



# Applying Lessons from the COVID-19 Pandemic to Improve Pediatric Asthma Care

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## ABSTRACT

Asthma is the most common chronic childhood condition and is a risk factor for severe respiratory viral infections. Thus, early during the coronavirus disease 2019 (COVID-19) pandemic there was concern that children with asthma would be at risk for severe COVID-19 illness and that asthma control could worsen as a result of the pandemic. This article seeks to summarize what was learned in the early stages of the pandemic about the impact of COVID-19 on children with asthma. We review evidence from several studies that demonstrated a significant decline in asthma morbidity in the first year of the pandemic. Additionally, we describe several potential mechanisms that may explain the reduced frequency in childhood asthma exacerbations as well as review lessons learned for future management of childhood asthma. While the COVID-19 pandemic initially brought uncertainty, it soon became clear that the pandemic had several positive effects for

children with asthma. Now we can apply the lessons that were learned during the pandemic to re-examine asthma care practices as well as advocate for best approaches for asthma management.

**Keywords:** Coronavirus; Environmental exposures; Children; Emergency department; Hospitalization; Morbidity; Exacerbations; Asthma triggers

### Key Summary Findings

Acute asthma exacerbations were less common during the first year of the COVID-19 pandemic compared with years prior to the pandemic; however, children who sought urgent asthma care during the first year of the pandemic may have had higher-acuity illness.

Potential mechanisms of reduced childhood asthma exacerbation frequency include: fewer viral infections, less physical activity, less air pollution, fewer school exposures, improved hygiene, and improved medication adherence.

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Opportunities from the COVID-19 pandemic, including rapid expansion of telemedicine, home spirometry, and improved indoor air quality in schools, can improve long-term asthma management.

Clinicians can use lessons learned from the pandemic to advocate for child health and health equity in the post-COVID era.

## INTRODUCTION

Asthma is the most common chronic childhood condition and has been linked to poor health outcomes. One in 12 children are affected in the USA, with Black and Hispanic children twice as likely to have asthma than White children [1]. Half of children with asthma have an exacerbation each year, resulting in 13.8 million missed school days, 1 million emergency department (ED) visits, and 140,000 hospitalizations annually [2–6].

It is well established that asthma is a risk factor for severe respiratory viral infections [7]. For example, asthma is associated with worse outcomes for children who have influenza [8], including a four-times-higher chance of being hospitalized [9]. As such, when the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus was first identified, there was uncertainty about how the virus would affect individuals with asthma. Early evidence suggested that certain groups had more severe disease with COVID-19, including populations disproportionately affected by asthma; however, it was unknown whether individuals with asthma would be at higher risk for contracting COVID-19, becoming more ill with COVID-19, and/or requiring greater healthcare use. Further, it was unknown whether asthma control would worsen during the COVID-19 pandemic owing to the effects of the disease or other aspects of the world's response. This article seeks to summarize what was learned in the pandemic's early stages about the impact of COVID-19 on children with asthma and consider lessons learned

for future care. This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

## PEDIATRIC ASTHMA DURING THE EARLY COVID-19 PANDEMIC

Early in the pandemic, there was a notable decline in acute asthma exacerbations requiring emergency intervention and hospitalization based on data predominately from large children's hospitals (Table 1). Many of these studies focused on healthcare utilization, while fewer focused on other metrics of asthma, such as disease control and medication adherence.

Kenyon and colleagues examined ED utilization for pediatric asthma exacerbations among children in Philadelphia during the first 4 months of the pandemic using a longitudinal, time-series analysis [10]. They compared ED visits for asthma from January to April 2020 to average daily visit counts in the prior 4 years. The authors reported a 76% decline in ED visits for childhood asthma during the early months of the pandemic compared with prior years. The decline corresponded with the citywide stay-at-home order implemented in mid-March 2020, was well below seasonal variation, and was observed for all levels of triage acuity. Additionally, the proportion of asthma ED visits resulting in hospitalization decreased in the month following the first reported COVID case, suggesting the decline in visits was not simply due to ED avoidance or delays in seeking care. Similar observations of reduced ED visits for asthma were observed in another urban center in Detroit that also corresponded with school closures in mid-March 2020 [11].

Simoneau and colleagues examined ED visits for asthma among children ages 2–22 years in Boston comparing the months of January to May 2020 with the same 5-month period in 2018 and 2019 [12]. They too observed a rapid decline of over 80% in ED visits for asthma beginning in mid-March of 2020 compared with the 2 years prior. Contrary to the Kenyon study, the percentage of asthma exacerbations

**Table 1** Summary of several key studies examining impact of COVID-19 on asthma outcomes among children

Study	Population	Location	Time period	Outcomes
Arsenault et al., <i>Allergy Asthma Proc</i> 2021	Children	Detroit, MI	January 2019 to December 2020	<ul style="list-style-type: none"> <li>• Decrease in ED visits for asthma each month starting in March 2020</li> <li>• Most significant decreases in spring 2020 and late summer through fall 2020</li> </ul>
Chua et al., <i>Pediatrics</i> 2021	0–19 years	USA, National	2018–2020	<ul style="list-style-type: none"> <li>• 23.5% decline in prescriptions dispensed for anti-asthmatics and 40.2% decline in short-acting beta-agonists in April to December 2020 versus 2019</li> </ul>
Kenyon et al., <i>J Allergy Clin Immunol Pract</i> 2020	Children	Philadelphia, PA	January to April 2020, compared with 2016–2019	<ul style="list-style-type: none"> <li>• Mean daily asthma ED visit rate decreased by 18.5 visits per day or 76% lower than pre-COVID</li> <li>• Similar findings regardless of triage acuity</li> <li>• Decrease in children admitted to hospital from ED from 31% pre-COVID to 22% in month after</li> </ul>
Papadopoulos et al., <i>Allergy</i> 2021	Children	Multinational, 25 departments in 15 countries	2020, compared with 2019	<ul style="list-style-type: none"> <li>• Fewer upper respiratory tract infections, fevers, ED visits, and hospital admissions in 2020 versus 2019</li> <li>• More than 90% had improved or unchanged asthma control</li> <li>• Improved FEV1 and peak expiratory flow rate</li> <li>• Increased treatment based on self-reported use of albuterol, inhaled corticosteroids, or systemic steroids</li> <li>• High self-report of adherence to asthma medications</li> </ul>
Sheehan et al., <i>J Allergy Clin Immunol Pract</i> 2021	2–17 years	Washington, DC	September to November 2020, compared with 2016–2019	<ul style="list-style-type: none"> <li>• Asthma-related ED visits, hospitalizations, and PICU admissions decreased in April 2020 and remained lower in summer and fall compared to prior years</li> <li>• Ratio of hospitalizations to ED visits higher during fall 2020 versus pre-pandemic</li> </ul>

**Table 1** continued

Study	Population	Location	Time period	Outcomes
Simoneau et al., <i>Ann Am Thor Soc</i> 2021	2–22 years	Boston, MA	January to March 2020, compared with 2018–2019	<ul style="list-style-type: none"> <li>• Decrease in ED visits for asthma after March 2020 by &gt; 80% versus 2018 and 2019</li> <li>• Percentage of total ED visits that were due to asthma was lower in 2020 versus 2018 and 2019</li> <li>• Proportion of asthma exacerbations requiring hospitalization was higher in 2020 than 2019 (but not 2018)</li> </ul>

that required admission to the hospital was higher in 2020 compared with 2019 (but not 2018), suggesting that the cases that did seek medical attention may have been of higher acuity. Sheehan and colleagues also observed that the ratio of hospitalizations to ED visits, as well as the ratio of PICU admissions to ED visits, was higher during the fall of 2020 compared with pre-pandemic years in a cohort of children aged 2–17 years in Washington DC [13]. This finding suggests that children presenting to the ED were more likely to be acutely ill. The authors hypothesized several potential reasons, including: potential fear of presenting to health care facilities due to anxiety about COVID; financial difficulties leading to delayed visits or refills; transportation issues; or caregiver illness that could have resulted in later presentation to health care. Another plausible explanation is that ED clinicians were more reluctant to discharge children with acute asthma exacerbations during the height of the pandemic.

In addition to a decline in urgent treatment of childhood asthma, prescriptions for asthma medications also declined in the early months of the pandemic. To examine prescription patterns, Chua and colleagues evaluated data from the IQVIA national prescription audit that contains monthly dispensing data from 92% of all US retail pharmacies [14]. They compared dispensing of all prescriptions in 2019 to 2020

and observed a 23.5% decline in asthma controller medications and 40.2% decline in short-acting beta-agonist prescriptions dispensed between April and December in 2020 compared with 2019. The authors posit that one explanation for this decline could be financial hardship during the pandemic that may have contributed to patients being unable to fill their prescriptions. Also, these data are limited in that we are not able to discern actual use of medications.

The observations of reduced frequency in childhood asthma exacerbations during the early pandemic period was not limited to the USA. One multinational study examined over 1000 children with asthma compared with over 500 children without asthma across 15 different countries as part of the Pediatric Asthma in Real Life (PeARL) consortium [15]. Papadopoulos and colleagues observed that children with asthma experienced fewer upper respiratory tract infections, fevers, ED visits, and hospital admissions due to asthma in 2020 compared with the year prior. They also observed that over 90% of their cohort had improved or unchanged asthma control and less than 10% reported worse asthma control in 2020. Interestingly, contrary to the study by Chua and colleagues, they reported an increased need for asthma treatment defined as increased self-reported albuterol use, inhaled corticosteroids, and

systemic steroids. They also observed a high self-report of adherence to asthma medications.

Taken together, these studies demonstrate that acute asthma exacerbations were less common during the first year of the COVID-19 pandemic compared with years prior to the pandemic. However, children who sought urgent asthma care may have had higher acuity illness as suggested by the higher ratios of hospitalizations and intensive care admissions compared with ED visits. Typical seasonal variations seen with asthma exacerbations were less prevalent during the COVID-19 pandemic. These findings suggest that the pandemic led to unique effects on children with asthma due to illness and non-illness-related influences.

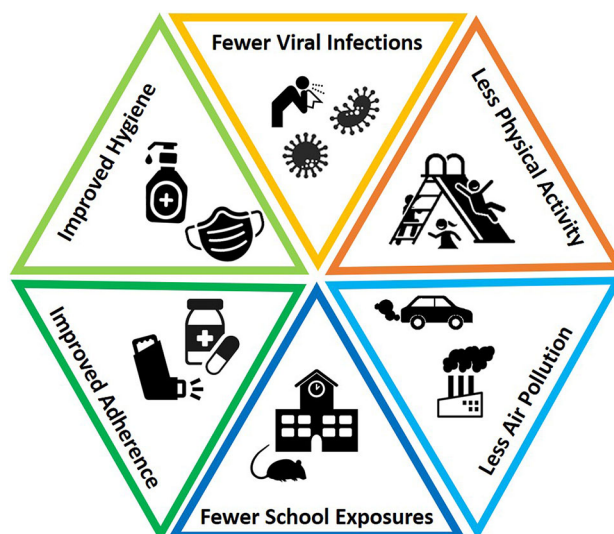
## POTENTIAL MECHANISMS OF REDUCED CHILDHOOD ASTHMA EXACERBATION FREQUENCY

Decreased exposure to several well-documented triggers of asthma could have contributed to reduced exacerbation frequency (Fig. 1). For example, a scoping review of 84 studies published from March 2020 to July 2021 demonstrated a significant decline in childhood physical activity patterns [16]. Reduced activity

by children during the first year of the pandemic was attributed to lockdown policies that limited the ability for children to engage in organized sports and other school-based activities and was worse in communities of low socioeconomic status and with limited locations for safe outdoor play. For many children, physical activity represents a trigger for acute asthma exacerbations and thus their reduced physical activity may have led to fewer exacerbations.

Multiple studies have described reduced air pollution exposure during the months of lockdown in many countries across the globe. Exposure to air pollution is a well-documented trigger of asthma exacerbations; thus, reduced pollution may have contributed to the decline in acute exacerbations. Additionally, environmental allergen exposure in school environments, particularly in urban communities, has been linked to childhood asthma morbidity [17, 18]. For example, studies have demonstrated that mouse allergen exposure is significantly higher in some Boston schools compared with in children's homes [18]. Thus, lockdown policies that kept children out of school may have led to reduction in environmental school exposures that could trigger asthma.

Indoor exposures in home environments, including allergens (e.g., dust mites, pets,



**Fig. 1** Potential mechanisms of reduced childhood asthma exacerbation frequency during the COVID-19 pandemic

rodents, molds) and pollutants (e.g., gas stoves, household disinfectants), have been implicated in contributing to disparities in childhood asthma prevalence and morbidity in urban, minoritized, and low-income communities. However, as described above, the prevalence of asthma exacerbations during the initial peak of the COVID-19 pandemic was significantly lower than in the same months during prior years. Interestingly, the reduced frequency of severe childhood asthma exacerbations corresponds with a period when children were locked down in their homes and presumably exposed to high concentrations of allergens and pollutants. This represents a paradox between increased home environmental asthma trigger exposures during COVID lockdown periods and reduced acute childhood asthma exacerbations that required healthcare utilization.

The decline in other respiratory viruses apart from COVID, particularly during the first year of the pandemic, has been well documented as well. Vittucci and colleagues conducted a retrospective analysis of nasopharyngeal samples from children aged 0–18 years in Italy from 2018 to 2021 [19]. They observed a significant decline in all viral respiratory infections by nearly 80% when they compared the 2020–2021 respiratory viral season (September to February) with the 2 years prior. Similar declines in overall childhood respiratory viral infections, aside from COVID, have been documented in many other countries [19–22]. Stout and colleagues examined unscheduled outpatient visits for asthma in Kansas City, Missouri from January to December 2020 compared with 2010–2019 using monthly visit counts [23]. After adjusting for known asthma triggers, including air pollution, pollen counts, and viral PCR test results, they observed that the decrease in healthcare utilization was attributed to a decline in overall respiratory viral infection rates.

The reduction in viral respiratory infections during the first year of the COVID pandemic could be attributed to a multitude of factors including increased vigilance with hand hygiene, social distancing, and masks working to reduce the spread of COVID. As an example, in the Morbidity and Mortality Weekly Report

from October 2021, there were significantly fewer pediatric COVID-19 cases between 1 July and 4 September 2021, within schools that had mask mandates compared with those with no mask mandates [24]. Thus, mask mandates likely contributed to reduction in overall respiratory viral transmission in addition to reducing the spread of COVID.

Lastly, improved medication adherence as documented in the multinational study by Papadapoulous and colleagues could have played a role in reduction in asthma exacerbations.

## OPPORTUNITIES FROM THE COVID-19 PANDEMIC THAT CAN IMPACT LONG-TERM ASTHMA MANAGEMENT

One of the most significant changes in outpatient management of chronic illnesses was the rapid expansion of telehealth services that allowed patients to seek medical care in a virtual environment. Usher-Pines and colleagues reported an increase in pediatric pulmonary telehealth visits from May 2020 to April 2021 compared with the year prior across eight large pediatric medical groups in California with a 38.8% rate of telehealth use during the pandemic period [25]. Telemedicine offers the opportunity to provide medical care remotely, which may be convenient for many patients and families and help overcome barriers to in-person visits such as missed school and workdays or transportation. However, it must be acknowledged that the digital divide continues to widen and people from marginalized groups and with lower socioeconomic status may have fewer opportunities to engage in telehealth services [26, 27].

Opportunities for home-based spirometry measurement also increased during the pandemic, particularly when pulmonary function laboratories closed or reduced their volumes to decrease the spread of COVID-19 that may be attributed to the aerosol-generating procedure. Prior to the pandemic, studies evaluated the utility of home spirometry to monitor children

with asthma and showed its potential for use [28]. Nichols and colleagues provided home spirometers to children with asthma and asked them to perform spirometry 24 h prior to their in-person or virtual visit or if symptomatic from asthma. The authors observed a significant reduction in canceled visits and no-show appointments as well as a reduction in hospitalizations for asthma during March to August 2020 compared with the same months the year prior that was attributed to the use of home spirometry. Thus, both virtual visits and home spirometry may be useful tools to improve attendance for follow-up visits in children with difficult-to-treat asthma.

Another major consequence of the COVID-19 pandemic were the efforts to improve indoor air quality, particularly in schools. Ventilation protocols that included opening windows to allow fresh outdoor air supply and installing HEPA filters and air purifiers in classrooms were targeted at reducing COVID-19 transmission. Yet, they also served the purpose of reducing indoor ambient pollutants and allergens that are known asthma triggers. Regular monitoring of indoor air quality, including in the school environment, could be the first step towards reducing indoor environmental exposures that may contribute to asthma exacerbations. Thus, several questions arise regarding the school environment and interventions to reduce childhood asthma morbidity: Should children with asthma continue to wear masks at school, especially during viral outbreaks? Should classroom sizes be modified for children with asthma? Should children with the most severe asthma be offered hybrid options for education, such as limiting in-person schooling during peak season for asthma exacerbations? While viable options, with each of them, we must consider social, financial, and practical implications for families and schools.

Several opportunities exist for child health advocacy for clinicians caring for children with asthma in the post-COVID era [29]. For example, clinicians and health advocates can use lessons learned from the pandemic to redouble advocacy efforts aimed at improving air quality. The pandemic also presents an opportunity to consider novel ways to maximize the delivery of

seasonal vaccines that are thought to reduce risk, particularly in children with asthma, such as the influenza and COVID vaccines. Continued support for video and telephone visits both from a reimbursement perspective and from an equitable health care delivery perspective could improve access to care. Health disparities were amplified and widely acknowledged during the pandemic, providing an opportunity to advocate for greater support to improve health equity through research and clinical care. Lastly, Rao and colleagues highlight that pediatric pulmonologists are in a unique position to advocate for increased support for state and local initiatives to increase access to high-quality asthma care and general health maintenance related to bias and equity [29].

## CONCLUSIONS

The COVID-19 pandemic brought to light important evidence regarding asthma for children with evidence suggesting benefits in terms of asthma control and morbidity. While this time initially brought uncertainty, it soon became clear that the pandemic had several positive effects for children with asthma. It is important to note that the studies described above were observational in nature so causation cannot be proven. Nonetheless, several potential explanations exist for the improved asthma control and morbidity during the pandemic. Considering potential reasons for such benefits and long-term implications is important. As such, it is now time to critically examine and apply lessons learned during the pandemic to re-examine asthma care practices and advocate for best approaches for asthma management.

Importantly, this article sheds light on the acute effects of the COVID-19 pandemic on children with asthma. Most data presented come from large academic centers in urban areas. The effects are likely not homogeneous, and the data presented cannot be generalized to all communities. Also, the long-term manifestations of an infection with SARS-CoV-2 on individuals with asthma are not yet well understood. Further research is required to understand the effects of the infection and the

pandemic on children with asthma from diverse backgrounds and locations. Such findings have potential to positively impact long-standing pediatric asthma inequities.

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**Compliance with Ethics Guidelines.** This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

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