EPIDEMIOLOGY AND CHARACTERISTICS OF PEDIATRIC COVID-19 CASES AMONG UMASS MEMORIAL HEALTH CARE PATIENTS

A Master's Thesis Presented

BY

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ABSTRACT

Background: The epidemiology of SARS-CoV-2 infection in the pediatric population, with a focus on racial and ethnic disparities and impact of societal public health measures, remains poorly understood.

Methods: This large observational study used electronically abstracted data from pediatric (≤ 19 years of age) patients who received a molecular test for SARS-CoV-2 at a UMass Memorial Health Care (UMMHC) site between March 8, 2020 and April 3, 2021 which was further supplemented by manual chart review of a subset of pediatric SARS-CoV-2 cases. Multivariable logistic regression models with interaction terms were used to identify risk factors for SARS-CoV-2 infection. Segmented regression analysis using Poisson models was used to estimate the effect of public health measures on the weekly incidence of SARS-CoV-2 infection.

Results: A total of 25,426 unique pediatric patients were tested for SARS-CoV-2 among whom 2,920 (11.5%) tested positive. The average age of those who tested positive was 10.8 years (SD: 5.8) and 48.1% were female. In the subset analysis, nearly three-quarters (75.9%) of SARS-CoV-2 diagnoses occurred through a telephone encounter, meaning that the child was not physically examined by a provider prior diagnosis and only 2.0% were admitted for inpatient care at diagnosis. Results of multivariable regression revealed that children or parents who self-reported Black race, Hispanic ethnicity, and non-English primary language were associated with approximately twice the odds of testing positive in comparison with White or English-speaking patients. Furthermore, increasing age was associated with increased odds of testing positive for SARS-CoV-2 (aOR: 1.1 (1-4 years),

1.2 (5-9 years), 1.4 (10-14 years), 1.6 (15-17 years), 1.7 (18-19 years)). However, this association between age and positivity rate, varies by race/ethnicity and primary language such that Non-Hispanic Black, Hispanic, and non-English speaking children had markedly greater odds of testing positive during adolescence in comparison to Non-Hispanic White and English-speaking counterparts. Results from segmented regression analysis demonstrated a decline in weekly incidence of cases 9.9% (95% CI: 7.8 – 11.9) after the Massachusetts state mask mandate was implemented. During the winter holidays, the rate of increase in the weekly incidence of cases was 12.1% (95% CI: 11.9 – 12.3) in this pediatric population.

Conclusions: Many SARS-CoV-2 cases have been diagnosed at UMMHC sites and notable racial/ethnic disparities exist that vary based on patient age. Public health measures are effective at preventing transmission of SARS-CoV-2 among children.

Keywords: SARS-CoV-2, pediatrics, racial/ethnic and language-based disparities, public health measures

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LIST OF SYMBOLS, ABBREVIATIONS, OR NOMENCLATURE

SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2

COVID-19: Coronavirus Disease 2019

MIS-C: Multisystem Inflammatory Syndrome in Children

UMMHC: UMass Memorial Health

Care

EMR: Electronic Medical Record

PCR: Polymerase Chain Reaction

NAAT: Nucleic Acid Amplification

Test

PREFACE

Fahey, N., TBD, Allison, J. Characteristics and Risk Factors for SARS-CoV-2 Infection among Pediatric Patients. Manuscript prepared for submission.

Fahey, N., TBD, Allison, J. Racial and Ethnic Disparities in Positivity Rates for SARS-CoV-2 Infection among Pediatric Patients. Manuscript prepared for submission.

Fahey, N., TBD. Allison, J. Impact of Public Health Measures and Key Events on Incidence of Pediatric SARS-CoV-2 Cases. Manuscript prepared for submission.

Symren Dhaliwal, Sabahat Rahman, Emily Farbman, Grace Wang, Vinaya Rajahraman, Timothy Chang, Elisabeth McGovern, Julia Oppenheimer, and Meaghan Molloy performed manual chart review and data entry for Aim 1.

CHAPTER I. INTRODUCTION

In December 2019, a novel virus referred to as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) spread from person-to-person by respiratory droplets, which was responsible for causing Coronavirus Disease 2019 (COVID-19), was initially identified in Wuhan, China.[1–5] Within months, the virus spread across the globe with the first confirmed case diagnosed in the United States on January 20, 2020 and in Massachusetts on February 1, 2020.[6,7] Since then, cases have continued to climb with more than 30,000,000 new cases of this viral infection in the United States.[8]

SARS-CoV-2 infection among pediatric patients in the United States account for 13.7% of all cases and ~0.19% of all deaths from SARS-CoV-2.[9,10] Illness is often mild in pediatric patients compared with their adult counterparts with less than 2% of pediatric cases requiring hospitalization. However, several risk factors related to age and co-morbidities have been identified in the pediatric population.[10–13] These risk factors include: age less than one year old, sickle cell disease, congenital heart disease, obesity, lung disease, diabetes, and immunosuppression. Pediatric patients are at risk for similar complications as adults including respiratory failure and myocarditis. Additionally, pediatric patients may develop post-illness sequelae known as Multisystem Inflammatory Syndrome in Children (MIS-C).[14,15] This syndrome is an inflammatory vasculitis characterized by persistent fever and laboratory evidence of inflammation, which can cause life-threatening illness.[16–22] As of March 29, 2021, there have been 3,185 cases of MIS-C in the US and 36 associated deaths.[23]

Public health measures to mitigate the spread of SARS-CoV-2 have been the mainstay since the pandemic began and continue to be important measures one year later. These interventions have extended across a number of different domains including personal, workplace, school, venues/events, and travel.[24] The key tenants of preventing the spread of SARS-CoV-2 have been masking, social distancing, hygiene measures, and limiting mobility. These measures are essential in reducing the transmission of SARS-CoV-2, but also have an unique toll on children as it relates to their mental health, education, and overall wellbeing.[25–28] However, SARS-CoV-2 infection among pediatric patients remains understudied, particularly as it relates to disparities among various subgroups and the impact of public health measures on pediatric incidence rates.

The purpose of this observational study was to describe the sociodemographic and symptomatology characteristics of pediatric patients at the time of presentation for SARS-CoV-2 infection in central Massachusetts, examine the risk factors for testing positive for SARS-CoV-2 including the interplay between age, race/ethnicity, and primary language, and explore the impact of public health measures and key events on the frequency of pediatric SARS-CoV-2 infections.

Specific Aims

Aim 1: Describe the presenting characteristics for pediatric patients (≤ 19 years of age) who tested positive for SARS-CoV-2 infection in central Massachusetts.

Aim 2: Examine the risk factors for testing positive for SARS-CoV-2 and examine the interplay between age, race, ethnicity, and primary language among pediatric SARS-

CoV-2 cases in central Massachusetts.

Aim 3: Explore the impact of public health measures and key events on the frequency of diagnosed pediatric SARS-CoV-2 cases in central Massachusetts.

CHAPTER II. METHODS

Study Population

This observational study used electronic medical record (EMR) data of patients 19 years of age and younger who were tested for SARS-CoV-2 infection with a molecular test within the UMass Memorial Healthcare (UMMHC) system. The UMMHC system serves a large catchment area in central Massachusetts and includes three tertiary care hospitals and many outpatient offices. The UMMHC system includes the Children's Medical Center at the UMass Memorial Medical Center campus in Worcester, MA. The Children's Medical Center is the only children's hospital in central Massachusetts and includes pediatric primary and specialty clinics, a pediatric emergency department, 30-bed inpatient pediatric unit, 10-bed pediatric intensive care unit, and a 49-bed neonatal intensive care unit.[29]

During the COVID-19 pandemic, UMMHC established drive-thru testing sites where patients with a medical order from a healthcare provider could be tested for SARS-CoV-2. These testing sites served both adult and pediatric patients. In addition to dedicated testing sites, SARS-CoV-2 testing was also available across UMMHC sites at outpatient offices, emergency departments, and inpatient settings.

Data Sources

The UMMHC system utilizes an EMR system called Epic. Each patient in the system is identified by a unique medical record number.

Automated Abstracted Data from the Electronic Medical Record: These data

include all patients 19 years of age and younger who were tested for SARS-CoV-2 infection with a molecular test within the UMMHC system between March 8, 2020 through April 3, 2021. These data were accessed through the University of Massachusetts Medical School Data Lake, which is a repository for EMR data from Epic. There were 25,426 unique pediatric patients tested for SARS-CoV-2 during the specified time period. For patients tested multiple times who had both negative and positive SARS-CoV-2 test results in the EMR, the date of their first positive test result was used to characterize them as a positive case. For patients tested multiple times who had only negative SARS-CoV-2 test results, the date of their first negative test result in the EMR was used to classify them as a negative case.

Manual Chart Review Data from the UMass Pediatric COVID-19 Registry: In April 2020, a registry for capturing chart review data on pediatric cases of SARS-CoV-2 infection with a positive molecular test diagnosed within the UMMHC system was established. Positive cases of SARS-CoV-2 infection among those 19 years of age and younger were identified through an Epic report on a regular basis. A team of medical students performed manual chart review of the EMR and data entry into a standardized RedCap form. Data collected from manual chart review focused on the clinical encounter associated with the diagnosis of SARS-CoV-2 infection and included information that could not be abstracted automatically from the EMR. These data include 1,021 pediatric cases of SARS-CoV-2 infection diagnosed within the UMMHC system between March 8, 2020 and November 30, 2020.

Variables

SARS-CoV-2 Infection: A positive result for a molecular SARS-CoV-2 test including Polymerase Chain Reaction (PCR) and Nucleic Acid Amplification Test (NAAT) were used to identify cases of SARS-CoV-2 infection. Test results that were either inconclusive or equivocal were excluded. Results from antigen and antibody tests for SARS-CoV-2 were also excluded due to the higher likelihood for a false positive test result or indication of a past infection, respectively.

Age: Pediatric was defined as 19 years of age and younger in an effort to include a broader group of adolescent patients who were being cared for in pediatric settings during the COVID-19 pandemic due to limited resources in adult settings. This age cutoff also was consistent with the statewide Massachusetts Department of Public Health pediatric age classification.[30] The age subgroups were defined based on the Center for Disease Control Pediatric COVID-19 Response Team Morbidity and Mortality Weekly Report: <1, 1-4, 5-9, 10-14, 15-17, and 18-19 years old.[31]

Race and Ethnicity: In the EMR, race and ethnicity are documented as two separate fields. Race categories include: White, Black or African American, Asian, Native American, Pacific Islander, or other. Ethnicity categories include: Hispanic, non-Hispanic, or other. In this study, the objective was to better characterize racial and ethnic disparities using a social production of disease framework.[32] Inasmuch, a composite race and ethnicity variable was created with the following categories: Hispanic, Non-Hispanic Black, Non-Hispanic White, Non-Hispanic Other, and Unknown.

Language: The patient's primary language as documented in the EMR is used to

inform healthcare providers of the language that the patient feels most comfortable receiving medical information. For pediatric patients, the language documented in the EMR most often reflects the communication preferences of their parent or guardian, particularly for younger age groups. Among adolescent patients, the language preference may be updated to reflect the patient's preferred language for communication, although not on a consistent basis. In this dataset, a total of 45 distinct languages were identified. The most common preferred languages were English, Spanish, Arabic, and Portuguese. For this study, this variable was operationalized into the following categories: English, Spanish, Other, and Not Recorded.

Insurance: Primary insurance type was abstracted from the EMR and dichotomized into public or private.

Encounter Type: Data collected through manual chart review allowed for the identification of the type of clinical encounter type associated with the positive SARS-CoV-2 test result at the time of diagnosis. Encounter types included telephone calls, in-person clinic visits, emergency department visits, and inpatient admissions.

Public Health Measures and Key Events: Throughout the course of the first year of the COVID-19 pandemic, Massachusetts implemented statewide policies for infection mitigation efforts to reduce the spread of SARS-CoV-2.[33] A statewide stay-at-home advisory was put into effect starting on March 24, 2020, which included the closure of non-essential businesses along with travel restrictions. This measure was followed by a mask mandate on May 6, 2020. On June 8, 2020, the state embarked on a phased, gradual reopening. The holiday period from mid-October through New Year's Day marked the

state's second peak in SARS-CoV-2 cases, which then declined steeply after the start of the New Year.[8]

Statistical Analysis

Descriptive analysis of sociodemographic factors was performed on the automated abstracted dataset including all pediatric patients tested for SARS-CoV-2. Incidence rates were calculated in cases per 100 person-years. Descriptive analysis of sociodemographic factors and presenting characteristics by presenting encounter type was performed on the manual chart review dataset of all pediatric cases of SARS-CoV-2 infection.

Bivariate logistic regression analysis was performed on the automated abstracted dataset to more systematically understand associations among several possible risk factors for testing positive for SARS-CoV-2 infection. Multivariable logistic regression analysis was performed to adjust for possible confounding in examining the association between age, race, ethnicity, primary language, insurance type, and gender. Subsequent multivariable logistic regression with age as an interaction term was performed to investigate positivity rate by race/ethnicity and language. The *margins* command was used to perform inverse logit calculations and estimate adjusted predicted probability.[34] Errors for adjusted predicted probability were estimated using the *delta* method.[35]

Segmented regression analysis using Poisson link was used to estimate trends in the weekly incidence rates of SARS-CoV-2 infection among pediatric patients in relation to public health measures and key events. The data were aggregated by weeks and each segment was dummy coded as 1 if the week fell into the respective segment. Differences

and 95% confidence intervals between the exponentiated beta coefficients for different segments were calculated using the *nlcom* postestimation command. All statistical analyses were performed using Stata 15.0 MP.

CHAPTER III. RESULTS

General Distribution

During the overall study period between March 8, 2020 and April 3, 2021, a total of 25,426 unique patients 19 years of age or younger were tested for SARS-CoV-2 infection across UMMHC sites. The first positive pediatric case at a UMMHC site was diagnosed on March 21, 2020. A total of 2,920 positive cases were identified, corresponding to an incidence rate of 17.2 cases per 100 person-years after accounting for time from March 8, 2020 to the first positive test for each participant (Table 1). The average age of those who tested positive was 10.8 years (SD: 5.8) and 48.1% were female.

Increasing age was associated with a higher rate of infection. Hispanic and Non-Hispanic Black race/ethnicity were also associated with higher rates of infection, almost doubling that of Non-Hispanic Whites. Those with a Non-English primary language had among the highest rates of infection. Specifically, those with Spanish as a primary language has a rate of 32.1 cases per 100 person-years, almost double the average rate observed in this pediatric population overall.

Aim 1: Presentation Characteristics

Table 2 displays the presenting characteristics from manual chart review of 1,021 pediatric patients who tested positive for SARS-CoV-2 at UMMHC sites between March 8th, 2020 and November 30th, 2020 based on clinical encounter type. More than three-quarters (75.9%) of SARS-CoV-2 diagnoses were linked to a telephone encounter and less than 2% were admitted as an inpatient at the time of diagnosis. Telephone encounter

was the most common encounter type across all age groups. However, children less than 1 years old accounted for nearly half (40%) of all admissions and were comparatively more likely to be seen in-person (49.2%) than other age groups (22.5%). Distribution of encounter type by other features included risk factors such as communal residence (5.1%), known exposure to SARS-CoV-2 (61.3%), and presence of acute symptoms (55.4%). The most common symptoms observed were fever (28.1%), cough (24.4%), and headache (16.7%). A higher proportion of patients diagnosed at an in-person encounter had at least one symptom in comparison with patients diagnosed by telephone encounter (84.1% vs 44.5%). Symptoms such as anosmia and dysgeusia were rare among pediatric patients at the time of diagnosis (5.8% and 4.9%, respectively).

Aim 2: Disparities in Positivity Rates

The association of age, gender, race/ethnicity, primary language, and primary insurance with testing positive for SARS-CoV-2 is described in Table 3. Prior to adjusting for several potential confounders, increasing age had a weak association in terms of an increased odds for testing positive for SARS-CoV-2 infection. However, after adjusting for several confounding variables, including gender, race/ethnicity, primary language, and insurance type, the oldest age group had 70% greater odds of testing positive than infants (95% CI: 1.4-2.1). The association between Hispanic patients and testing positive for SARS-CoV-2 was attenuated after adjusting for primary language.

To further explore the interplay between race/ethnicity, language, and age in relation to testing positive for SARS-CoV-2, we cross-tabulated these covariates

(Supplementary Tables 1 and 2). More than three fourths of patients reported English as their primary language, regardless of their race/ethnicity status. Additionally, collinearity analysis among the covariates did not identify any variable or category with a variance inflation factor higher than 10, suggesting that the multicollinearity assumption was not violated in the multivariable model.

Results of the interaction analysis are shown in Figures 1 and 2. Both figures confirm findings from Table 3 that positivity rate increases with age and among children who are *not* Non-Hispanic Whites or English speaking. The association of increasing age and higher prevalence of testing positive was consistent across different race/ethnicity groups; however, this relationship was more pronounced among Hispanic and Non-Hispanic Black patients in comparison with Non-Hispanic White patients. The interaction of primary language and age in relation to positivity rate suggests that there was a marked increase in risk of testing positive among Non-English speaking adolescents 15 years of age or older, where no such increase was observed among English speaking adolescents (Figure 2).

Aim 3: Impact of Public Health Measures and Key Events

The distribution of SARS-CoV-2 cases in the context of public health measures and key events is described in Table 4. During the stay-at-home advisory period prior to the mask mandate (3/24/2020 – 5/5/2020), 5% of all diagnosed positive SARS-CoV-2 cases occurred. During the holiday and post-holiday periods, more than 80% of all diagnosed positive cases were observed. Figure 3 shows the weekly incidence of SARS-CoV-2

infection among pediatric patients and results of the segmented regression analysis after adjusting for age, insurance type, and gender of the patient. During the stay-at-home advisory period, the number of new cases increased at a rate of 18.7% weekly, while it decreased at a rate of 9.9% after the initiation of the Massachusetts statewide mask mandate. As Massachusetts underwent gradual reopening, the rates increased by 7.3%, which accelerated to a weekly increase of 12.1% during the winter holidays, followed by a decrease during the post-holiday period immediately after the start of the New Year.

CHAPTER IV. DISCUSSION

This large observational study utilizing EMR data describes the sociodemographic and presenting symptomatology characteristics of pediatric patients diagnosed with SARS-CoV-2 infection in central Massachusetts. The results of this study suggest racial/ethnic and language-based disparities in test positivity rates and variation in weekly incidence rates in relationship to public health measures and key events throughout the first one year of the COVID-19 pandemic.

Aim 1: Presentation Characteristics

Manual chart review data of more than one thousand pediatric cases of SARS-CoV-2 infection at the time of diagnosis revealed that approximately 75% of cases had a telephone encounter as the index clinical encounter associated with their SARS-CoV-2 molecular test order and subsequent diagnosis. Relatively few cases were diagnosed by in-person clinic visits. Less than 2% of cases were admitted to an inpatient setting at the time of diagnosis. These findings are consistent with national data and existing literature suggest that the presenting symptoms of SARS-CoV-2 infection in pediatric patients are often mild.[36–38] However, our finding of disproportionately high in-person visits among infants (49.2%) in comparison to other groups (22.5%) may underscore two interrelated mechanisms. Infants have a developing immune system, and therefore, have a higher predisposition for morbidity and mortality related to infection. Consequently, healthcare providers have a lower threshold for in-person evaluation and prolonged observation of infants, particularly in the setting of a novel infection such as SARS-CoV-2.

Additionally, there is emerging evidence of severe SARS-CoV-2 illness in infancy.[39] We also observed that 55% of cases had a least one symptom present at the time of diagnosis, with the most common symptoms being fever, cough, and headache. Symptoms of anosmia and dysgeusia were rare, which is consistent with pediatric literature and in contrast to adults where these symptoms are described more commonly.[40,41] This discrepancy may be related to an improved ability to self-report anosmia and dysgeusia with age. Additionally, it may also be a function of the later presentation of these specific symptoms in the infection course[42] and a possible difference in the timing of diagnosis among children and adults.

Aim 2: Disparities in Positivity Rates

Our findings of increasing age, Hispanic or Non-Hispanic Black race/ethnicity, non-English primary language, and public health insurance as risk factors for testing positive for SARS-CoV-2 infection among this patient population in central Massachusetts is consistent with other literature among pediatric and adult population.[43–50] The social production of disease framework described by Rothman et al can provide valuable context in interpreting these associations observed in our study. Increasing age of children is associated with increased mobility and interaction with members outside of the household, leading to a higher risk of exposure to SARS-CoV-2. School closure may have limited, but did not eliminate, mobility in this group.[51,52] This is especially true among children who are Hispanic or Non-Hispanic Black because they are more likely to have a socioeconomic disadvantage, work in service industry, participate in the

workforce, and live in densely populated residences.[53–57] Additionally, adolescents who do not speak English as their primary language were observed to have additional risk based on our effect modification analysis, which underscores the need to improve public health messaging and ensure that it is available in multiple languages.

Aim 3: Impact of Public Health Measures and Key Events

We observed a robust association between major public health measures and the number of new pediatric SARS-CoV-2 cases per week. With the first peak early in the pandemic, there was a decline in the incidence of pediatric cases after the mask mandate was put into effect. The impact of masking on the rates of infection in young children is particularly interesting because masks are not recommended for children less than two years of age.[58] Furthermore, adherence to masking among young children two years of age and older can be challenging. The temporal relationship of the mask mandate and the decline in pediatric cases suggests that masking among adults and older children yields benefits for all children. By contrast, the second peak during the winter holidays may suggest a lack of social distancing at gatherings, where adult non-adherence to public health measures also had implications for the occurrence of infection in children. This finding reinforces the broader societal impact of various public health measures. These findings are consistent with other observational studies of temporal association between non-pharmaceutical intervention and transmission rates of SARS-CoV-2 at a population level and with studies that demonstrate the impact of social gathering on transmission of SARS-CoV-2 virus.[59–62]

Study Strengths and Limitations

This study has several strengths and limitations. It was an observational, cross-sectional study focused on the presenting features of SARS-CoV-2 infection available in the medical record of a single healthcare system. Inasmuch, there are limitations in causal inferences, understanding the trajectory of illness, and generalizability. However, this is the first study of its kind using pediatrics data from central Massachusetts. Robust data curation techniques based on a standardized abstraction process and manual chart review verification yielded reliable and high-fidelity data. This study was not able to account for the impact of school reopening and vaccination due to significant heterogeneity. Rigorous epidemiology and biostatistical approaches were utilized to understand the regional epidemiology of SARS-CoV-2 infection among pediatric patients within the largest health system in the central Massachusetts region. However, these data do not capture all undiagnosed and diagnosed cases of SARS-CoV-2 infection within the region. It is possible that a proportion of children with mild or no symptoms never received a SARS-CoV-2 test or were tested outside of the UMMHC system and therefore are not represented in this analysis of observational data. However, based on prior literature on estimating the impact of missing data within this context,[63] it is likely that the findings reported in this study are an underestimation and represent a conservative estimate that favors the null hypothesis.

CHAPTER V. CONCLUSIONS

This study examined automated abstracted and manual chart review EMR data of pediatric patients diagnosed with SARS-CoV-2 infection in the UMMHC system during the first year of the COVID-19 pandemic. Findings from this study suggest that the presenting symptoms of SARS-CoV-2 infection among pediatric patients are relatively mild and often the initial diagnosis occurs in the outpatient setting. Public health measures such as masking and social distancing are effective at preventing pediatric SARS-CoV-2 infection. However, both racial/ethnic and primary language-based disparities exist in positivity rates across all pediatric age groups and are particularly prominent during adolescence. It is imperative that public health messaging is inclusive, acceptable, and accessible to all populations within our communities. The ability to implement public health measures and reduce the spread of SARS-CoV-2 infection are essential for pediatric health given the potential severe complications of SARS-CoV-2 infection as well as the other psychosocial consequences of the COVID-19 pandemic on pediatric mental health, education, and overall wellbeing.

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TABLES

Table 1. Sociodemographic characteristics of pediatric patients who were tested for SARS-CoV-2 at UMMHC sites between March 8th, 2020 and April 3rd, 2021

Table 1: Sociodemographic characteristics of pediatric patients who were tested for SARS-CoV-2 at UMMHC sites between March 8th, 2020 and April 3rd, 2021				
Variable	Total (%)	SARS-CoV-2 (+)	Person-years	Incidence Rate
Total	25,426	2,920 (11.5)	16,933	0.172 (0.166-0.179)
Age				
< 1	1, 488 (5.9)	157 (5.4)	992	0.158 (0.135-0.185)
1 – 4	4,650 (18.3)	476 (16.3)	3,167	0.150 (0.137-0.164)
5 – 9	5,498 (21.6)	617 (21.1)	3,768	0.164 (0.151-0.177)
10 – 14	6,297 (24.8)	741 (25.4)	4,255	0.174 (0.162-0.187)
15 – 17	5,374 (21.1)	665 (22.8)	3,475	0.191 (0.177-0.206)
18 – 19	2,119 (8.3)	264 (9.0)	1,286	0.205 (0.182-0.232)
Gender				
Female	12,332 (48.5)	1,405 (48.1)	8,216	0.171 (0.162-0.180)
Male	13,089 (51.5)	1,515 (51.9)	8,722	0174 (0.165-0.183)
Race/Ethnicity				
Hispanic	5,933 (23.3)	981 (33.6)	3,886	0.252 (0.237-0.269)
Non-Hispanic Black	1,452 (5.7)	209 (7.2)	955	0.219 (0.191-0.251)
Non-Hispanic White	15,355 (60.4)	1,416 (48.5)	10,329	0.137 (0.130-0.144)
Other	1,568 (6.2)	182 (6.2)	1,028	0.177 (0.153-0.205)
Unknown	1,118 (4.4)	132 (4.5)	744	0.177 (0.150-0.210)
Primary Language				
English	22,782 (89.6)	2,494 (85.5)	15,332	0.163 (0.156-0.169)
Spanish	1,301 (5.1)	259 (8.9)	807	0.321 (0.284-0.363)
Other	978 (3.8)	160 (5.5)	612	0.261 (0.224-0.305)
Not Documented	365 (1.4)	6 (0.2)	192	0.031 (0.014-0.070)
Primary Insurance				
Public	10,986 (43.2)	1,534 (52.6)	7,393	0.208 (0.198-0.218)
Private	12,743 (50.1)	1,301 (44.5)	8,650	0.150 (0.142-0.159)
Not Documented	1,697 (6.7)	84 (2.9)	899	0.093 (0.075-0.116)
Public Health Events				
Stay-at-home Advisory	770 (3.0)	152 (5.2)	Not applicable	
Mask Mandate	938 (3.7)	161 (5.5)		
Gradual Reopening	7,063 (27.8)	224 (7.7)		
Holidays	8,926 (35.1)	1,348 (46.2)		
Post-Holidays	7,746 (30.5)	1,034 (35.4)		

Table 2. Presenting characteristics of pediatric patients who tested positive for SARS-CoV-2 at UMMHC sites between March 8th, 2020 and November 30th, 2020 based on clinical encounter type

Table 2: Presenting characteristics of pediatric patients who tested positive for SARS-CoV-2 at UMMHC sites between March 8th, 2020 and November 30th, 2020 based on clinical encounter type					
Variable	Total	Telephone	Clinic	Emergency Department	Admission
Total	1,021	775 (75.9)	33 (3.2)	193 (18.9)	20 (2.0)
Age					
< 1 years	63 (6.2)	32 (4.1)	1 (3.0)	22 (11.4)	8 (40.0)
1-4	158 (15.5)	116 (15.0)	5 (15.2)	35 (18.1)	2 (10.0)
5-9	205 (20.1)	160 (20.7)	6 (18.2)	36 (18.7)	3 (15.0)
10-14	247 (24.2)	203 (26.2)	7 (21.2)	34 (17.6)	3 (15.0)
15-17	242 (23.7)	183 (23.6)	6 (18.2)	50 (25.9)	3 (15.0)
18-19	106 (10.4)	81 (10.5)	8 (24.2)	16 (8.3)	1 (5.0)
Gender					
Female	481 (47.3)	341 (44.2)	20 (60.6)	109 (56.5)	11 (55.0)
Male	536 (52.7)	430 (55.8)	13 (39.4)	84 (43.5)	9 (45.0)
Race/Ethnicity					
Hispanic	415 (40.7)	291 (37.6)	16 (48.5)	102 (52.9)	6 (30.0)
Non-Hispanic Black	75 (7.4)	59 (7.6)	0 (0.0)	11 (5.7)	5 (25.0)
Non-Hispanic White	424 (41.5)	343 (44.3)	16 (48.5)	58 (30.1)	7 (35.0)
Other	72 (7.1)	49 (6.3)	1 (3.0)	20 (10.4)	2 (10.0)
Unknown	35 (3.4)	33 (4.3)	0 (0.0)	2 (1.0)	0 (0.0)
Recent contact someone with a known history of SARS-CoV-2					
Yes	633 (62.3)	489 (63.1)	21 (63.6)	116 (61.1)	7 (36.8)
Primary residence in a group or communal setting					
Yes	50 (4.9)	40 (5.2)	0 (0.0)	7 (3.6)	3 (15.0)
Symptom history in relation to the encounter					
1+ symptom documented	552 (54.1)	345 (44.5)	28 (84.9)	164 (85.0)	15 (75.0)
Fever	278 (27.3)	153 (19.8)	7 (21.2)	107 (55.4)	11 (55.0)
Cough	240 (23.5)	139 (17.9)	11 (33.3)	83 (43.2)	7 (35.0)
Dyspnea	48 (4.7)	13 (1.7)	4 (12.1)	30 (15.6)	1 (5.0)
Congestion	142 (13.9)	84 (10.9)	11 (33.3)	44 (22.9)	3 (15.0)
Sore Throat	111 (10.9)	64 (8.3)	8 (24.3)	37 (19.6)	2 (10.0)
Myalgia	88 (8.6)	48 (6.2)	2 (6.1)	36 (18.8)	2 (10.0)
Fatigue	67 (6.6)	32 (4.1)	3 (9.1)	27 (14.1)	5 (25.0)
Headache	154 (15.1)	92 (11.9)	8 (24.2)	49 (25.7)	5 (25.0)
Anosmia	58 (5.7)	39 (5.0)	3 (9.1)	16 (8.3)	0 (0.0)
Dysgeusia	46 (4.5)	33 (4.3)	1 (3.0)	12 (6.3)	0 (0.0)
Nausea/Vomiting	72 (7.1)	18 (2.3)	3 (9.1)	45 (23.3)	6 (30.0)
Diarrhea	46 (4.5)	25 (3.2)	0 (0.0)	17 (8.8)	4 (20.0)

Table 3. Risk factors associated with pediatric patients who tested positive for SARS-CoV-2 at UMMHC sites between March 8th, 2020 and April 3rd, 2021

Table 4: Risk factors associated with pediatric patients who tested positive for SARS-CoV-2 at UMMHC sites between March 8th, 2020 and April 3rd, 2021						
Variable	O.R.	95% CI	aO.R.	95% CI	aO.R.	95% CI
Age (ref: < 1 year)						
1-4 years	1.0	0.8-1.2	1.0	0.9-1.3	1.1	0.9-1.3
5-9 years	1.1	0.9-1.3	1.2	1.0-1.5	1.2	1.0-1.5
10-14 years	1.1	0.9-1.4	1.3	1.1-1.6	1.4	1.1-1.7
15-17 years	1.2	1.0-1.4	1.5	1.3-1.8	1.6	1.3-1.9
18-19 years	1.2	1.0-1.5	1.6	1.3-2.0	1.7	1.4-2.1
Gender (ref: female)						
Male	1.0	0.9-1.1	1.0	1.0-1.1	1.0	1.0-1.1
Race Ethnicity (ref: Non-Hispanic White)						
Hispanic	2.0	1.8-2.1	1.9	1.7-2.1	1.7	1.6-1.9
Non-Hispanic Black	1.7	1.4-1.9	1.6	1.3-1.9	1.6	1.3-1.9
Other	1.3	1.1-1.5	1.3	1.1-1.6	1.2	1.0-1.5
Unknown	1.3	1.1-1.6	1.3	1.1-1.6	1.5	1.2-1.8
Primary Language (ref: English)						
Spanish	2.0	1.8-2.3	Not included in this model		1.4	1.2-1.6
Other	1.6	1.3-1.9			1.5	1.3-1.8
Not recorded	0.1	0.1-0.3			0.2	0.1-0.4
Primary Insurance (ref: Private)						
Public	1.4	1.3-1.6	1.2	1.1-1.3	1.2	1.1-1.3
Not documented	0.5	0.4-0.6	0.8	0.6-1.0	0.8	0.6-1.0

Table 4. Public Health Measures and Key Events in Massachusetts during the COVID-19 Pandemic in 2020 – 2021

Table 4: Incidence of pediatric cases of SARS-CoV-2 at UMMHC sites by of public health measures and key events in Massachusetts during the COVID-19 Pandemic in 2020 – 2021		
	Start Date	**Incidence (col%)**
Stay-at-home Advisory	March 24, 2020	152 (5.2)
Mask Mandate	May 6, 2020	161 (5.5)
Gradual Reopening	June 8, 2020	225 (7.7)
Holidays	Oct 12, 2020	1,349 (46.2)
Post-Holidays	Jan 2, 2021	1,033 (35.4)

Supplementary Table 1. Distribution of primary language by race/ethnicity among pediatric patients who were tested for SARS-CoV-2 at UMMHC sites between March 8th, 2020 and April 3rd, 2021

Supplementary Table 1: Distribution of primary language by race/ethnicity among pediatric patients who were tested for SARS-CoV-2 at UMMHC sites between March 8th, 2020 and April 3rd, 2021						
	Total	**Hispanic**	**Non-Hispanic Black**	**Non-Hispanic White**	**Other**	**Unknown**
English	22,782 (89.6)	4,373 (73.7)	1,390 (95.7)	14,841 (96.7)	1,275 (81.3)	903 (80.6)
Spanish	1,301 (5.1)	1,301 (21.9)	0	0	0	0
Other	978 (3.9)	238 (4.0)	58 (4.0)	340 (2.2)	275 (17.5)	67 (6.0)
Not Documented	368 (1.5)	21 (0.4)	4 (0.3)	174 (1.1)	18 (1.2)	151 (13.5)

Supplementary Table 2. Distribution of race/ethnicity and primary language by age in years among pediatric patients who were tested for SARS-CoV-2 at UMMHC sites between March 8th, 2020 and April 3rd, 2021

Supplementary Table 2: Distribution of race/ethnicity and primary language by age in years among pediatric patients who were tested for SARS-CoV-2 at UMMHC sites between March 8th, 2020 and April 3rd, 2021							
	Total	**<1**	**1-4**	**5-9**	**10-14**	**15-17**	**18-19**
Hispanic	5,933 (23.3)	531 (35.7)	1,380 (29.7)	1,377 (25.1)	1,268 (20.1)	965 (18.0)	412 (19.4)
Non-Hispanic Black	1,452 (5.7)	107 (7.2)	290 (6.2)	314 (5.7)	357 (5.7)	251 (4.7)	133 (6.3)
Non-Hispanic White	15,355 (60.4)	639 (42.9)	2,424 (52.1)	3,225 (58.7)	4,041 (64.2)	3,639 (67.7)	1,387 (65.5)
Other	1,568 (6.2)	115 (7.7)	340 (7.3)	324 (5.9)	367 (5.8)	304 (5.7)	118 (5.6)
Unknown	1,121 (4.4)	96 (6.5)	216 (4.7)	258 (4.7)	264 (4.2)	218 (4.1)	69 (3.3)
English	22,782 (89.6)	1,236 (83.1)	4,053 (87.2)	4,940 (89.9)	5,738 (91.1)	4,879 (90.7)	1,936 (91.4)
Spanish	1,301 (5.1)	137 (9.2)	325 (7.0)	311 (5.7)	275 (4.4)	187 (3.5)	66 (3.1)
Other	978 (3.9)	107 (7.2)	250 (5.4)	194 (3.5)	196 (3.1)	178 (3.3)	53 (2.5)
Not Documented	368 (1.5)	8 (0.5)	22 (0.5)	53 (1.0)	88 (1.4)	133 (2.5)	64 (3.0)

FIGURES

Figure 1. Positivity rate for SARS-CoV-2 across age and race/ethnicity among pediatric patients who were tested at UMMHC sites between March 8th, 2020 and April 3rd, 2021

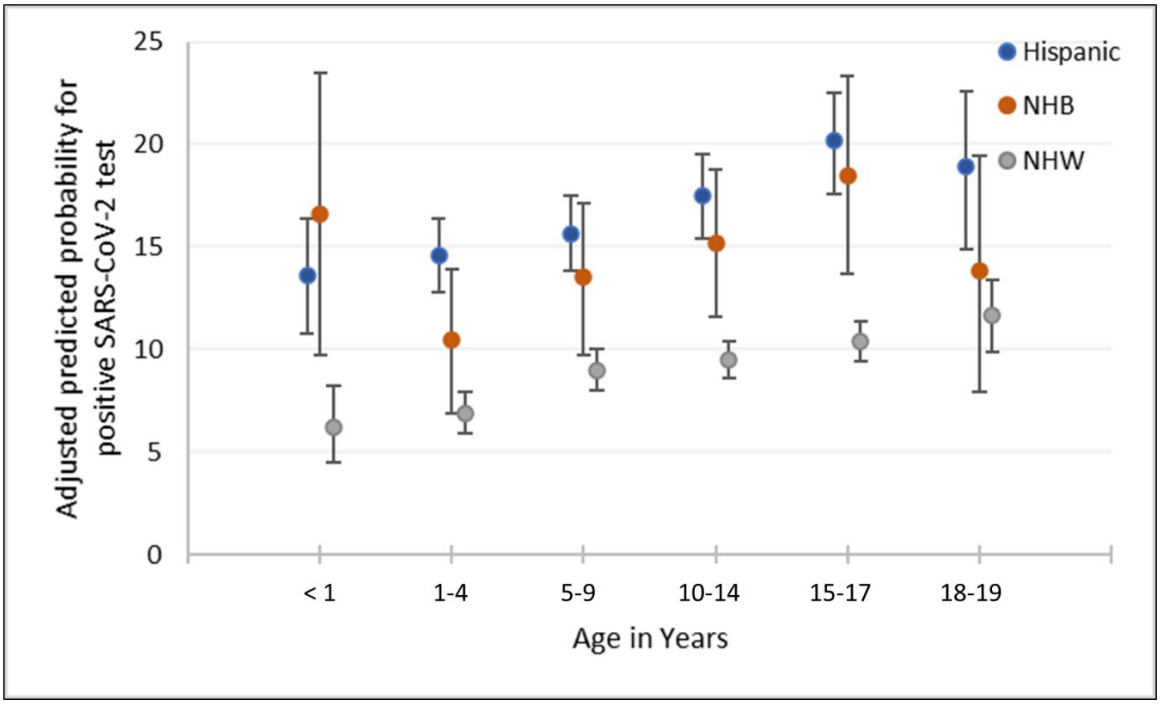

Figure 2. Positivity rate for SARS-CoV-2 across age and primary language among pediatric patients who were tested at UMMHC sites between March 8, 2020 and April 3rd, 2021

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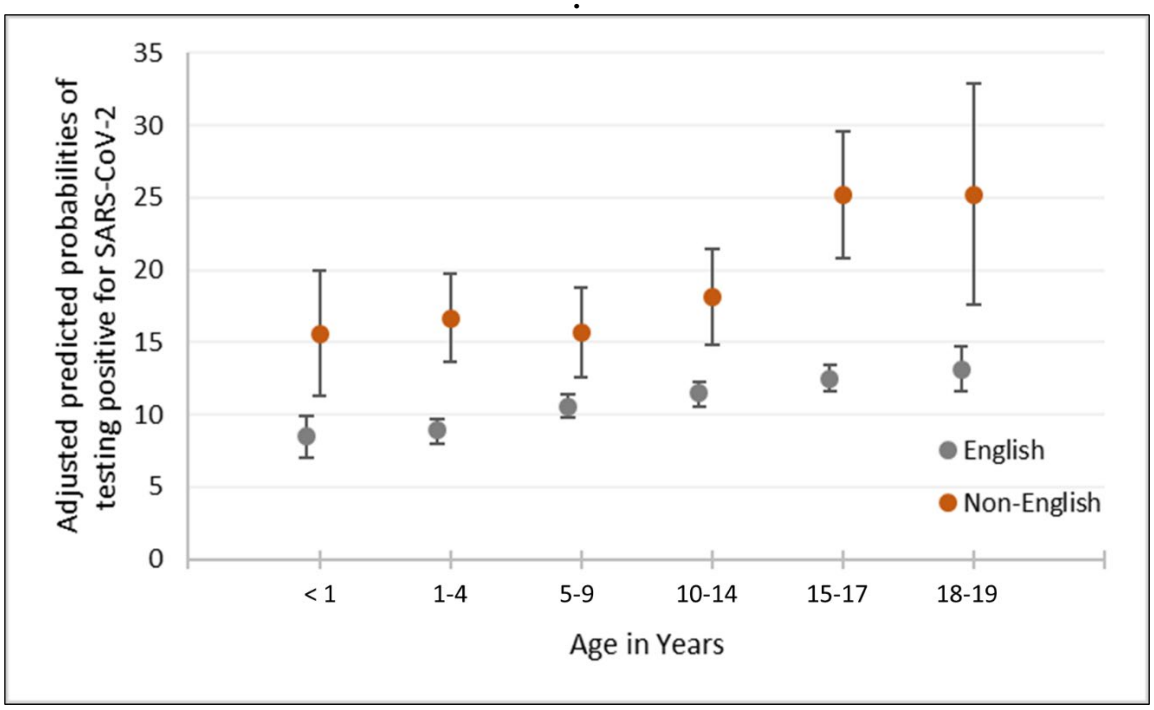
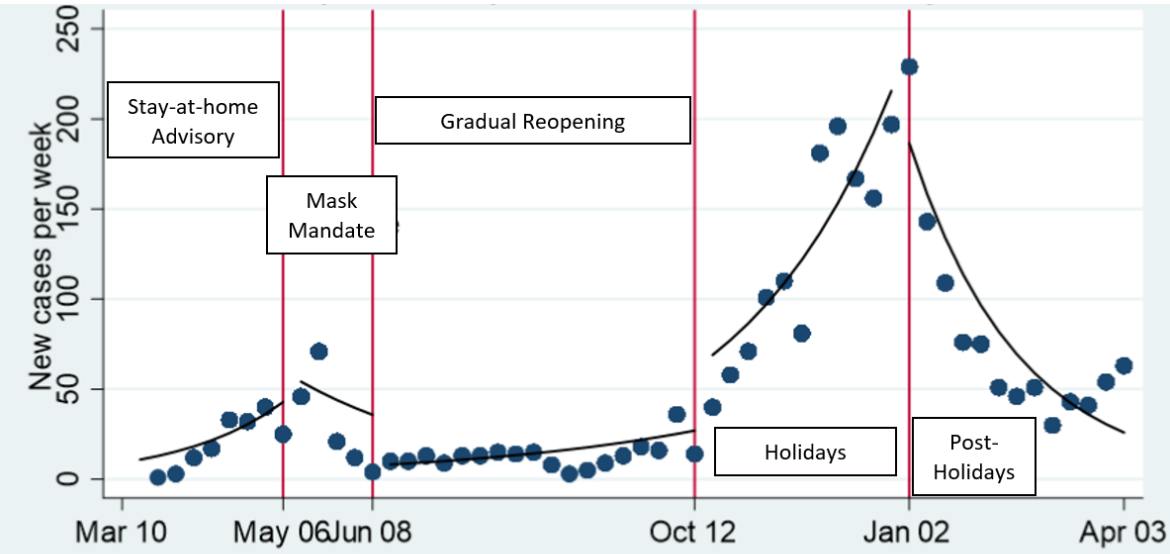


Figure 3. Weekly incidence of SARS-CoV-2 cases in relation to public health measures and key events among pediatric patients who were tested at UMMHC sites between March 8, 2020 and April 3rd, 2021



First cases: 18.7% **increase** (95% CI: 16.3 – 21.1)
Mask mandate: 9.9% **decrease** (95% CI: 7.8 – 11.9)
Reopening: 7.3% **increase** (95% CI: 6.6 – 8.0)
Holidays: 12.1% **increase** (95% CI: 11.9 – 12.3)
Post-Holidays: 15.2 % **decrease** (95% CI: 15.0 – 15.3)

Modeled using Poisson regression and adjusted for age, insurance type, and gender