

# Pediatric Respiratory Illness Hospitalizations Prior to COVID-19 and During the First Year of the COVID-19 Pandemic in Southeast Wisconsin

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## ABSTRACT

**Background:** Public health measures combatting the COVID-19 pandemic also led to a decrease in other pediatric respiratory illnesses. We describe the local pattern of pediatric respiratory hospitalizations in southeast Wisconsin prior to COVID-19 and during the first year of the pandemic.

**Methods:** We performed a cross-sectional examination of hospitalizations for asthma, bronchiolitis, and bacterial pneumonia at a single tertiary children's hospital prior to COVID-19 through the first year of the COVID-19 pandemic.

**Results:** We found a significant decrease in the average monthly hospitalization rates prior to and during COVID-19 for asthma, bronchiolitis, and bacterial pneumonia ( $P < 0.001$ ), with average percent decrease of hospitalizations per month of 48%, 78%, and 47.7%, respectively.

**Discussion:** The decrease in hospitalizations is likely multifactorial and related to public health measures, behavior changes, and other epidemiological factors.

including respiratory syncytial virus (RSV) and influenza, and associated diseases like asthma and bronchiolitis.<sup>2,3</sup> Asthma, bronchiolitis, and bacterial pneumonia are among the most common respiratory diagnoses leading to the hospitalization of children.<sup>4</sup> These respiratory illnesses have a seasonality to their presentations: asthma prevalence increases in the fall with a peak in September and October, while bronchiolitis and bacterial pneumonia increase in the winter with peaks in December and January.<sup>5,6</sup> The annual respiratory season typically spans September through April.

Public health measures against COVID-19 began in Wisconsin with a declaration

## INTRODUCTION

The coronavirus 19 (COVID-19) pandemic led to dramatic changes in the behavior of populations worldwide to limit the spread of severe acute respiratory syndrome coronavirus 2 (SAR-CoV-2). Early public health measures taken against COVID-19 included masking, physical distancing, limiting the size of gatherings, restricting travel, and moving businesses and schools to virtual environments.<sup>1</sup> These measures affected the incidence of other infectious illnesses. Early in the pandemic, there was a significant decrease in the prevalence of other respiratory viruses,

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of a public health emergency on March 12, 2020. All schools closed the following day and remained closed through the end of the school year.<sup>7</sup> The Safer at Home Order was enacted on March 24, 2020, which limited movement outside the home to essential functions and closed nonessential businesses, although it was later overturned by the Wisconsin Supreme Court on May 13, 2020. The first statewide mask mandate was issued on July 30, 2020.<sup>8</sup> In the fall, school districts in southeast Wisconsin remained primarily virtual, with some districts offering opt-in plans for in-person education or hybrid models. Throughout the school year, more schools began to return in-person, and most schools were back to in-person education by March 2021 with mask requirements. The effect of these local public health measures in southeastern Wisconsin on pediatric respiratory illnesses over a full respiratory season has not been described.

Our objective is to describe the incidence of hospitalization for 3 common pediatric respiratory illnesses—asthma, bronchiolitis, and bacterial pneumonia—in southeast Wisconsin and com-

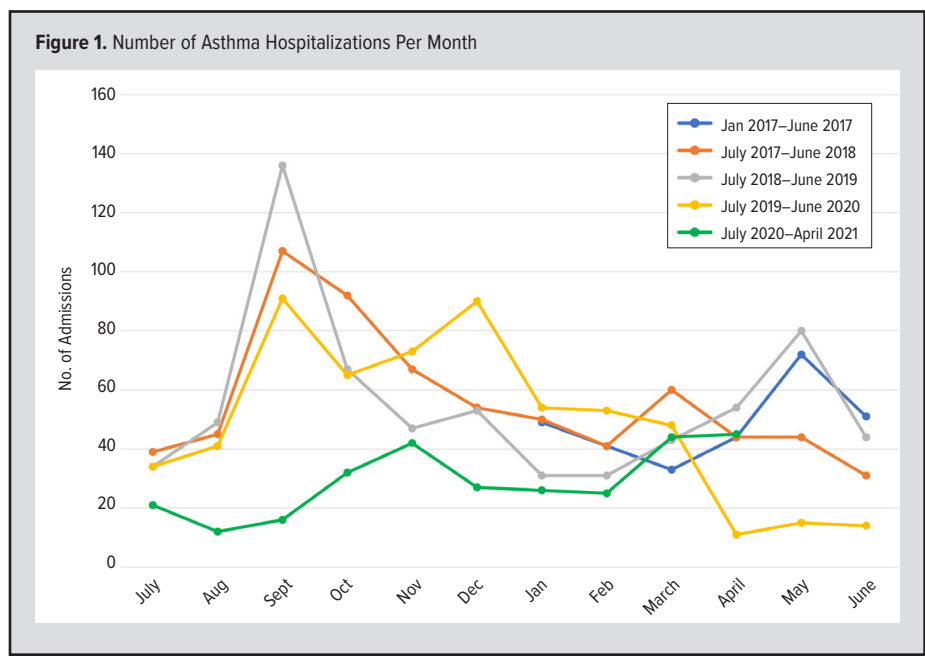
pare pre-COVID-19 respiratory seasons during 2017-2019 with the 2020-2021 intra-COVID-19 respiratory season corresponding to the first full respiratory season of the COVID-19 pandemic. Earlier literature describing the trend towards a decrease in pediatric respiratory illnesses during the pandemic did not capture a full respiratory season and was limited to the earlier months of the pandemic when public health measures were most robust. In this study, we include the first full respiratory season in the northern hemisphere since the declaration of the COVID-19 pandemic.

## METHODS

This is a retrospective examination of hospitalizations at a single center in Milwaukee, Wisconsin from September 1, 2017, through April 30, 2021. Our hospital is a 306-bed tertiary care, academic, stand-alone children's hospital and admits over 16,000 patients per year, on average, prior to the COVID-19 pandemic. Our primary catchment area is the southeast region of Wisconsin, representing an approximate population of 2,260,000.<sup>9</sup> Our site Institutional Review Board deemed this study exempt.

We identified all patients hospitalized in the acute and intensive care units with encounter diagnoses of asthma, bronchiolitis, and bacterial pneumonia using ICD-10 codes (*International Statistical Classification of Diseases, Tenth Revision*) (Appendix 1). Results included patients hospitalized under observation and inpatient status and were analyzed by month. Patients aged 0-24 months with bronchiolitis and 0-18 years with asthma or bacterial pneumonia were included.

The pre-COVID-19 period was defined as January 2017 through February 2020; the intra-COVID-19 period was defined as March 2020 through April 2021. The pre-COVID hospitalization mean by calendar month was calculated using each corresponding month's hospitalizations during 2017-2019. The month with the highest mean hospitalizations was defined as the peak month. The percent reduction in hospitalizations was calculated using pre-COVID peak month means and the intra-COVID hospitalizations for that corresponding month. The mean monthly hospitalization rate during the respiratory season (September-April) was calculated for each diagnosis pre- and intra-COVID. Two-tailed *t* test assuming unequal variances was applied to determine significant difference between the mean monthly hospitalizations pre- and intra-COVID. All calculations were done in Microsoft Excel for Microsoft 365 MSO version 16.0.



## RESULTS

### Asthma

Pre-COVID-19, asthma admissions showed a seasonal increase in the fall, winter, and spring months, with peaks in September and May (Figure 1). Admissions sharply declined in April 2020 and remained low without a typical peak during the fall. The pre-COVID peak month was September with 111.3 hospitalizations, while intra-COVID September had 16 hospitalizations—an 85.6% decrease in peak month hospitalizations. The pre-COVID mean monthly hospitalization rate was 60.9 (SD ± 24.6, range 31-136) and intra-COVID mean was 31.6 (SD ± 12.1, range 11-48), significantly lower ( $P < 0.001$ ) than the pre-COVID average and corresponding to a 48% decrease.

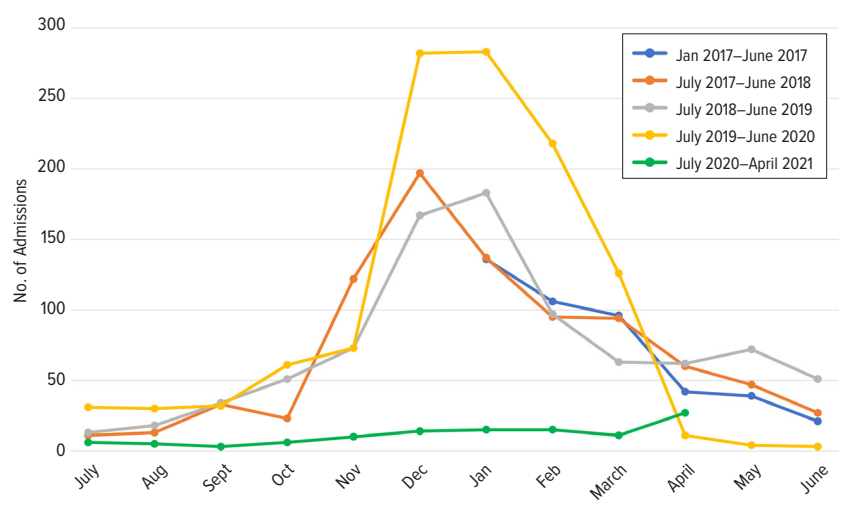
### Bronchiolitis

Pre-COVID bronchiolitis hospitalizations increased in the fall, peaking around December and January and decreasing in the spring (Figure 2). Intra-COVID-19, there was a sharp decrease in hospitalizations starting in April 2020 and lack of the typical seasonal increase in the fall and winter. The pre-COVID peak month for hospitalizations was December, with a mean hospitalization of 215.3. The intra-COVID December had 14 hospitalizations, a 93.5% decrease. The mean number of admissions per month during the pre-COVID respiratory season was 108.5 (SD ± 72.1, range 23-283). During the intra-COVID respiratory season, the monthly hospitalization mean was 23.8 (SD ± 34.6, range 3-126), significantly lower than the pre-COVID monthly mean ( $P < 0.001$ ) and representing a 78% decrease.

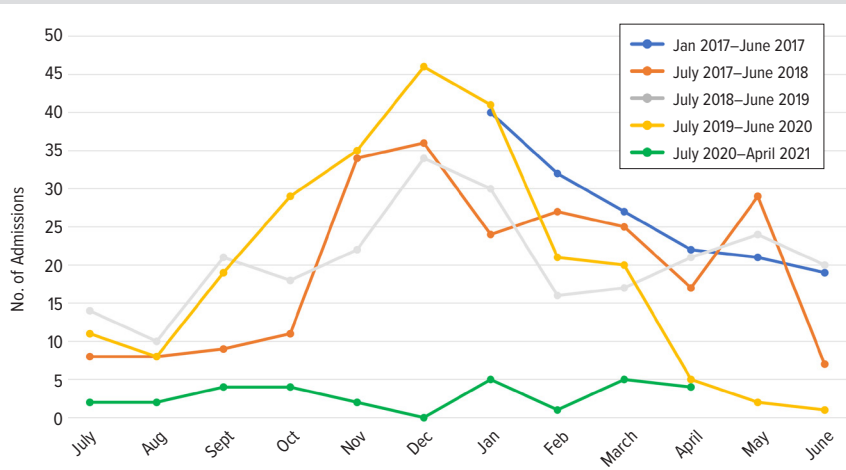
### Bacterial Pneumonia

Pre-COVID-19 admissions showed a seasonal peak in December and January (Figure 3). Bacterial pneumonia admissions declined

**Figure 2.** Number of Bronchiolitis Hospitalizations Per Month



**Figure 3.** Number of Bacterial Pneumonia Hospitalizations Per Month



in April 2020 and remained low. December was the peak month for pre-COVID hospitalizations, with an average of 39 versus zero during the intra-COVID December—a 100% decrease. The mean monthly hospitalization rate during the pre-COVID respiratory seasons was 60.4 (SD ± 24.6, range 31-136). The intra-COVID mean monthly hospitalization rate was significantly lower ( $P < 0.001$ ) at 31.6 (SD ± 12.1, range 11-48), representing a 47.7% decrease from pre-COVID.

## DISCUSSION

Pediatric hospitalization rates for bronchiolitis, asthma, and bacterial pneumonia decreased significantly during the first year of the COVID-19 pandemic in southeastern Wisconsin. Our findings are consistent with previous literature describing the seasonality of pediatric respiratory illnesses prior to the pandemic<sup>5,6</sup> and the decrease in pediatric respiratory illnesses after implementa-

tion of public health measures to combat the pandemic.<sup>2,3,10</sup> In contrast to previous work, our data spans an entire respiratory season and show that both observational and inpatient hospitalizations remained low in southeastern Wisconsin during the COVID-19 pandemic, despite fluctuations in public health measures throughout the year.

We chose to examine the hospitalization rates of bronchiolitis, asthma, and bacterial pneumonia, as they are common pediatric lower respiratory tract diseases with seasonal presentations but differing underlying etiologies. Despite different etiologies, all 3 diseases showed a marked decrease in incidence during the COVID-19 pandemic response and blunting of prior seasonality.

The decrease in pediatric hospitalizations for respiratory illness is likely multifactorial and related to public health measures and behavior changes occurring as a response to the pandemic. Pre-COVID-19, handwashing and physical distancing were shown to decrease viral respiratory illnesses in children.<sup>11,12</sup> We saw the largest percent decrease pre- to intra-COVID-19 admissions in bronchiolitis—the diagnosis most closely tied to viral transmission—with significant but smaller percent decreases in asthma and bacterial pneumonia. The smaller decreases in asthma and bacterial pneumonia may relate to nonviral drivers of seasonality such as allergens.<sup>13</sup> Results

also may reflect patients being less likely to seek care for respiratory illnesses, although the longer time frame of our study makes this less likely as restrictions on movement and businesses were eased. As public health measures continue to be eased, a resurgence of respiratory illnesses may be seen. The overall lack of immunity to typical respiratory viruses given the lack of exposure over the past year may also lead to an increased incidence of respiratory hospitalizations during the next winter season.<sup>14</sup> Our data may suggest that sustainable public health measures aimed at reducing viral transmission (ie, masking, handwashing) might ease pediatric hospitalizations without the need for the more invasive measures such as lockdowns taken earlier in the pandemic.

Our study has several limitations, including being a single center study. While our hospital is the only tertiary pediatric hospital in the southeastern Wisconsin region, patients may have been seen in other regions or states. Because this is an observational study,

causation for the decrease in hospitalizations for respiratory illnesses cannot be established, although it is reasonable to suspect that public health measures likely had an impact on hospitalizations. Identifying hospitalizations by diagnoses codes is limited by errors in coding and hospitalizations with multiple diagnoses. Further, we were unable to determine individual exposures such as daycare use and sick contacts, which may have provided insight into other epidemiological factors and their impact on hospitalization rates during the COVID-19 pandemic.

Our study confirms locally the decrease in hospitalizations for respiratory illnesses in pediatric patients during the first year of the COVID-19 pandemic. Continued surveillance of respiratory hospitalizations is warranted given changing public health measures and increasing in-person interactions, and it remains to be seen how further developments with the COVID-19 pandemic may continue to affect pediatric hospitalizations. Likewise, further research is needed to elucidate the optimal balance between public health measures targeting the general spread of infectious respiratory illnesses and their impact on society.

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**Appendix:** Available at [www.wmjonline.org](http://www.wmjonline.org).

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