Comparative analysis of outcomes of influenza and COVID-19 admissions among children with asthma: Analysis of US National Readmission Database

Ying-Chen Chen, Chia-Pi Cheng, Po-Cheng Chen, Jinn-Li Wang, Chia-Chen Wu, Ying-Chun Lu

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Ying-Chen Chen[1]; Chia-Pi Cheng[2]; Po-Cheng Chen[3]; Jinn-Li Wang[4]; Chia-Chen Wu[5]; Ying-Chun Lu[6]

[1] Tri-Service General Hospital, National Defense Medical Center Taipei TW
[2] Department and Graduate institute of Biology and Anatomy, National Defense Medical Center Taipei TW
[3] Division of Pediatric Rehabilitation, Department of Physical Medicine and Rehabilitation, Wo On Rehabilitation Clinic New Taipei TW
[4] .Division of Hematology and Oncology, Department of Pediatrics, Wan Fang Hospital, Taipei Medical University Taipei TW
[5] National Defense Medical Center Keelung TW
[6] Wan Fang Hospital, Taipei Medical University Taipei TW

Corresponding Author:
Ying-Chun Lu

Wan Fang Hospital, Taipei Medical University
7th Floor, No. 11, Alley 70, Lane 113, Donghu Road, Neihu District
Taipei
TW

Abstract

Background: Asthma is a common chronic condition in children, and severe complications can occur with infections like COVID-19 and influenza. There is limited research comparing the in-hospital outcomes of asthmatic children with these infections.

Objective: This study aims to compare the in-hospital outcomes of these infections in asthmatic children from a population-based perspective.

Methods: This retrospective study used data from the 2020 United States (US) Nationwide Readmissions Database. Children 1-19 years old with asthma admitted for COVID-19 or influenza infections were eligible for inclusion. Outcomes evaluated included in-hospital mortality, major complications, and 90-day readmission rate. Logistic regression was employed to assess the associations between infection type and outcomes.

Results: A total of 1,472 hospitalized children with asthma were included, and 405 were admitted due to COVID-19 infection and 1,067 for influenza. After adjustment, the multivariate analysis revealed that children admitted for COVID-19 had a significantly higher risk of sepsis/shock (adjusted odds ratio [aOR] = 4.30, 95% confidence interval [CI]: 1.79-10.32), but a lower risk of bacterial/fungal pneumonia (aOR = 0.37, 95% CI: 0.23-0.61) compared to those who admitted for influenza. No significant different in mortality risk was observed. Stratified analyses by age revealed that among children 1-5 years old, the risk of 90-day readmission was significantly higher those with COVID-19 than influenza (aOR = 3.02, 95% CI: 1.09-8.35).

Conclusions: US children with asthma hospitalized for COVID-19 had higher risks of sepsis/shock compared to those admitted for influenza, while children admitted for influenza had higher risk for bacterial/fungal pneumonia.

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Comparative analysis of outcomes of influenza and COVID-19 admissions among children with asthma: Analysis of US National Readmission Database

Running title: Influenza and COVID-19 in-patient outcomes in children with asthma

Ying-Chen Chen, MD[1], Chia-Pi Cheng, PhD[2], Po-Cheng Chen, MD[3], Jinn-Li Wang, PhD[4-5], Chia-Chen Wu, MD[6-7], Ying-Chun Lu, MD[5,8*]

[1.] Department of Pediatric, Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan

[2.] Department and Graduate institute of Biology and Anatomy, National Defense Medical Center, Taipei, Taiwan

[3.] Division of Pediatric Rehabilitation, Department of Physical Medicine and Rehabilitation, Wo On Rehabilitation Clinic, New Taipei, Taiwan

[4.]Division of Hematology and Oncology, Department of Pediatrics, Wan Fang Hospital, Taipei Medical University, Taipei, Taiwan

[5.] Department of Pediatrics, School of Medicine, College of Medicine, Taipei Medical University, Taipei, Taiwan

[6.] Department of Surgery, Tri-Service General Hospital Keelung Branch, National Defense Medical Center, Keelung, Taiwan

[7.] Division of Thoracic Surgery, Department of Surgery, Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan

[8.] Department of Pediatrics, Wan Fang Hospital, Taipei Medical University, Taipei, Taiwan

[*]Correspondence to: Ying-Chun Lu

Department of Pediatrics, Wan Fang Hospital, Taipei Medical University, 7th Floor, No. 11, Alley 70,

Lane 113, Donghu Road, Neihu District, Taipei City, Taiwan (114048)

Tel: +886-963252183;

Email: alchune@gmail.com

ABSTRACT

Background: Asthma is a common chronic condition in children, and severe complications can occur with infections like COVID-19 and influenza. There is limited research comparing the in-hospital outcomes of asthmatic children with these infections.

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Results: A total of 1,472 hospitalized children with asthma were included, and 405 were admitted due to COVID-19 infection and 1,067 for influenza. After adjustment, the multivariate analysis revealed that children admitted for COVID-19 had a significantly higher risk of sepsis/shock (adjusted odds ratio [aOR] = 4.30, 95% confidence interval [CI]: 1.79-10.32), but a lower risk of bacterial/fungal pneumonia (aOR = 0.37, 95% CI: 0.23-0.61) compared to those who admitted for influenza. No significant different in mortality risk was observed. Stratified analyses by age revealed that among children 1-5 years old, the risk of 90-day readmission was significantly higher those with COVID-19 than influenza (aOR = 3.02, 95% CI: 1.09-8.35).

Conclusions: US children with asthma hospitalized for COVID-19 had higher risks of sepsis/shock compared to those admitted for influenza, while children admitted for influenza had higher risk for bacterial/fungal pneumonia.

Keywords: Asthma, children, influenza, COVID-19, National Readmission Database (NRD)

INTRODUCTION

Asthma affects individuals across all age groups, and over the last few decades there has been a significant rise in the prevalence of asthma globally [1]. The incidence, morbidity, and mortality associated with childhood asthma have markedly increased over the past 40 years. Despite asthma being the most prevalent chronic illness in children, underdiagnosis and undertreatment remain common issues [2, 3]. During pregnancy, factors such as the maternal diet and microbiome may elevate the risk of asthma. Additionally, postnatal microbial exposures and colonization have been shown to influence the likelihood of developing allergic diseases and asthma [4, 5]. The treatment of asthma follows a stepwise and control-based strategy, involving an iterative cycle of assessment, treatment adjustment, and review to reduce symptoms and prevent exacerbations. Anti-inflammatory therapy is the primary approach for managing asthma [6, 7].

Respiratory viral infections such as COVID-19 and influenza can worsen the symptoms of children with asthma and potentially lead to severe complications. Recent research indicates that asthma increases the risk of hospitalization in children infected with COVID-19 [8, 9]. Additionally, individuals with uncontrolled asthma are more likely to experience severe illness from COVID-19 infection that requires hospitalization [10]. Children with asthma who contract influenza can have a worsening of asthma symptoms and also may require hospitalization [11]. Although children with asthma to contract COVID-19 or influenza infection can have more serious disease and poorer outcomes than children without asthma, there is a lack of studies examining the in-hospital outcomes of children with asthma who develop a COVID-19 or influenza infection.

Thus, the purpose of this study is to compare in-hospital mortality, complication rates, and 90-day readmission rates between asthmatic children admitted for COVID-19 and those admitted for influenza using a national United States (US) database.

METHODS

Data source

The Nationwide Readmissions Database (NRD) is a database of all-payer hospital inpatient stays that can be used to generate national estimates of readmissions. An overview of the NRD can be found at: https://hcup-us.ahrq.gov/nrdoverview.jsp. The NRD is a 100% sample from the Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SID) with discharge- and hospital-level exclusions. The database contains verified patient linkage numbers that can be used to track a person across hospitals within a State while adhering to strict privacy guidelines. Researchers can identify diagnoses and procedures in the NRD using the International Classification of Disease, Tenth Revision, Clinical Modification (ICD-10-CM), and procedure codes (ICD-10-PCS) codes.

Study design and population

This population-based retrospective cohort study used NRD data from the year 2020. Inclusion criteria for this study were: 1) Children 1 to 19 years old; 2) First admission for COVID-19 or influenza between January 1 and September 30, 2020, identified with the relevant ICD-10-CM codes documented as the principal diagnosis; 3) Asthma as a secondary diagnosis. Children with missing information on the main endpoints, sex, and sample weights were excluded. Following the index admission, patients were considered ‘at-risk’ for hospitalization, and were included in the follow-up period until December 31 of the admission year or until death. Detailed ICD-10-CM codes used are provided in Supplementary Table S1.

Ethics statement

This study adheres to the terms of the HCUP data-use agreement. Specifically, the data were acquired from the Online HCUP Central Distributor and are anonymized. Since there was no direct

patient involvement, no further informed consent is required.

Variables and outcome measures

Data collected included patient age, sex, insurance status, and household income. Data relating to hospital characteristics such as weekend admission, admission type (emergent or elective), hospital bed size, and location/teaching status were also collected. Major comorbidities extracted from the medical records and included in the analysis were hypertension, diabetes mellitus, obesity/overweight, neurological disease, Down syndrome/chromosomal anomalies, metabolic disease, cystic fibrosis, amyloidosis, sickle cell disease, congenital heart conditions, congenital lung conditions, autoimmune disease, and mental or physical disability. These are comorbidities frequently considered in hospital admissions of children.

The outcomes evaluated included in-hospital mortality, and complications including sepsis/shock, secondary bacterial/fungal pneumonia, respiratory failure/mechanical ventilation, and acute kidney injury (AKI). In addition, 90-day readmission rates were also assessed.

Statistical analysis

The NRD database includes discharge-level weights (DISCWT), stratum (NRD_STRATUM), and cluster (HOSP_NRD) variables, which were used to estimate discharges from community hospitals in the US, excluding rehabilitation and long-term acute care facilities. These variables were also used to calculate standard errors (SEs) and to produce national estimates for all analyses in this study. In SAS statistical software, the SURVEY procedure is available for the analysis of sample survey data. Descriptive statistics of patients at the time of index admission were presented as either number (n) and weighted percentage (%), or mean and SE, and patients were categorized into the COVID-19 or influenza group. Categorical data were examined using the PROC SURVEYFREQ

statement, while continuous data were assessed through the PROC SURVEYREG statement. The SURVEYFREQ procedure includes the Rao-Scott chi-square test to assess the significance between weighted proportions. The SURVEYREG procedure fits linear models for survey data, and provides significance tests for the model effects. Logistic regressions were performed using the PROC SURVEYLOGISTIC statement to compare the risk of adverse outcomes between children admitted for COVID-19 or influenza infection, including in-hospital mortality, major complications, and 90-day readmission. Data were reported as odds ratio (OR) and 95% confidence interval (CI). All p-values were 2-sided, and a value of $p < 0.05$ was considered statistically significant. Statistical analyses were performed using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA).

RESULTS

Patient selection

The selection process for the study population is illustrated in Figure 1. A total of 1,472 patients 1-19 years old with asthma and admitted for the first time with COVID-19 or influenza were identified in the year 2020 NRD. Of the 1,472 patients, 405 were admitted for COVID-19 and 1,067 for influenza. This sample represents a total of 3,604 hospitalized individuals in the entire US after applying the sample weights provided by the NRD.

Patient characteristics

Patient characteristics are summarized in Table 1. The mean age of all patients was 8.5 years, and 59% were males. Significant differences were observed in age, household income, insurance status/primary payer, hospital bed size, and location/teaching status between patients with COVID-19 and those with influenza. In addition, the proportions of patients with diabetes mellitus, hypertension, obesity/overweight, metabolic disease, sickle cell disease, and congenital heart

conditions were significantly different between patients with COVID-19 and those with influenza.

Patients admitted for COVID-19 had higher frequencies of in-hospital mortality (2.5% vs. 0.4%, p = 0.003), sepsis/shock (8.4% vs. 1.0%, p < 0.001), respiratory failure/mechanical ventilation (9.1% vs. 4.3%, p < 0.001), and AKI (9.0% vs. 2.2%, p < 0.001) compared to those admitted for influenza. On the other hand, the proportion of patients with secondary bacterial/fungal pneumonia was significantly greater in the group admitted for influenza compared to those admitted for COVID-19 (18% vs. 8%, p < 0.001).

Comparison of adverse outcomes between children admitted for COVID-19 versus influenza

A comparison of outcomes between children admitted for COVID-19 and influenza is shown in Table 2. After adjustment in the multivariable analysis, patients admitted for COVID-19 had a significantly higher risk of sepsis/shock (adjusted odds ratio [aOR] = 4.30, 95% CI: 1.79-10.32, p = 0.001), but a lower risk of secondary bacterial/fungal pneumonia (aOR = 0.37, 95% CI: 0.23-0.61, p < 0.001) compared to those admitted for influenza (Table 2).

Comparison of adverse outcomes between children admitted for COVID-19 versus influenza, stratified by age

The results of the stratified analysis are shown in Table 3. In the group of patients 1-5 years old, compared to those admitted for influenza those admitted for COVID-19 had a significantly greater 90-day readmission rate (aOR = 3.02, 95% CI: 1.09-8.35, p = 0.033), but a significantly lower risk of secondary bacterial/fungal pneumonia (aOR = 0.13, 95% CI: 0.02-0.96, p = 0.046). In the group of patients who were 6-10 years old, compared to those admitted for influenza those admitted for COVID-19 had a significantly higher risk of sepsis/shock (aOR = 6.64, 95% CI: 1.23-35.91, p = 0.028). In the group of patients who were 11-19 years old, compared to those admitted for influenza

patients admitted for COVID-19 had a significantly higher risk of sepsis/shock (aOR = 4.79, 95% CI: 1.79-12.84, p = 0.002), but a significantly lower risk of secondary bacterial/fungal pneumonia (aOR = 0.42, 95% CI: 0.24-0.73, p = 0.002) (Table 3).

DISCUSSION

In this study, we compared the outcomes of children with asthma hospitalized with COVID-19 or influenza using the US NRD. Results showed that COVID-19 patients had a higher risk of sepsis/shock, whereas influenza patients were more likely to develop secondary bacterial/fungal pneumonia. There was no significant difference in in-hospital mortality between the two groups. Age-stratified analysis indicated that children aged 1-5 with COVID-19 had a threefold higher risk of 90-day readmission compared to those with influenza. Older children (11-19 years) with COVID-19 faced higher sepsis/shock risk but a lower risk of secondary bacterial/fungal pneumonia. These findings highlight the different clinical challenges in managing influenza and COVID-19 in asthmatic children.

Both influenza and COVID-19 are serious infections, and comorbidities like asthma can worsen their clinical outcomes. While there have been studies comparing the outcomes of these infections in adults, there is limited research on children, especially those with asthma. Xie et al.[12] found that hospitalization for COVID-19 was associated with a higher risk of death compared to influenza (6% for COVID-19 vs. 3.7% for influenza; HR = 1.16). The risk of death decreased with more COVID-19 vaccinations (p = 0.009). An earlier study comparing patients diagnosed with influenza during the 2017-2018 season to those with COVID-19 between February and June 2020 found that, despite being younger and having fewer comorbidities, COVID-19 patients had a higher risk of severe illness[13]. Immunocompromised patients with COVID-19 also had significantly higher mortality than those with influenza (33% vs. 8%, p = 0.01). However, these studies did not focus on pediatric or

asthma populations.

Most studies on COVID-19 infection in children with asthma indicate that co-existing asthma is linked to a poorer prognosis[14-16]. For example, Robbins et al. [15] reported that children with asthma seen in the emergency department (ED) for COVID-19 were more likely to have severe infections compared to those without asthma. Another study of 5,510 asthmatic patients, including 414 with COVID-19, found a positive correlation between COVID-19 severity and asthma symptoms [14]. Similarly, Lara et al. [16] showed that asthma significantly increased the risk of hospitalization in children with COVID-19. In the context of the global obesity epidemic, Aytekin et al.[17] reported that obesity further decreased lung function in children with asthma who recovered from COVID-19.

While many studies report that asthma worsens COVID-19 outcomes, some studies present conflicting results. For instance, one study of 107 pediatric COVID-19 patients found that asthma and allergic diseases were not risk factors for hospitalization[18]. Interestingly, having a pet seemed to protect against hospitalization. Yilmaz et al. [19] suggested that COVID-19 may have a milder course than influenza in children (not specifically those with asthma). However, Dupont et al. [20] found worse outcomes in asthmatic children with COVID-19 compared to those with influenza.

Both COVID-19 and influenza can exacerbate asthma symptoms, but our findings show that children with asthma admitted for COVID-19 had a higher risk of developing sepsis/shock compared to those admitted for influenza. COVID-19 is known to trigger a severe immune response or cytokine storm, leading to high systemic inflammation, rapid respiratory deterioration, and increased risk of sepsis and shock [21]. The SARS-CoV-2 virus, compared to the influenza virus, can cause more severe immune alterations [22], potentially worsening the chronic inflammation associated with asthma.

Conversely, we found that children with asthma admitted for influenza had a higher risk of secondary bacterial infections than those admitted for COVID-19. Influenza can directly damage the respiratory epithelium, impairing mucociliary clearance and allowing bacterial pathogens to invade, leading to secondary infections like bacterial pneumonia[23]. COVID-19, though causing severe

respiratory complications, does not typically cause the same level of epithelial damage as influenza[23, 24]. Poorly controlled asthma may exacerbate these risks, as noted by Lansbury et al.[24], who reported that bacterial co-infection rates in COVID-19 patients were much lower than during influenza pandemics. This finding suggests that the routine use of antibiotics in COVID-19 patients may not be necessary. Early in the pandemic, despite low rates of bacterial co-infections (<10%), antibiotics were widely prescribed to COVID-19 patients (75%) [25]. Such practices might have reduced secondary bacterial infection rates, making influenza patients more susceptible to secondary infections.

Despite these differences in complications, we observed no significant difference in in-hospital mortality rates between the two groups. This could be due to effective clinical management or the resilience of the pediatric population. However, younger children (1-5 years old) with COVID-19 had a higher 90-day readmission rate than those with influenza, indicating a need for targeted follow-up care post-discharge.

Studies have shown that COVID-19 vaccines are safe and effective for children, including those with asthma [10]. Ongoing research continues to support vaccination, particularly for those with uncontrolled asthma, who are at increased risk of severe disease and complications [10].

These findings can guide healthcare providers in optimizing care during respiratory viral outbreaks. The study underscores the need for different management strategies for asthmatic children hospitalized with COVID-19 or influenza. Specifically, the higher risk of sepsis/shock in COVID-19 patients calls for proactive monitoring and early intervention. Vaccination and close follow-up, particularly for younger children with COVID-19, are crucial to prevent hospitalizations and manage complications.

Strengths and limitation

A strength of this study is its use of a large, nationally representative dataset, providing a

comprehensive overview of hospitalizations across the US. This broad scope enhances the generalizability of the findings, and allows for a detailed understanding of the differential impact of COVID-19 and influenza on children with asthma. Additionally, the analysis included in-hospital data and readmission data, which is informative in assessing healthcare utilization for these patients. However, several limitations should be noted. The retrospective nature of the study may introduce selection biases, and the use of ICD codes is commonly associated with underestimating some less severe comorbidities and medical conditions. The accuracy of coding practices might also impact the results. Furthermore, despite adjustments for various confounders, several key clinical parameters such as vaccination history, COVID-19 viral load, laboratory measures, influenza subtypes, detailed treatment regimens, asthma medication use, and asthma's severity were not available in the dataset. These factors could significantly influence patient outcomes, and limit the ability to fully understand the nuances of disease interactions in this population. Unmeasured factors, such as detailed clinical histories, could also impact the results.

Conclusion

In conclusion, children with asthma in the US hospitalized for COVID-19 have a higher risk of sepsis/shock compared to those admitted for influenza. Conversely, those admitted for influenza are at increased risk of secondary bacterial/fungal pneumonia. These findings underscore the need for targeted clinical management strategies for children with asthma, tailored to the specific risks posed by COVID-19 and influenza.

Data Availability Statement: All of the data supporting underlying findings are included in the manuscript and its supplemental files.

Acknowledgments: None

Conflicts of Interest: The authors declare no conflicts of interest.

Consent of Publication: All authors approve the manuscript and give their consent for submission and publication.

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Figure legends

Figure 1. Flow diagram of patient selection

Table 1. Comparisons of children with asthma hospitalized for COVID-19 or influenza

Characteristics	Total (N = 1,472)	COVID-19 (n = 405)	Influenza (n = 1067)	p-value
Adverse outcomes				
In-hospital mortality	13 (0.9)	10 (2.5)	3 (0.4)	**0.003**
Major complications, any	313 (22.1)	94 (22.7)	219 (22.0)	0.796
Sepsis/shock	47 (2.9)	35 (8.4)	12 (1.0)	**<0.001**
Secondary bacterial/fungal pneumonia	202 (15.1)	28 (7.6)	174 (17.7)	**<0.001**
Respiratory failure/mechanical ventilation	84 (5.6)	40 (9.1)	44 (4.3)	**<0.001**
AKI	52 (4.0)	34 (9.0)	18 (2.2)	**<0.001**
90-Day readmission rate [a]	84 (6.0)	27 (6.9)	57 (5.7)	0.383
Demography				
Age, years	8.5 ± 0.2	13.3 ± 0.3	6.8 ± 0.2	**<0.001**
1-5	557 (37.9)	50 (12.5)	507 (46.9)	**<0.001**
6-10	381 (27.1)	51 (14.1)	330 (31.7)	
11-15	234 (17.0)	95 (26.0)	139 (13.8)	
16-19	300 (18.0)	209 (47.4)	91 (7.6)	
Sex				0.267
Male	862 (59.2)	227 (56.8)	635 (60.0)	
Female	610 (40.8)	178 (43.2)	432 (40.0)	
Household income				**0.018**
Q1	488 (32.2)	159 (38.7)	329 (29.9)	
Q2	393 (27.2)	107 (27.0)	286 (27.3)	
Q3	338 (24.0)	85 (21.3)	253 (24.9)	
Q4	242 (16.6)	48 (13.0)	194 (17.9)	
Missing	11	6	5	
Insurance status/primary payer				**<0.001**
Medicare/Medicaid	886 (58.8)	281 (68.6)	605 (55.3)	
Private including HMO	518 (36.8)	105 (26.7)	413 (40.4)	
Self-pay/no charge/other	68 (4.4)	19 (4.7)	49 (4.3)	
Admission type				0.577
Elective	40 (2.8)	8 (2.4)	32 (2.9)	

Emergent	1,431 (97.2)	397 (97.6)	1034 (97.1)	
Missing	1	0	1	
Hospital-related characteristics				
Hospital bed number				**0.026**
Small	179 (13.2)	34 (8.8)	145 (14.7)	
Medium	306 (21.8)	71 (19.3)	235 (22.6)	
Large	987 (65.1)	300 (71.9)	687 (62.7)	
Location/teaching status				**0.020**
Metropolitan non-teaching	99 (7.3)	21 (4.8)	78 (8.2)	
Metropolitan teaching	1,304 (88.8)	372 (92.6)	932 (87.4)	
Non-metropolitan	69 (3.9)	12 (2.6)	57 (4.4)	
Weekend admission				0.410
No	1084 (73.8)	291 (72.1)	793 (74.4)	
Yes	388 (26.2)	114 (27.9)	274 (25.6)	
Comorbidities				
DM	41 (2.5)	32 (6.8)	9 (1.0)	**<0.001**
Hypertension	44 (2.7)	31 (7.1)	13 (1.2)	**<0.001**
Obesity/overweight	157 (9.7)	122 (28.1)	35 (3.2)	**<0.001**
Neurological disease	138 (9.4)	44 (12.0)	94 (8.5)	0.053
Down syndrome/chromosomal anomaly	33 (2.3)	9 (2.3)	24 (2.3)	0.992
Metabolic disease	55 (3.9)	32 (8.6)	23 (2.3)	**<0.001**
Cystic fibrosis	9 (0.7)	3 (0.7)	6 (0.7)	0.985
Sickle cell disease	75 (5.4)	34 (8.5)	41 (4.3)	**0.003**
Congenital heart condition	21 (1.4)	14 (3.3)	7 (0.7)	**<0.001**
Autoimmune disease	31 (2.1)	15 (3.2)	16 (1.7)	0.082
Disability	73 (4.9)	20 (4.6)	53 (5.0)	0.733

Abbreviations: CVA, cerebral vascular accident; VTE, venous thromboembolism; DM, diabetes mellitus; AKI, acute kidney injury; HMO, Health Maintenance Organization.

Continuous variables are presented as mean ± SE; categorical variables are presented as unweighted counts (weighted percentage).

p-values < 0.05 are shown in bold.

[a] Excluding patients who died in the hospital.

Table 2. Risk of adverse outcomes between children with asthma hospitalized due to COVID-19 or influenza

Adverse outcomes	Univariate		Multivariable	
	OR (95% CI)	p-value	aOR (95% CI)	p-value
In-hospital mortality [a]	6.15 (1.51-24.99)	**0.011**	2.18 (0.56-8.49)	0.262
Major complications, any [b]	1.04 (0.76-1.42)	0.795	0.90 (0.67-1.21)	0.497
Sepsis/shock [c]	9.23 (4.18-20.36)	**<0.001**	4.30 (1.79-10.32)	**0.001**
Secondary bacterial/fungal pneumonia [d]	0.38 (0.23-0.64)	**<0.001**	0.37 (0.23-0.61)	**<0.001**
Respiratory failure/mechanical ventilation [e]	2.24 (1.39-3.61)	**<0.001**	1.47 (0.83-2.61)	0.183
Acute kidney injury [f]	4.45 (2.24-8.85)	**<0.001**	1.97 (0.92-4.22)	0.079
90-Day readmission rate [g, h]	1.23(0.77-1.96)	0.387	0.95 (0.56-1.62)	0.846

Abbreviations: OR, odds ratio; aOR, adjusted odds ratio; CI, confidence interval.

p-values < 0.05 are shown in bold.

[a] Adjusted for all variables significant in the univariate analysis: age (continuous), diabetes mellitus, neurological disease, metabolic disease, disability.

[b] Adjusted for all variables significant in the univariate analysis: insurance status/primary payer, diabetes mellitus, neurological disease, metabolic disease, sickle cell disease, congenital heart condition.

[c] Adjusted for all variables significant in the univariate analysis: age (continuous), diabetes mellitus, obesity/overweight, neurological disease, metabolic disease, congenital heart condition, disability.

[d] Adjusted for all variables significant in the univariate analysis: insurance status/primary payer, neurological disease, sickle cell disease.

[e] Adjusted for all variables significant in the univariate analysis: age (continuous), household income, diabetes mellitus, hypertension, obesity/overweight, neurological disease, metabolic disease, congenital heart condition, disability.

[f] Adjusted for variables significant in the univariate analysis: diabetes mellitus, obesity/overweight, neurological disease, Down syndrome/chromosomal anomaly, metabolic disease, congenital heart condition.

[g] Adjusted for all variables significant in the univariate analysis: household income, hypertension, neurological disease, metabolic disease, cystic fibrosis, sickle cell disease, disability.

[h] Excluding patients who died in the hospital.

Table 3. Risk of adverse outcomes of children with asthma and COVID-19 or influenza, stratified by age

	aOR (95% CI)	p-value
Age 1-5 years		
In-hospital mortality [a]	NA	-
Major complications, any [b]	0.56 (0.13-2.34)	0.425
Sepsis/shock [c]	1.41 (0.14-14.14)	0.770
Secondary bacterial/fungal pneumonia [d]	0.13 (0.02-0.96)	**0.046**
Respiratory failure/mechanical ventilation [e]	1.41 (0.23-8.77)	0.710
Acute kidney injury [f]	3.55 (0.29-43.66)	0.321
90-Day readmission rate [g, h]	3.02 (1.09-8.35)	**0.033**
Age 6-10 years		
In-hospital mortality [a]	2.53 (0.27-23.46)	0.411
Major complications, any [b]	0.91 (0.39-2.10)	0.817
Sepsis/shock [c]	6.64 (1.23-35.91)	**0.028**
Secondary bacterial/fungal pneumonia [d]	0.42 (0.13-1.39)	0.156
Respiratory failure/mechanical ventilation [e]	1.32 (0.45-3.88)	0.610
Acute kidney injury [f]	2.11 (0.31-14.25)	0.439
90-Day readmission rate [g, h]	0.49 (0.13-1.81)	0.281
Age 11-19 years		
In-hospital mortality [a]	6.02 (0.87-41.75)	0.069
Major complications, any [b]	0.90 (0.58-1.38)	0.620
Sepsis/shock [c]	4.79 (1.79-12.84)	**0.002**
Secondary bacterial/fungal pneumonia [d]	0.42 (0.24-0.73)	**0.002**
Respiratory failure/mechanical ventilation [e]	1.82 (0.61-5.42)	0.280
Acute kidney injury [f]	1.56 (0.78-3.13)	0.205

90-Day readmission rate [g, h]	0.80 (0.37-1.74)	0.565

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval, NA, no event occurred in one group.

p-values < 0.05 are shown in bold.

[a] Adjusted for all variables significant in the univariate analysis (except for stratified or NA variables): diabetes mellitus, neurological disease, metabolic disease, disability.

[b] Adjusted for all variables significant in the univariate analysis (except for stratified or NA variables): insurance status/primary payer, diabetes mellitus, neurological disease, metabolic disease, sickle cell disease, congenital heart condition.

[c] Adjusted for all variables significant in the univariate analysis (except for stratified or NA variables): diabetes mellitus, obesity/overweight, neurological disease, metabolic disease, congenital heart condition, disability.

[d] Adjusted for all variables significant in the univariate analysis (except for stratified or NA variables): insurance status/primary payer, neurological disease, sickle cell disease.

[e] Adjusted for all variables significant in the univariate analysis (except for stratified or NA variables): household income, diabetes mellitus, hypertension, obesity/overweight, neurological disease, metabolic disease, congenital heart condition, disability.

[f] Adjusted for all variables significant in the univariate analysis (except for stratified or NA variables): diabetes mellitus, obesity/overweight, neurological disease, Down syndrome/chromosomal anomaly, metabolic disease, congenital heart condition.

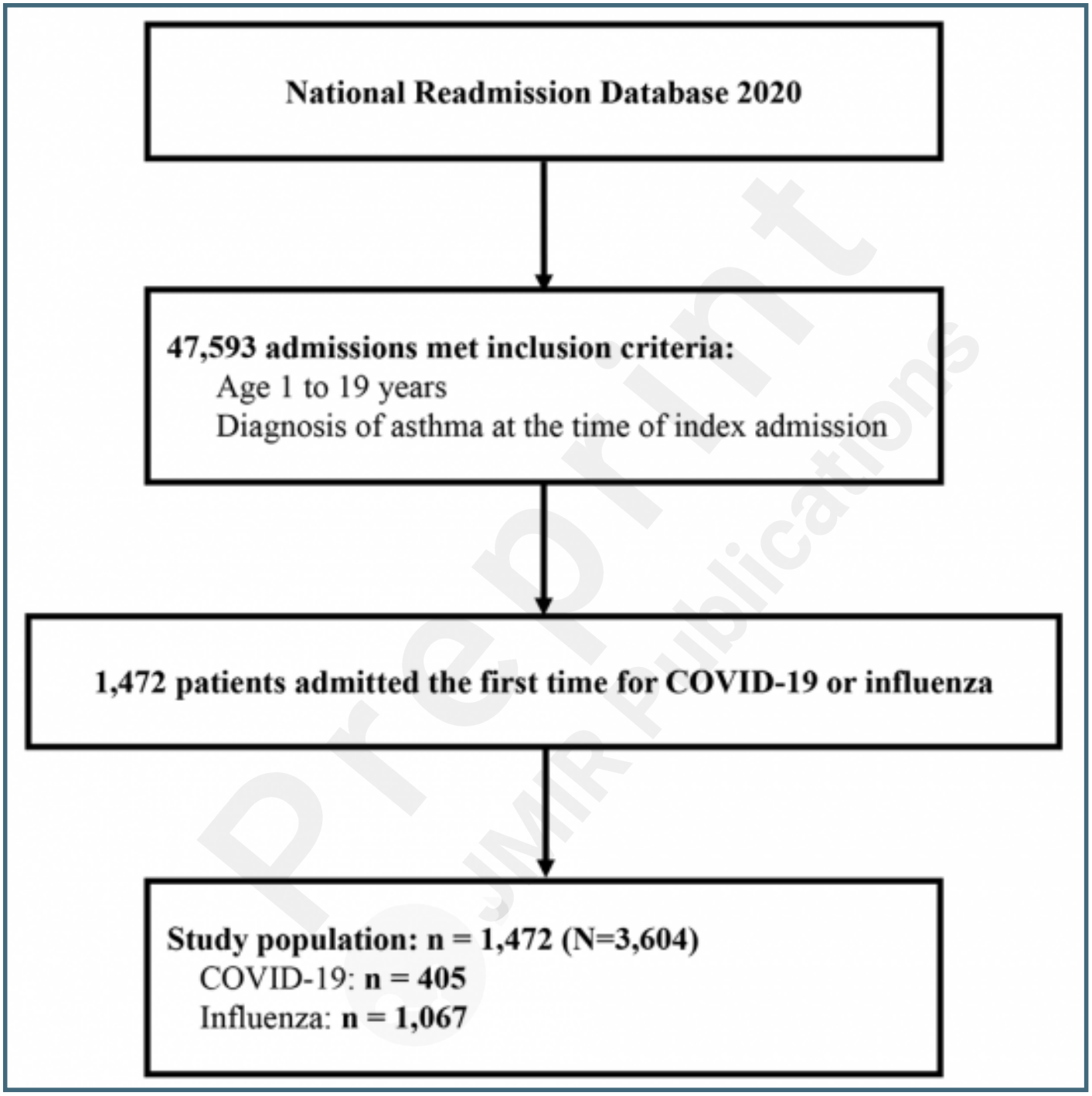
[g] Adjusted for all variables significant in the univariate analysis (except for stratified or NA variables): household income, hypertension, neurological disease, metabolic disease, cystic fibrosis, sickle cell disease, disability.

[h] Excluding patients who died in the hospital.

Supplementary Files

Figures

The selection process for the study population is illustrated in Figure 1. A total of 1,472 patients 1-19 years old with asthma and admitted for the first time with COVID-19 or influenza were identified in the year 2020 NRD.



Multimedia Appendixes

Supplementary Table 1. ICD codes used.
URL: http://asset.jmir.pub/assets/e699c7c362d7b7996c88715babb0c24e.docx