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Prolonged School Closure and Pediatric Respiratory Hospitalization: The Silver Lining of the COVID-19 Pandemic

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Abstract

Objective. This is a single-center retrospective cohort study that aimed to quantitatively assess the association between prolonged school closure (>2 weeks) and pediatric respiratory hospitalization during the COVID-19 pandemic. *Methods.* Subjects included 1243 patients presenting to Children's Hospital of Michigan during the winters of 2019, 2020, and 2021. The primary outcome measures were total respiratory hospitalizations and respiratory diagnoses. *Results.* Data was analyzed using a 2-sample z-test for proportions. We found that pediatric patients in the setting of prolonged school closure had significantly fewer hospitalizations in 2020 compared to 2019 (9% vs 47%; $P < .001$) and 2021 (9% vs 45%; $P < .001$). There were decreases in bronchiolitis, asthma/reactive airway disease (RAD), and pneumonia hospitalizations compared to 2019 and 2021. *Conclusions.* Our study showed that during prolonged school closure, there was a significant decrease in pediatric respiratory hospitalization. As such, it should be considered when creating a pandemic response strategy.

Keywords

RSV bronchiolitis, asthma exacerbation, RAD exacerbation, pediatric respiratory hospitalization, virus mitigation, pandemic response, children

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Specialties: General pediatrics, Infectious diseases, Pulmonology, Allergy/Immunology

Introduction

Advances in genetic sequencing and its now widespread use in clinical medicine and research have allowed for vast opportunities to study the role of microorganisms' effect on humans. Specifically, it has allowed for improved understanding of the epidemiology of outbreaks of infectious diseases and the evolution of microorganisms in response to both the environment and the hosts they infect. Among the most common of infections affecting pediatric patients are those of respiratory viruses. The etiologic culprits of these infections include most commonly: rhinoviruses, respiratory syncytial virus (RSV), parainfluenza, influenza, human metapneumovirus, adenoviruses, and coronaviruses.

It has been well documented that particular environments increase the likelihood that children contract an acute respiratory infection. Childcare facilities, schools, and crowded areas in general allow for greater transmission via respiratory droplets or contact method.[1] In 2009, the H1N1 virus pandemic response included school closures in the United States.[2] Prior to this pandemic, there was a lack of consensus on this method as a disease mitigation strategy.[3] However, multiple studies document a decrease in acute respiratory infections following this intervention at the community level.[2,4-9] In

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2007, the United States Department of Health and Human Services proclaimed that, "school closures are likely to be ineffective, infeasible, or unacceptable to the public, especially when there is limited scientific evidence supporting such restrictions.[10]"

Since the beginning of 2020, the novel SARS-CoV2 or COVID-19 virus has spurred the initiation of research into how this particular virus is transmitted and what interventions at the community, state, and national level may be developed to mitigate its spread.[11,12] Social distancing, handwashing, use of alcohol-based sanitizer, plexiglass barriers, cloth masks, and surface sanitization were among the first methods used to stop transmission. However, the closure of most schools and businesses in the United States during the pandemic provides a unique opportunity to study its effect on the transmission of not only COVID-19 but also that of other seasonal viruses present concomitantly.

In children, infection with COVID-19, much like other respiratory viruses, is mild and self-limited, causing mostly mild upper respiratory symptoms. Children, however, are important vectors of viral transmission to the general population, including the elderly and immunocompromised. Complications of respiratory viral infections, such as secondary bacterial infection, and rarely of COVID-19 such as Multisystem Inflammatory Syndrome in Children (MIS-C) do pose greater morbidity and mortality risk. Further, shifts in the epidemiological patterns of viral infections among pediatric patients play a role in healthcare utilization and influence the timing of public health initiatives such as vaccination. As new variants of the original COVID-19 virus surface, it is more important than ever to identify strategies that truly decrease the risk of transmission and infection. Doing so could inform new public health initiatives that could transform the epidemiological profile of respiratory infections for children in the United States. We therefore aim to quantitatively assess the association between prolonged school closure (>2 weeks) and pediatric respiratory hospitalization during the first year of the COVID-19 pandemic.

In conducting this study, we hypothesize that pediatric patients, in the setting of prolonged school closure, had a significant decrease in hospitalization for respiratory illnesses such as asthma or reactive airway disease (RAD) exacerbation, bronchiolitis, croup, and pneumonia. We further hypothesize that there was a decrease in admissions to the hospital with influenza A, influenza B and RSV for all pediatric age groups studied. The null hypothesis is that there was no change in hospitalization for respiratory illness and similar prevalence of the specified viruses for all pediatric age groups studied in the setting of prolonged school closure.

Methods

Study Design

We conducted a retrospective cohort study comparing admissions due to respiratory illnesses during the winter of 2020 in which schools were closed for a prolonged period of time (>2 weeks) with the same targets during 2019 when no such school closure was implemented. We also compared the same targets during 2021 in which schools were open under similar COVID precautions.

In November and December of 2020, many schools in the Detroit/Wayne County area were closed in an attempt to mitigate the spread of COVID-19 in the community. To determine that schools were indeed closed, we contacted all public, private and charter schools in Wayne County ranging from kindergarten to twelfth grade. We did not contact preschools or daycares. We were able to obtain data on 93% of students enrolled (252,402) and found that of those, approximately 243,000 students, or 96%, were not in school from November to December.

In 2020 and 2021, Children's Hospital of Michigan (CHM) required that all patients admitted to the hospital be tested for COVID, influenza, and RSV via rapid polymerase-chain reaction (PCR) nasal swab. Hospital administration kept a record of all patients tested. We used this record with the electronic medical record (EMR) to obtain our data. We then did an EMR chart search of all the diagnoses we included in 2020 and 2021 to obtain data for 2019. At that time, RSV, influenza and COVID-19 PCR testing was not required for all admissions. De-identifying codes were assigned to each subject in our data sheet.

Setting

This study was conducted at the main campus of the Children's Hospital of Michigan located in Detroit, Michigan, and included the following patient care areas: general inpatient, observation, and intensive care units. CHM serves predominantly low-income patients from surrounding urban and suburban communities. It is located in Southeast Michigan and frequently serves African American, Hispanic, and Middle Eastern populations. CHM is in Wayne County, where 29% of children live below the poverty line.[13]

Study Subjects

This study included all pediatric patients less than 18 years old presenting to CHM. All subjects who fit the inclusion criteria and were admitted for respiratory hospitalization to the general inpatient, observation,

pediatric intensive care, or neonatal intensive care unit from November 1 to December 14 of 2020 were included in the school closure cohort. Subjects presenting during the same dates in 2019 were included in the pre-school closure cohort. Subjects presenting during the same dates in 2021 were included in the post-school closure cohort. Exclusion criteria included any patient 18 years or older, patients that tested positive for COVID, and patients that presented for non-respiratory or birth-related respiratory diagnoses. The final sample size when adding all 3 cohorts was 1243 patients.

Primary and Secondary Outcome Measures

Our primary outcome measures were total respiratory hospitalizations and diagnoses. The primary diagnoses for admission included asthma and RAD exacerbation, bronchiolitis, croup, pneumonia, and other diagnoses (including acute chest syndrome, tracheitis, cystic fibrosis exacerbation, obstructive sleep apnea, and acute bacterial sinusitis).

The age group, laboratory proven viruses, chief complaint, and specific dispositions of each patient were considered secondary outcome measures. The age groups were categorized into non-school age children (<4 years old), school-age children (4-12 years old), and teenagers (13-17 years old). We recorded if subjects tested positive for RSV, influenza A, influenza B or COVID-19 (in data from 2020 and 2021). If a respiratory viral panel (RVP) was ordered for a subject, we also documented any negative or positive findings on the RVP. We documented chief complaints from the emergency department visit that resulted in hospital admission. The chief complaints included: cough, fever, difficulty in breathing (DIB), wheezing, and other complaints (including chest pain, headache, altered mental status, vomiting, fussiness, increased secretions/blood-tinged secretions, seizure, and apnea). We then recorded the dispositions of these patients, which included the general inpatient and observation units, pediatric intensive care unit (PICU) or neonatal intensive care unit (NICU). The observation unit sub-category was ultimately excluded as there were periods when the observation unit was closed, and patients were admitted under observation status to the inpatient units due to low hospital census.

Statistical Analysis

Data collected for this retrospective cohort study was categorical in nature and was presented using raw numbers and proportions. Percentages reported were calculated using the number of admissions for the specified variable in one 6-week period (ie, RSV in 2019) over n, the total number of admissions over the 3 time periods studied (ie, RSV in 2019, 2020 and 2021). To examine proportional differences between pairwise year groups (2019 vs 2020; 2020 vs 2021; and 2019 vs 2021), a 2-sample z-test for proportions was utilized for clinical variables of interest. SPSS Version 26 and R software was utilized to perform statistical procedures. A P-value of $\leq .05$ was chosen as a cut-off for statistically significant differences between pairwise years.

Timeline

The study was conducted from November 1, 2019, to December 14, 2021. We only used data for comparison during which schools were closed (November 1-December 14, 2020) and compared it to the same period in 2019 and 2021.

Ethical Approval and Informed Consent

The Central Michigan University Institutional Review Board waived the need for ethics approval and the need to obtain consent for the collection, analysis, and publication of the retrospectively obtained and anonymized data for this non-interventional study (IRB #2021-1084).

Results

Total Respiratory Hospitalizations

As shown in Table 1, pediatric patients, in the setting of prolonged school closure (2020), had a significant decrease in hospitalization due to respiratory illness compared to pre-school closure, 2019 (9% vs 47%; $P < .001$) and post-school closure, 2021 (9% vs 45%; $P < .001$).

There was no significant difference in hospitalization due to respiratory illness between the 2019 and 2021 cohorts (47% vs 45%; $P = .395$).

Diagnoses

Figure 1 shows that pediatric patients, in the setting of a prolonged school closure, had a significant decrease in hospitalization due to bronchiolitis (4% vs 54%; $P < .001$), asthma/RAD exacerbation (18% vs 25%; $P = .027$), and pneumonia (8% vs 60%; $P < .001$) compared to 2019. When comparing the prolonged school closure cohort to the 2021 cohort, there was also a significantly lower percentage of admissions due to bronchiolitis (4% vs 42%; $P < .001$), asthma/RAD exacerbation (18% vs 58%; $P < .001$), and pneumonia (8% vs 32%; $P < .001$).

Table 1. Number and Percentage of Respiratory Hospitalizations by Year.

	2019 (%)	2020 (%)	2021 (%)	*P*-value 2019 vs 2020	*P*-value 2020 vs 2021	*P*-value 2019 vs 2021	Total (n)
Total respiratory hospitalizations	578 (47)	108 (9)	557 (45)	<.001*	<.001*	.395	1243
Dx bronchiolitis	364 (54)	25 (4)	282 (42)	<.001*	<.001*	<.001*	671
Dx asthma or reactive airway disease	80 (25)	57 (18)	188 (58)	.027*	<.001*	<.001*	325
Dx pneumonia	118 (60)	16 (8)	64 (32)	<.001*	<.001*	<.001*	198
Dx croup	3 (12)	5 (20)	17 (68)	.441	<.001*	<.001*	25
Dx all others	12 (52)	5 (22)	6 (26)	.032*	.726	.07	23
Age <4	476 (50)	61 (6)	413 (43)	<.001*	<.001*	.004*	950
Age 4-12	80 (33)	36 (15)	125 (52)	<.001*	<.001*	<.001*	241
Age 13-17	22 (43)	11 (22)	18 (35)	.019*	.124	.418	51
RSV	307 (60)	0 (0)	201 (40)	<.001*	<.001*	<.001*	508
Influenza A	2 (25)	0 (0)	6 (75)	.131	.002*	.045*	8
Influenza B	10 (100)	0 (0)	0 (0)	<.001*	1	<.001*	10
Rhino/Enterovirus	41 (47)	13 (15)	34 (39)	<.001*	<.001*	.284	88
Adenovirus	7 (44)	1 (6)	8 (50)	.014*	.006*	.726	16
RVP all others	16 (94)	0 (0)	1 (6)	<.001*	.308	<.001*	17
CC DIB	329 (42)	70 (9)	386 (49)	<.001*	<.001*	<.001*	785
CC cough	149 (59)	17 (7)	87 (34)	<.001*	<.001*	<.001*	253
CC fever	70 (55)	10 (8)	48 (38)	<.001*	<.001*	.006*	128
CC wheezing	18 (38)	7 (15)	23 (48)	.010*	.010*	.303	48
CC all others	12 (41)	4 (14)	13 (45)	.019*	.009*	.787	29
Unit floor	368 (50)	58 (8)	311 (42)	<.001*	<.001*	.003*	737
Unit PICU	121 (60)	21 (10)	61 (30)	<.001*	<.001*	<.001*	203
Unit NICU	12 (50)	5 (21)	7 (29)	.035*	.505	.139	24

Number of respiratory hospitalizations across the 3 cohorts. Percentages represent frequency over total number of patients presenting for specified diagnosis, age group, laboratory test, complaint, or unit during the same 6-week study period in 3 years.
Abbreviations: DX, diagnosis; CC, chief complaint.
*Significant at $\alpha = .05$.

There was a significant decrease in hospitalization due to bronchiolitis (54% vs 42%; $P < .001$) and pneumonia (60% vs 32%; $P < .001$) between the 2019 and 2021 cohorts. However, there was a significant increase in hospitalization due to asthma exacerbation and RAD in 2021 compared to 2019 (58% vs 25%; $P < .001$).

Age

Non-school age children (age < 4), in the setting of a prolonged school closure, had a significantly lower percentage of hospitalization due to respiratory illness compared to 2019 (6% vs 50%; $P < .001$) and 2021 (6% vs 43%; $P < .001$). There was also a significant decrease in hospitalization of non-school age children due to respiratory illness between the 2019 (50%) and 2021 (43%) cohorts ($P < .001$).

School-age children (age 4-12), in the setting of prolonged school closure, had a significantly lower percentage of hospitalization due to respiratory illness compared to 2019 (15% vs 33%; $P < .001$) and 2021 (15% vs 52%; $P < .001$). There was a significant increase in hospitalization of school-age children due to respiratory illness between the 2019 (33%) and 2021 (52%) cohorts ($P < .001$).

Teenagers (age 13-17), in the setting of a prolonged school closure, had a significant decrease in hospitalization due to respiratory illness when compared to 2019 (22% vs 43%; $P = .019$). There was no significant difference between the 2020 and 2021 cohorts ($P = .124$). Further, there was no significant difference in hospitalizations between 2019 and 2021 cohorts ($P = .418$).

Respiratory Viruses

Pediatric patients, in the setting of prolonged school closure, had a significant decrease in hospitalization with RSV (0% vs 60%; $P < .001$), rhino/enterovirus (15% vs 47%; $P < .001$), and adenovirus (6% vs 44%; $P = .014$) compared to 2019. The prolonged school closure cohort also had a lower percentage of admissions with positive RSV (0% vs 40%; $P < .001$), rhino/enterovirus (15% vs 39%; $P < .001$), and adenovirus (6% vs 50%; $P = .006$) compared to 2021. There was a significant decrease in

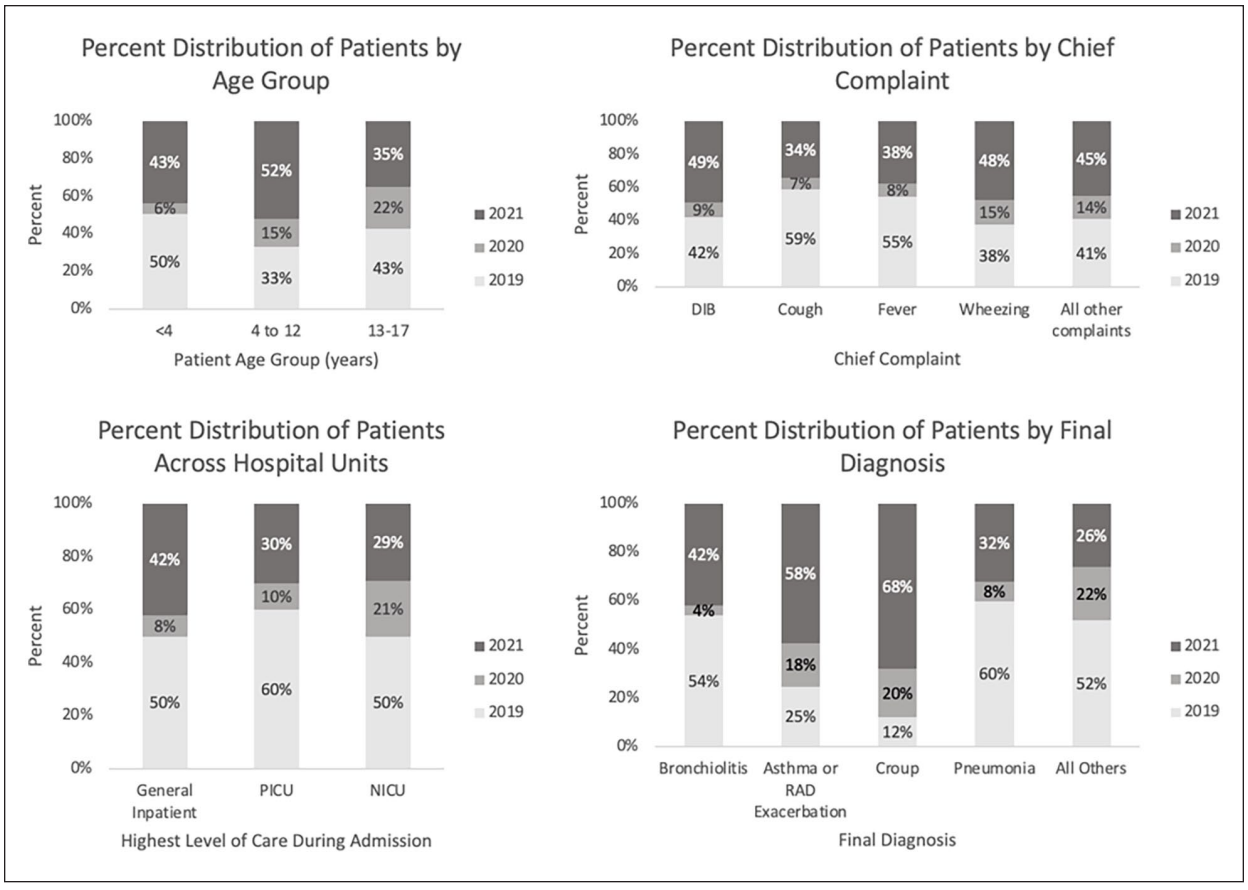

Figure 1. Charts showing percent of total subjects within specified age group, unit, complaint, or diagnosis. Percentages represent frequency over total number of patients presenting over all 3 years for each category during the same 6-week study period.

hospitalization with RSV in 2021 compared to 2019 (40% vs 60%; $P < .001$).

There were 0 positive RSV, influenza A, and influenza B tests in patients admitted to the hospital for respiratory illness in 2020.

Chief Complaints

Admitted pediatric patients, in the setting of a prolonged school closure, had fewer chief complaints of DIB (9% vs 42%; $P < .001$), cough (7% vs 59%; $P < .001$), fever (8% vs 55%; $P < .001$) and wheezing (15% vs 38%; $P = .010$) compared to 2019. The prolonged school closure cohort also had a lower percentage of admissions with chief complaint of DIB (9% vs 49%; $P < .001$), cough (7% vs 34%; $P < .001$), fever (8% vs 38%; $P < .001$) and wheezing (15% vs 48%; $P = .010$) compared to 2021.

When comparing the 2019 and 2021 cohorts, fewer admitted patients presented with chief complaints of cough (59% vs 34%; $P < .001$) and fever (55% vs 38%; $P = .006$), respectively. There was, however, a significant increase in hospitalization with a chief complaint of DIB in 2021 compared to 2019 (49% vs 42%; $P < .001$).

Unit

Pediatric patients, in the setting of a prolonged school closure, had a significant decrease in admissions due to respiratory illness to the inpatient floor (8% vs 50%; $P < .001$) and to the PICU (10% vs 60%; $P < .001$) compared to 2019. The prolonged school closure cohort also had fewer admissions to the inpatient floor (8% vs 42%; $P < .001$) and to the PICU (10% vs 30%; $P < .001$) compared to 2021.

There was a significant decrease in admissions to the inpatient floor (50% vs 42%; $P < .001$) and to the PICU (60% vs 30%; $P < .001$) between 2019 and 2021, respectively.

Discussion

On March 23rd, 2020, Michigan governor Gretchen Whitmer issued an executive order to "suspend activities that are not necessary to sustain or protect life," resulting in the closure of schools and businesses across the state, and a transition to virtual/online school and services for the next several months.[14] This resulted in much debate about the pros and cons of school closure which was previously called "ineffective" by the U.S. Department of Health and Human Services.[10] Previous studies done on school closures during influenza epidemics showed a decrease in the epidemic peak.[15] Auger et al[11] noted a temporal association between school closure and decreases in COVID-19 incidence and mortality, with a larger relative reduction found in states that implemented school closure earlier.

We found that prolonged school closure was associated with significantly fewer hospitalizations for all respiratory illnesses, including those secondary to bronchiolitis, asthma exacerbation/RAD, and pneumonia when compared to pre-school closure and post-school closure data. School closure was also associated with a decrease in respiratory admissions to the inpatient floor and PICU, and admissions with RSV, rhino/enterovirus, and adenovirus. Our results also show a decrease in respiratory hospitalizations with chief complaints of DIB, cough, fever and wheezing during school closure. In addition, a similar trend was observed in both non-school age children and school-age children. These results are consistent with our proposed hypothesis.

In comparing our non-school closure cohorts (2019 and 2021), we did not find a significant difference in total respiratory hospitalizations despite other mitigation strategies that were still in place in 2021 including hand washing, masking, and social distancing. Although there was no difference in total respiratory hospitalizations between the 2 non-school closure cohorts, there was an interesting and statistically significant increase in asthma exacerbations/RAD and a proportional decrease in both bronchiolitis and pneumonia in 2021 compared to 2019.

The number of hospital admissions for asthma exacerbations/RAD was significantly lower in 2020 compared to 2019 and 2021. This finding is to be expected given asthma exacerbations have a seasonal pattern, with most episodes occurring in the late fall or early spring, especially when children are returning to school. With the start of school, children are more readily exposed to viral upper respiratory infections and aeroallergens, both known triggers for asthma exacerbations/RAD. With school closure, these inciting factors are reduced.[16] This marked decrease in asthma exacerbations/RAD during the COVID-19 pandemic is not localized to Michigan but has been reported nationwide and even across the globe. A 2020 study by Taquechel et al demonstrated an 84% decrease in hospital encounters for asthma during the pandemic and a 2021 study done in Japan found decreased asthma admissions in 2020 compared with previous years for children and adults.[17]

Although the decrease in hospital admissions for asthma exacerbations/RAD among the prolonged school closure cohort was expected, the data did reveal a striking increase in admissions in 2021 when compared to 2019, which was not expected. Between these 2 groups, there was a 2-fold increase among hospital admissions related to asthma exacerbations/RAD, increasing from 80 (25%) in 2019 to 188 (58%) in 2021. In 2021, schools resumed in-person learning, yet other viral mitigation strategies such as hand washing, masking, and social distancing were still active. Despite these measures, respiratory viruses reemerged and hospital admissions for asthma exacerbations/RAD increased. Medication compliance and follow up are important aspects of good asthma control. A 2021 study by Navalpakam et al[18] reported improved medication compliance and follow up starting in 2020, especially with the establishment of telehealth. Although 29% of children living in Wayne County live below the poverty line, it is believed that they had similar access and utilization to tele-health services. This is evidenced by a study showing that approximately 80% to 83% of households in Michigan counties had internet access through broadband. Also, Wayne County had the third highest number of telehealth visits per 1000 beneficiaries in 2020 with 1816 visits.[19] Navalpakam et al also discussed this improved asthma management was due to parental fear of children developing asthma exacerbations from catching COVID. Therefore, appropriate management of asthma seemed to be less likely to contribute to the increased hospital admissions for asthma exacerbations/RAD between 2019 and 2021.

A 2022 study by Hazan, Fox, Mok and Haspel also reported a similar increase in asthma exacerbations/RAD in 2021 compared to 2019 and 2020 with children 0 to 5 years of age accounting for 81% of cases. Their study speculated that use of viral mitigation measures led to an increased prevalence of respiratory viruses post-pandemic. They discussed that hygiene and social distance practices initiated to prevent virus spread may have delayed normal immune system education. Thus, when viruses reemerged post-pandemic, children had a naïve immune system making them more susceptible to these viruses, thereby triggering increased asthma exacerbations/RAD. These ideas discussed by Hazan et al.

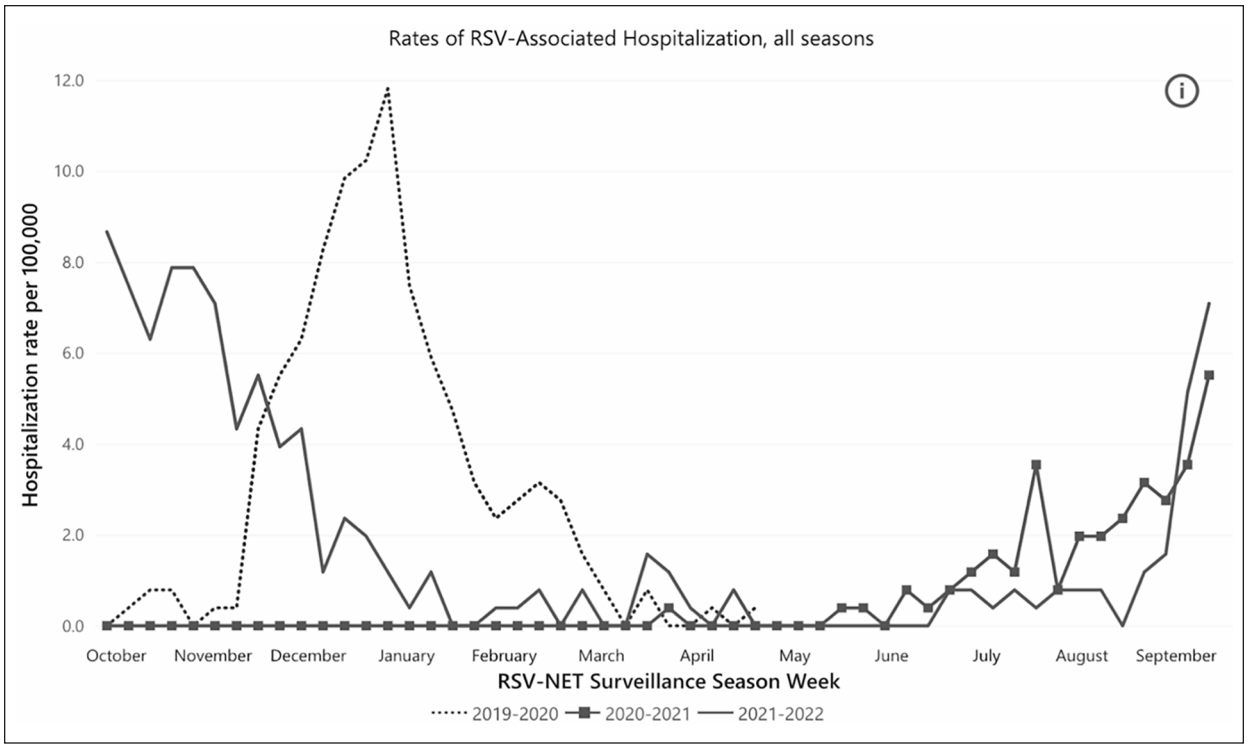

Figure 2. Rate of RSV-associated hospitalization among children aged 0 to 17 years in Michigan in 2019-2020, 2020-2021, and 2021-2022. Chart obtained from CDC RSV Hospitalization Surveillance Network.[26]

are applicable to our data set as well, especially in the 4-12-year-old age group.

Along with the increase in asthma exacerbations/RAD in 2021, there was also a noted increase in the total number of hospital admissions among the 4-12-year-old age group from 80 (33%) in 2019 compared to 125 (52%) in 2021. The increase in hospital admissions among this age group can be explained by the increase in asthma exacerbations/RAD possibly secondary to resurgence of viral positivity among immunologically naïve school-age children.

Non-school age children had a significant decrease in respiratory hospitalizations in 2020 compared to 2019 and 2021. There were 93% fewer admissions with bronchiolitis in 2020 compared to 2019 and 91% fewer compared to 2021. We suspect that this age group had decreased respiratory hospitalizations in the setting of school closure due to lack of exposure to respiratory pathogens brought home by older school-age/teenage siblings. The 2020 bronchiolitis reduction we noted is comparable to reductions seen in Massachusetts and Italy when compared with previous years. Proposed reasons for the decline included social distancing and other socio-sanitary measures such as hand hygiene, face masks, and stay at home orders.[20,21]

RSV positive admissions followed a similar trend as bronchiolitis with significant reductions in 2020 compared to 2019 and 2021, but also a significant decrease in 2021 from 2019. RSV positive hospitalizations made up 53% of the total respiratory hospitalizations in 2019 compared to 0% during school closure and 36% in 2021. A similar reduction was present across Michigan as shown in Figure 2.[22] Significant decreases in respiratory infections during the COVID-19 pandemic are well documented in the literature.[23-25]

The decrease in RSV positive admissions, and subsequently, bronchiolitis found in 2021 compared to pre-pandemic (2019) could be a consequence of seasonal changes in RSV. An atypical surge prior to the normal peak in December to February has been reported.[25,27] Similar to the overcorrection theory postulated by Hazan et al[28], Bardsley et al[23] hypothesized that the lack of RSV during winter 2020 to 2021 led to an "immunity debt," with young children who did not have previous immunity to RSV becoming more susceptible to infection when health precautions were relaxed.

Although school closure could be an effective way to mitigate the spread of respiratory viral illness, there are negative consequences to closing schools. School closures result in loss of access to school-based programs

such as specialized learning plans, extracurricular and enrichment activities, and healthcare services. It also results in loss of special services for children with disabilities. Similarly, many children rely on school lunch and physical education programs as their daily source of nutrition and exercise. Without regular healthy nutrition and exercise, children can develop a rising body mass index which contributes to childhood obesity.[29,30]

School closure also affects child mental health. Children develop the necessary social and emotional skills through school from frequent interaction with their peers. With school closure, children do not develop these skills as readily. When confined to their home, they can experience increased anxiety and loneliness from the lack of relationships with their peers.[29,31] School closures can also contribute to widening educational disparities, as children from low socioeconomic backgrounds may not have access to resources that support remote learning.[29] These negative effects of school closure on the physical, psychosocial and educational well-being of children should be considered when weighing the benefits of school closure on infection control.

This study had several limitations. It is a retrospective, single-center study in an urban setting with a small sample size. There were concurrent preventative measures instituted to mitigate virus spread during the pandemic in 2020 and 2021, which made it difficult to isolate the effect of prolonged school closure alone on respiratory illness. Although we did try to account for seasonality of viruses by comparing our prolonged school closure cohort to the same 6-week period in our other years, we did not foresee the seasonal variation in RSV that resulted in 2021. Data pertinent to other viruses may not represent true prevalence as patients were not universally screened using a full respiratory viral panel. In addition, patients presenting to the emergency department but not requiring admission were excluded from this study and would provide a unique perspective on prevalence of mild respiratory symptoms and other diagnoses during the time periods of interest. Morbidity and mortality were not assessed although severity of illness is an important consideration in pandemic response.

We did not assess daycare or preschool closure which could have influenced our non-school age group. However, Child Care Aware of America reported that 89% of child care centers in the Midwest had already been reopened by December of 2020.[32] Data was not available for attendance in these centers during that time, but as of August 2020, attendance had reached approximately 70%.[33] There were no group size restrictions in place at child care centers in Michigan as of November 2020.[34]

Despite these limitations, our study shows that during prolonged school closure, there was a significant decrease in pediatric respiratory hospitalization. Therefore, school closure should be considered when creating a pandemic and even epidemic response strategy.

More studies are needed in other geographic locations where prolonged school closure was instituted. Also, the increase in asthma/RAD exacerbations in 2021 compared to 2019 when most other diagnoses decreased elicits some follow up considerations. There is a paucity of data in the literature about asthma preventative care during the pandemic. This should be addressed along with its effect on asthma hospitalization, morbidity, and mortality.

Conclusion

This study examined the association between prolonged school closure and hospitalization secondary to pediatric respiratory illnesses. Although we are greater than 3 years past the initial announcement of COVID-19 as a pandemic in the United States, new variants of the COVID-19 virus are still being identified. Therefore, it is important to analyze and decide what strategies work best to decrease the future risk of transmission and infection in our pediatric population. It is also imperative to consider the role of children as vectors of viral transmission to the general population in any future preventative measures taken to combat the spread of COVID-19. School closure is a preventative measure that was instituted to mitigate virus spread during the COVID-19 pandemic, and our study shows that it is associated with a significant decrease in hospitalization for pediatric respiratory illness.

Abbreviation/Acronym List

RAD Reactive Airway Disease
RSV Respiratory Syncytial Virus
RVP Respiratory Viral Panel
DIB Difficulty in Breathing
PICU Pediatric Intensive Care Unit
NICU Neonatal Intensive Care Unit
DX Diagnosis
CC Chief Complaint

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Author Contributions

AJB: Contributed to conception and design; Contributed to acquisition, analysis, and interpretation; Drafted the manuscript; Critically revised the manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy. ZFS: Contributed to conception and design; Contributed to acquisition, analysis, and interpretation; Drafted the manuscript; Critically revised the manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy. AMG: Contributed to conception and design; Contributed to acquisition, analysis, and interpretation; Drafted the manuscript; Critically revised the manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy. ATM: Contributed to conception and design; Contributed to acquisition, and analysis; Drafted the manuscript; Critically revised the manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy. RK: Contributed to conception and design; Contributed to acquisition and analysis; Drafted the manuscript; Critically revised the manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy. SH-E: Contributed to conception and design; Contributed to acquisition and interpretation; Critically revised the manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy.

Declaration of Conflicting Interests

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Ethical/Consent Statement

Our study was approved by the Central Michigan University Institutional Review Board (approval no. 2021-1084) on September 26, 2021. This is a retrospective study and does not require informed consent. Patient data will not be shared with outside parties.

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