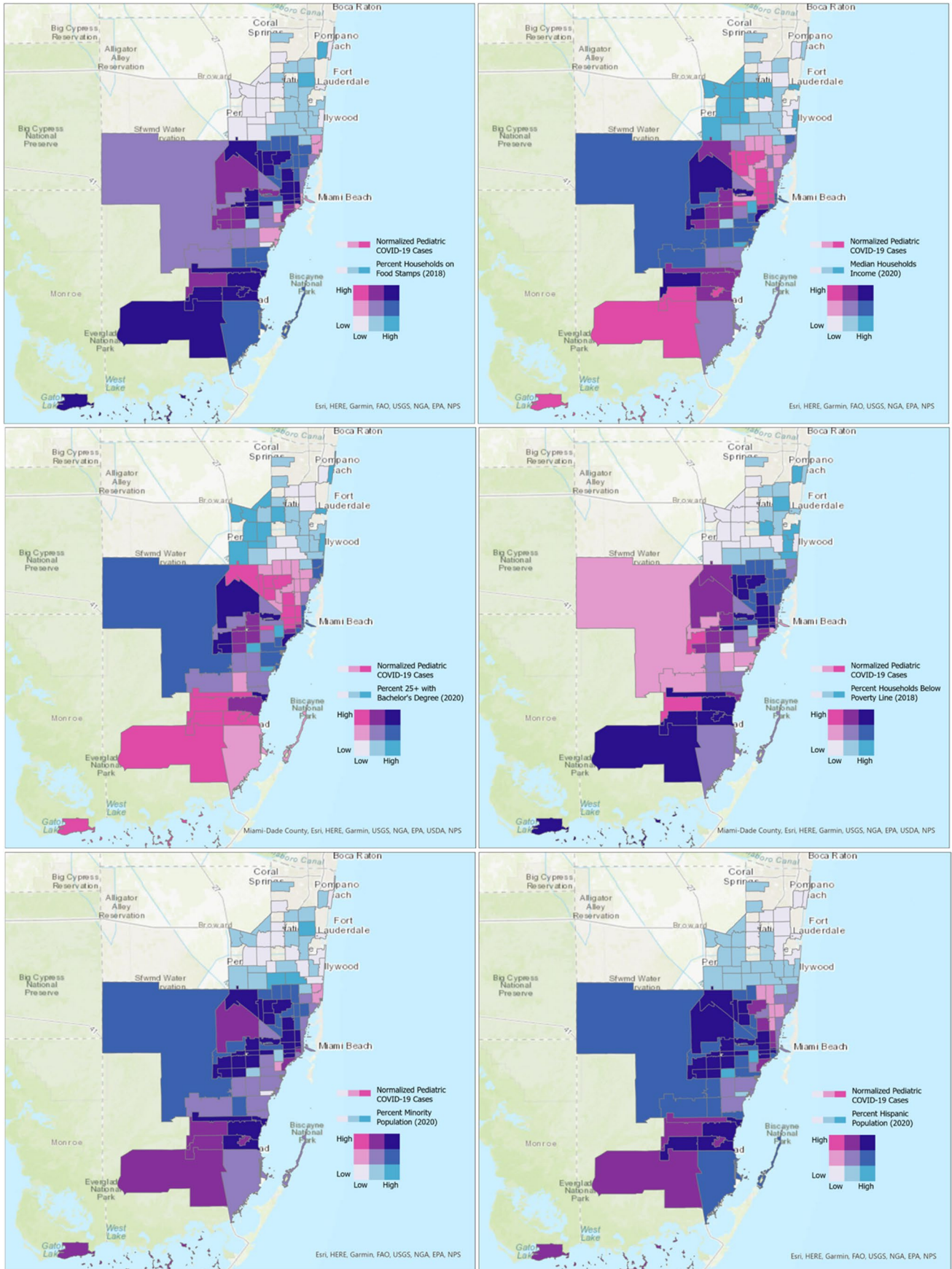


Fig. 2 Relationship between normalized pediatric COVID-19 cases and sociodemographic factors. From top, left: % households on food stamps and median household income. From middle left: % households with adults over 25 years old possessing a bachelor's degree and % households below poverty line. From bottom left: % minority population and % Hispanic population

than 0.1, violating the assumption of no multicollinearity. The model was re-run with the remaining five variables. Median household income, percentage of households with adults over 25 years old possessing a bachelor's degree, and percentage minority population were not statistically significant and were removed from the model. A final multiple regression model showed that percentage of households below the poverty line and percentage of Hispanic population statistically significantly predicted the number of pediatric COVID-19 cases, $F(2, 100) = 60.84$, $p < 0.001$, adjusted $R^2 = 0.54$. These two variables added statistically significantly to the prediction, $p < 0.001$. Regression coefficients and standard errors can be found in Table 2.

Chi-squared analysis was performed to evaluate relationship between race and ethnicity and pediatric COVID-19 cases. Race/ethnicity categories included White Hispanic ($n = 929$), Black Hispanic ($n = 14$), White non-Hispanic ($n = 132$), and Black non-Hispanic ($n = 86$). White Hispanics had a statistically significantly higher positive case number compared to White non-Hispanics and Black non-Hispanics, $p < 0.05$. The odds ratio of testing positive for pediatric COVID-19 if a participant identified as White Hispanic versus White non-Hispanic was 1.823, 95% CI [1.507 to 2.206]. For White Hispanic versus Black non-Hispanic, the odds ratio was 2.146, 95% CI [1.706 to 2.700]. Black Hispanics also had a statistically significantly higher positive case number compared to White non-Hispanics and Black non-Hispanics, $p < 0.05$. The odds ratio of testing positive for pediatric COVID-19 if a participant identified as Black Hispanic versus White non-Hispanic was 2.652, 95% CI [1.447 to 4.859]. For Black Hispanic versus Black non-Hispanic, the odds ratio was 3.121, 95% CI [1.681 to 5.797]. The number of positive pediatric COVID-19 cases in White Hispanics and Black Hispanics was not statistically significantly different, $p > 0.05$. Results are summarized in Table 3.

Discussion

Through analysis of demographic data using Pearson's correlation to evaluate pediatric COVID-19 cases, there was a disproportionate impact of COVID-19 on communities with markers of lower SES and higher percentage of racial/ethnic minority populations; the markers of SES included usage of food stamps, household income, and educational attainment. This coincides with our current understanding of how social

determinants of health influence the health of individuals and communities. A cross-sectional study done in Washington D.C. evaluating 1,000 pediatric patients from a pediatric drive-through/walk-up testing site had similar results. The study found higher rates of COVID-19 infection among minority children compared to non-Hispanic White children and noted that children from lower socioeconomic groups had a higher burden of COVID-19 infection [9]. While it is important to establish that there is a disproportionate impact of COVID-19 on specific communities, it is imperative to investigate further the underlying reasons for these disparities. Some possible areas for further investigation include health literacy and frontline worker status of adolescents and parents.

To further evaluate which sociodemographic markers influenced pediatric COVID-19 cases, we used multiple regression to create a predictive model. Percentage of households below the poverty line and percentage of Hispanic population in a zip code were shown to be statistically significant. The recent spike in pediatric COVID-19 cases from the Omicron variant winter surge [4] emphasizes the importance of predictive methods in being able to illuminate which factors should be targeted through policy.

Chi-squared and post hoc analysis revealed that children/adolescents that identified as White Hispanic or Black Hispanic had statistically significant higher COVID-19 cases than those that identified as White non-Hispanic or Black non-Hispanic. Once again, exploring the impact of COVID-19 on different populations is an important first step. Further exploration into the root cause of this difference is needed.

Our study explored a region of the county with a racial and ethnic makeup that differs from the overall makeup of the USA. In our study, 70.2% of participants identified as Hispanic which is much higher than the 18.5% seen across the total US population [7]. A larger population of participants identified as White (86.4%), compared to 76.3% nationally [7]. Furthermore, 13.6% participants identified as Black, which is similar to national figures at 13.4% [7]. While our study had the advantage of being able to explore the impact of COVID-19 on children/adolescents in Hispanic communities in the USA, the overall generalizations to the entire USA should be done with caution. Another limitation of this study was the assumption that all zip codes analyzed were independent of one another which is an oversimplification of reality. Additionally, we normalized pediatric COVID-19 cases by zip codes' general population as this information was more readily available than specific population numbers for children/adolescents and would ensure we could use as many subjects as possible in the study. This choice relies on the assumption that there is an equal proportion of children/adolescents in all zip codes. Lastly, it should be noted that this study explored a population that self-selected to be tested for COVID-19 via a

Table 2 Multiple regression model with adjusted R^2 of .54, a large effect size

COVID detected	B	95% CI for B		SE B	β	R^2	ΔR^2
		LL	UL				
Model						.55	.54*
% households below poverty line	1.585E-5*	1.21E-5	2.05E-5	2.34E-6	.46*		
% Hispanic population	6.801E-6*	5.17E-6	8.44E-6	8.25E-7	.56*		

B, unstandardized regression coefficient; *CI*, confidence interval; *LL*, lower limit; *UL*, upper limit; *SE B*, standard error of the coefficient; β , standardized coefficient; R^2 , coefficient of determination; ΔR^2 , adjusted R^2 .

*Statistically significant at the $p < .001$

We found that % households below the poverty line and % Hispanic population are predictive of pediatric COVID-19 cases

Table 3 Chi-squared analysis between self-reported race/ethnicity

Race/ethnicity	χ^2	<i>p</i>	OR	95% CI
White Hispanic (<i>n</i> = 929)				
vs. White non-Hispanic (<i>n</i> = 132)	39.144	< .001	1.823	1.507 to 2.206
vs. Black non-Hispanic (<i>n</i> = 86)	44.456	< .001	2.146	1.706 to 2.700
Black Hispanic (<i>n</i> = 14)				
vs. White non-Hispanic (<i>n</i> = 132)	10.705	.001	2.652	1.477 to 4.859
vs. Black non-Hispanic (<i>n</i> = 86)	14.302	< .001	3.121	1.681 to 5.797

χ^2 = chi square; *p* = *p*-value, OR = odds ratio, CI = confidence interval

Participants who identified as White Hispanic or Black Hispanic were more likely to test positive for COVID-19 than those that identified as White non-Hispanic or Black non-Hispanic. No statistically significant difference between White Hispanics and Black Hispanics ($p > 0.5$)

community-focused mobile clinic. This may influence our results as the population that utilizes mobile clinics might signify lack of access to regular primary care. Further explorations of a more robust patient sampling geographic area would be of interest in future studies.

Conclusion

COVID-19 has greatly impacted the US population since its first emergence in Wuhan, China, in December 2019. This study demonstrated that markers of lower SES including usage of food stamps, lower education level, and low household income correlated with higher COVID-19 cases in the pediatric population. Hispanic ethnicity also correlated to a higher case number. A model showed the percentage of households below the poverty line, and the percentage of Hispanic people living in a zip code can be used to predict pediatric COVID-19 cases in the studied area. The data informs our understanding of the social determinants of health on pediatric COVID-19 infections and the resulting health disparities we have seen throughout this pandemic. This study serves as a foundation for the important work that lies ahead in creating equitable policy and resource allocation during this pandemic and any future public health crises.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s40615-022-01362-y>.

Author Contribution a. Emily Bao—investigation, methodology, formal analysis, writing—original draft, and writing—review and editing.

b. Lavanya Easwaran—investigation, methodology, formal analysis, writing—original draft, and writing—review and editing

c. Michael Maurer—data curation, project administration, and supervision

d. Lisa Gwynn—PI, conceptualization, project administration, and supervision

Declarations

Ethics Approval This study has been approved by the University of Miami IRB, study ID: 20201428 (MOD00044749) (document attached).

Competing Interests The authors declare no competing interests.

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