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Childhood asthma diagnoses declined during the COVID-19 pandemic in the United States

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Abstract

Background Prior studies have documented declines in pediatric asthma exacerbations and asthma-related health care utilization during the COVID-19 pandemic, but less is known about the incidence of asthma during the pandemic.

Methods We conducted a retrospective cohort study of children under age 18 without a prior diagnosis of asthma within a large US commercial claims database. Incident asthma was defined using a combination of diagnosis codes, location of services, and medication dispensing. Crude quarterly rates of asthma diagnosis per 1000 children were calculated, and the incidence rate ratio and 95% confidence interval were estimated for newly diagnosed asthma during versus before the pandemic using negative binomial regression, adjusted for age, sex, region, and season.

Results Compared with 3 years prior to the pandemic, crude incident diagnosis rates of asthma decreased by 52% across the first four quarters of the US pandemic. The covariate-adjusted pandemic-associated incidence rate ratio was 0.47 (95% confidence interval 0.43, 0.51).

Conclusions New diagnoses of childhood asthma in the US declined by half during the first year of the pandemic. These findings raise important questions whether pandemic-related changes in infectious or other triggers truly altered the incidence of childhood asthma beyond the well-described disruptions in healthcare access.

Keywords Asthma/epidemiology, Child, Adolescent, Pandemics, Database

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Background

The COVID-19 pandemic has caused profound interruptions in healthcare access and delivery [1, 2]. Prior studies have documented declines in pediatric asthma exacerbations and asthma-related emergency department usage and hospitalization [2, 3]. Only one previous paper studied incident asthma diagnoses in children [4]. However, this study from Japan included data only from selected facilities with complete electronic medical record data, identified patients based on a single asthma diagnosis, and did not evaluate incidence rates of diagnosis based on a known denominator.

Given the unanswered questions about asthma diagnoses in children during the COVID-19 pandemic, we sought to determine whether there were pandemic-related declines in the incidence of new asthma diagnoses in children in the United States.

Methods

Aim, design and setting

To examine whether the incidence of new asthma diagnoses in children in the United States changed during the early stages of the COVID-19 pandemic, we performed a retrospective cohort study. We conducted this study using the HealthCore Integrated Research Database (March 2016–February 2021), a large US commercial claims database.

Study population

We identified members under 18 years old with ≥ 12 months of baseline continuous enrollment without a prior diagnosis of asthma. Incident asthma was defined using a combination of International Classification of Diseases, Version 10, Clinical Modification (ICD-10-CM) diagnosis codes (J45) and location and timing of medical services (≥ 1 inpatient hospitalization, ≥ 2 outpatient visits ≥ 8 weeks apart, or ≥ 1 outpatient visits plus dispensing of disease-specific medications within

1 month). This algorithm was adapted from previously validated algorithms with positive predictive values $\geq 90\%$ [5].

Comparison

We compared the crude and adjusted rates of new asthma diagnoses during the first year of the US COVID-19 pandemic with rates of new asthma diagnoses during the prior 3 years.

Statistical analysis

Crude rates of asthma diagnosis per 1,000 children per quarter with 95% confidence intervals (CIs) were calculated from 2017 to 2021. Each quarter was 90 days in length and anchored on March 1, 2020, considered the start of the first quarter of the pandemic. Incidence rates during the first year of the pandemic (March 2020–February 2021) versus 3 years before the pandemic (March 2017–February 2020) were modeled using multivariable negative binomial regression with the SAS command, PROC GENMOD. Regression models were adjusted for the following covariates: age group (categorized as 1–5, 6–11, or 12–17), sex (male or female), region (Midwest, Northeast, South, West, or Missing), and quarter (quarters 1–4, to account for seasonality). Models used offsets of the log of children per quarter. Regression coefficients were exponentiated to obtain incidence rate ratios (IRRs) with Wald 95% CI. Analyses were conducted using SAS version 9.4.

Results

Compared with the 12-quarter pre-pandemic period, crude incident diagnosis rates of asthma decreased by 52% across the first four quarters of the US pandemic (pandemic 3.05 per 1000 children [95% CI 2.30–3.80] vs. pre-pandemic 6.40 [95% CI 5.89–6.92]) (Fig. 1).

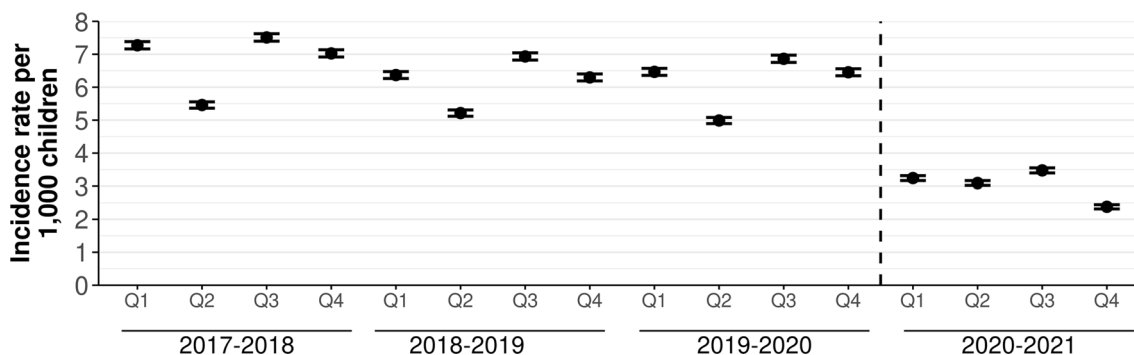


Fig. 1 Quarterly incident diagnosis rates of childhood asthma, March 2017–February 2021. Crude quarterly diagnosis rates of asthma per 1000 children (circles) and 95% confidence intervals (bars). Dashed line indicates start of the US COVID-19 pandemic in March 2020

The covariate-adjusted pandemic-associated IRR aligned with the observed crude rates: 0.47 (95% CI 0.43, 0.51) (Table 1).

Discussion

In a large, geographically diverse pediatric US population, new asthma diagnoses declined by half among children over the first 12 months of the COVID-19 pandemic. These findings underscore a dramatic change in the incidence of asthma in the US during the early phases of the pandemic, complementing other literature on pandemic-related improvements in asthma control.

Prior studies on children with pre-existing asthma documented large reductions in asthma exacerbations and asthma-related use of emergency services during the pandemic [2, 3, 6]. While the pandemic led to notable disruptions in healthcare access and delivery [1, 2], the apparent improvements in asthma control may have also occurred, in part, to lower exposures to circulating respiratory viruses, such as rhinovirus [7], and other environmental triggers [8].

In contrast to the many studies that have focused on pediatric patients and populations previously diagnosed with asthma, much less has been published on the incidence of asthma during the pandemic. To our knowledge, only one prior study has investigated new cases of asthma: a Japanese study showing declines in the number of pediatric asthma diagnoses across multiple facilities in the first 15 months of the pandemic [4]. These authors also showed a correlation between declines in asthma incidence and declines in numbers of documented cases

of respiratory syncytial virus and rhinovirus. In contrast to that study, our study was population-based, performed in a general US population, estimated actual changes in incidence, and used a robust outcome definition.

Viruses such as rhinovirus are well-described triggers of childhood wheezing and subsequent diagnoses of asthma in children [9]. Notably, young children with allergic sensitization are more susceptible to rhinovirus-associated wheezing [10]. Rhinovirus infection may also predispose some children to develop asthma, particularly in the presence of certain commensal respiratory microbiota, such as *Moraxella*, *Haemophilus*, and *Streptococcus*. [11, 12] We posit that physical distancing and wearing of masks in the early stages of the pandemic limited exposure to and inhalation of asthma-inducing respiratory viruses. In various surveillance studies, a substantial reduction in the circulation of rhinovirus and other non-SARS-CoV-2 respiratory viruses was observed early in the pandemic, coinciding with protective measures such as lockdown and school closures [13, 14]. Given the role of pollutants in the development of childhood asthma [15], pandemic-associated declines in air pollution may also have contributed to the observed decrease in asthma incidence [16, 17].

A limitation of our study includes possible misclassification of either asthma diagnosis or newly diagnosed asthma based on our diagnostic algorithm. However, it was based on previously validated and highly accurate algorithms [5]. Additionally, our study did not include more recent data on asthma incidence in the US.

Conclusion

In conclusion, new diagnoses of childhood asthma in the US declined by half during the first year of the pandemic. These findings raise important questions whether pandemic-related changes in infectious or other triggers truly altered the incidence of childhood asthma beyond the well-described disruptions in healthcare access. Research on disease etiology and more recent diagnostic trends and clinical outcomes of asthma will help answer these questions.

Abbreviations

CI	Confidence interval
ICD-10-CM	International Classification of Diseases, Version 10, Clinical Modification
IRR	Incidence rate ratio

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Table 1 Incident diagnosis rate ratios of childhood asthma, March 2017–February 2021

Characteristic	Level	IRR ^a	95% CI
Age Group (reference = 1–5 yo)	6–11 yo	1.21	1.10, 1.33
	12–17 yo	1.41	1.28, 1.56
Sex (reference = Female)	Male	1.26	1.16, 1.36
Region (reference = West)	Midwest	0.84	0.74, 0.95
	Northeast	1.05	0.93, 1.19
	South	1.05	0.93, 1.19
	Missing	1.47	1.30, 1.67
Quarter (reference = Q1) ^b	Q2	0.80	0.72, 0.89
	Q3	1.10	0.98, 1.23
	Q4	0.86	0.77, 0.96
	Pandemic (reference = pre-pandemic) ^c	Pandemic	0.47

CI confidence interval, IRR incidence rate ratio, Q quarter, yo years old

^a IRR modeled by multivariable negative binomial regression

^b Average effects of Q2, Q3, and Q4 vs. Q1 across all years 2017–2021

^c Pre-pandemic = March 2017–February 2020; pandemic = March 2020–February 2021

Bocage, MPH (both from HealthCore, Inc., Wilmington, DE) provided project management and quality review for this study. Kyoko Saito (Brown University, Providence, RI) provided administrative support.

Author contributions

DBH conceptualized and designed the study, coordinated and supervised data analysis, interpreted study results, and drafted the initial manuscript. ALN and YY analyzed study data, interpreted study results, and reviewed and revised the manuscript. CH, RAP, SC, and BLS interpreted study results and reviewed and revised the manuscript. LEP conceptualized and designed the study, coordinated and supervised data analysis, interpreted study results, and reviewed and revised the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Commercial claims data used for this study are not publicly available due to restrictions imposed by existing or anticipated agreements.

Declarations

Ethics approval and consent to participate

This study was determined to be exempt for review by the New England Institutional Review Board (IRB) (now WCG IRB) (#1294354) and Rutgers IRB (Pro2021002022).

Consent for publication

Not applicable.

Competing interests

ALN, YY, and LEP are employees of HealthCore, Inc. BLS has received consulting fees from Abbvie and the Consumer Healthcare Products Association. LEP has received research support from Sanofi unrelated to this work. DBH, CH, RAP, and SC declare that they have no competing interests.

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