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Clinical outcomes among hospitalized US adults with asthma or chronic obstructive pulmonary disease, with or without COVID-19

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Abstract

Objective: This study assesses the risk of severe clinical outcomes during hospitalizations of adults with asthma and/or COPD plus COVID-19 and compares those risks with those during hospitalizations of adults with asthma and/or COPD without COVID-19.

Methods: We used data from 877 U.S. hospitals from the Premier Healthcare Database during March 2020–March 2021. Hospitalizations (n = 311,215) among patients aged ≥18 years with an ICD-10-CM diagnosis involving asthma or COPD were classified into three groups: adults with asthma (but not COPD), adults with COPD (but not asthma), and adults with both asthma and COPD. We used multivariable Poisson regression to assess associations of severe clinical outcomes [intensive care unit (ICU) admission, use of invasive mechanical ventilation (IMV), and death] and COVID-19 status.

Results: The percentage of hospitalizations among patients with asthma and COVID-19 resulting in ICU admission, IMV, and death were 46.9%, 14.0%, and 8.0%, respectively. These risks were higher than those among patients with asthma without COVID-19 (adjusted risk ratio [aRR], 1.17 [95% confidence interval (CI), 1.14–1.21], 1.61 [95% CI, 1.50–1.73], and 5.56 [95% CI, 4.89–6.32]), respectively. Risks of ICU admission, IMV, and death were also high among patients

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with COPD and COVID-19 and exceeded the corresponding risks among patients with COPD without COVID-19.

Conclusion: Hospitalizations among patients with asthma and/or COPD with COVID-19 had a more severe clinical course than hospitalizations for asthma and/or COPD exacerbations without COVID-19.

Keywords

Asthma; chronic obstructive pulmonary disease; COVID-19; asthma–COPD overlap

Introduction

Asthma and chronic obstructive pulmonary disease (COPD) affect about 20 million (8%) and 15 million (6%) U.S. adults, respectively (1,2). Some people have both asthma and COPD, often called “asthma–COPD overlap”; the U.S. prevalence of asthma–COPD overlap is not well-established, but has been estimated to be 1–3% (3,4). Exacerbations of asthma and/or COPD can result in hospitalizations, intensive care unit (ICU) stays, invasive mechanical ventilation (IMV), or death (5,6). Since the emergence in 2020 of a novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2, the virus that causes coronavirus disease 2019 [COVID-19]), the impact of comorbid asthma or COPD on COVID-19 severity has been an area of active research (7–13).

Limited research suggests that individuals with COPD have a higher risk for severe illness, including death, from COVID-19 (7,8,14,15). One limitation of previous research is that smoking, a strong risk factor for COPD, may not have been thoroughly accounted for in all studies assessing risk of severe COVID-19 outcomes among patients with COPD. Multiple meta-analyses found no significant associations between asthma and severe COVID-19 (9,16–21). Several meta-analyses reported lower risk of death (10,22,23), one reported higher risk of intubation (22), and another reported lower risk of hospitalization (24). Heterogeneity in study design (e.g. study population or definition of asthma) might explain some of this variation; confounding by recent oral steroid use is also a possibility. In contrast, little is known about the risk of severe clinical outcomes among hospitalized people with asthma and/or COPD and COVID-19 and how that risk compares with that among people hospitalized for asthma and/or COPD exacerbations without COVID-19 (12,25,26).

To address this knowledge gap, we aimed to document the risks of severe clinical outcomes of patients hospitalized with asthma and/or COPD with COVID-19 and the extent to which those risks differed from risks among patients hospitalized with asthma and/or COPD without COVID-19. We analyzed electronic health record data from across the United States, which included 311,215 hospitalizations of adults with asthma and/or COPD. Our analyses distinguished between hospitalizations among adults with asthma (but not COPD), hospitalizations among adults with COPD (but not asthma), and hospitalizations among adults with both asthma and COPD. We hypothesized that risk of severe clinical outcomes would differ between hospitalizations of patients with and without COVID-19.

Materials and methods

Data source and study population

We used electronic health record data from the Premier Healthcare Database Special COVID-19 Release (PHD-SR, release date 05/11/2021) (27). The Premier Healthcare Database contains de-identified hospital-based discharge data of inpatient and outpatient medical visits, including data from approximately 20% of annual U.S. inpatient admissions. These data are from a variety of hospital types, located in both rural and urban areas. Patients are linked across hospital encounters by a masked identifier. More information about the Premier Healthcare Database is available from prior publications (28,29).

Our study population comprised inpatients aged ≥18 years admitted to hospitals in February 2020–March 2021 and discharged in March 2020–March 2021 with an *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) diagnosis involving asthma or COPD (J45 or J44 code) (Figure 1). Hospitalizations included those originating from healthcare (e.g. emergency department or clinic) and non-healthcare settings. To reduce the possibility of including hospitalizations for non-respiratory reasons (e.g. gallbladder surgery) among people with asthma and/or COPD, we limited analysis to hospitalizations with a primary ICD-10-CM diagnosis code with asthma or COPD or a secondary ICD-10-CM diagnosis with a specific code indicating an asthma or COPD exacerbation (see Figure 1 for complete list of ICD-10-CM codes included). Hospitalizations were classified into those among patients with COVID-19 and without COVID-19. To define the "exposure" (i.e. presence of concurrent COVID-19), we used ICD-10-CM discharge codes for COVID-19; specifically B97.29 (*Other coronavirus as the cause of disease classified elsewhere*) for hospitalizations with a discharge month during March–April 2020 and U07.1 (*COVID-19 virus identified*; introduced in April 2020) for hospitalizations with a discharge month during April 2020–March 2021 (30). Patients could contribute up to two total hospitalizations to the analysis (1 COVID-19 hospitalization and 1 non-COVID-19 hospitalization). These selection criteria led to a total of 311,215 hospitalizations included in the analysis (from 304,833 adults). Hospitalizations were then classified into one of three analytic groups based on patient characteristics: asthma but not COPD, COPD but not asthma, or both asthma and COPD (asthma–COPD overlap).

Outcome assessment

For each hospitalization included in our analysis, we assessed whether the hospitalization was associated with any of the following three outcomes indicating severe illness ("severe outcome"): ICU admission, IMV, or death. We chose these outcomes ("severe outcome") as indicators of severe illness, as in prior publications (28,31). ICU admission and IMV were defined using hospital billing codes. Death was defined by a hospital discharge code indicative of death while hospitalized or under hospice care.

Assessment of clinical comorbidities

To assess comorbidities as potential covariates, we used ICD-10-CM codes to identify certain chronic medical conditions that have been identified as risk factors for severe COVID-19 illness, specifically chronic kidney disease, type 2 diabetes, certain heart

conditions (cardiomyopathies, congestive heart failure, ischemic heart disease, and myocardial infarction), cancer, pulmonary fibrosis, obesity (body mass index ≥ 30 kg/m), sickle cell disease, Down syndrome, or solid organ transplant (eTable 1) (32). For each hospitalization, comorbidities were categorized as absent or present based on the ICD-10-CM codes assigned to that hospitalization.

Statistical analysis

We used patients' asthma and COPD status to complete analyses among three groups: 1) hospitalizations among patients with asthma but not COPD; 2) hospitalizations among patients with COPD but not asthma; and 3) hospitalizations among patients with asthma–COPD overlap. We calculated the frequencies and percentages of patient characteristics by COVID-19 status for each group. Then, we calculated the frequencies and percentages of outcomes (ICU, IMV, and death) by group, stratified by COVID-19 status.

We assessed associations of each dichotomous outcome and COVID-19 diagnosis using multivariable Poisson regression models with robust standard errors (33). We calculated adjusted risk ratios (aRRs) and 95% confidence intervals (CIs) adjusting for age group (18–39, 40–49, 50–64, 65–74, or ≥75 years), race/ethnicity (non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Hispanic, and non-Hispanic persons of other races), sex (male, female), health insurance type (Medicare, Medicaid, private, other health insurance type [includes charity, indigent, self-pay, workers compensation, direct employer contract, other government payors, and other health insurance type]), admission month quarter (February–March 2020, April–June 2020, July–September 2020, October–December 2020, January–March 2021), U.S. Census region (Midwest, Northeast, South, West), and comorbid conditions (cancer, chronic kidney disease, type 2 diabetes, heart condition, obesity, pulmonary fibrosis, and "other comorbid condition" [includes Down syndrome, sickle cell disease, and/or solid organ transplant]). All variables included in adjusted models were selected *a priori*. Models were adjusted for correlation by medical facility and patient using an exchangeable correlation structure. We also conducted subanalyses on the association between severe outcomes and COVID-19 status by age group, sex, race/ethnicity, and health insurance type. For patients with asthma only, we conducted a secondary analysis on the association between severe outcomes and COVID-19 status by asthma severity (defined by ICD-10-CM diagnosis). Also, we performed a sensitivity analysis that included codes for chronic bronchitis and emphysema (J41 and J43) in the definition of COPD. All statistical analyses were performed using SAS, version 9.4 (SAS Institute, Cary, NC).

This activity was reviewed by the Centers for Disease Control and Prevention (CDC) and was deemed exempt from institutional review board over-sight per 45 CFR §46.101(b)(4) and exempt from patient informed consent per 45 CFR §164.506(d)(2) (ii)(B) because the disclosed Premier Healthcare Database Special COVID-19 Release (PHD-SR) data are considered deidentified.

Results

Our analysis included 311,215 hospitalizations among 304,833 adults with asthma, COPD, or both admitted to 877 hospitals across the United States. Specifically, of the 311,215

hospitalizations, 33,417 (10.7%) hospitalizations were among adults with asthma (but not COPD), 263,163 (84.6%) hospitalizations were among adults with COPD (but not asthma), and 14,635 (4.7%) hospitalizations were among adults with asthma–COPD overlap.

Asthma hospitalizations

Among patients with asthma (but not COPD), there were 6,894 hospitalizations with COVID-19 (Table 1, eTable 2). Patients with asthma were predominantly female (69.4% and 69.5% of hospitalizations with and without COVID-19, respectively). Patients with asthma aged 40–49 and 50–64 years accounted for a higher percentage of COVID-19 hospitalizations compared with hospitalizations with asthma but not COVID-19 (19.7% and 34.7% vs. 16.2% and 25.4%, respectively). For hospitalizations among patients with asthma and COVID-19, a higher percentage of patients identified as Hispanic (18.7% vs. 12.9%) and fewer as non-Hispanic White (45.8% vs. 50.6%) compared with hospitalizations among patients without COVID-19. Median length of stay (LOS) was five days (interquartile range [IQR], seven days) for hospitalizations with asthma and COVID-19, whereas median LOS was three days (IQR, three days) for hospitalizations with asthma but not COVID-19.

Among hospitalizations of patients with asthma and COVID-19, the percentages of ICU admission, IMV, and death were 46.9%, 14.0%, and 8.0%, respectively (Table 2). Among hospitalizations of patients with asthma but not COVID-19, the percentage of ICU admission, IMV, and death was 40.7%, 9.2%, and 1.6% respectively. Among patients with asthma and COVID-19, the percentage of death increased with age (2.2% of patients age 18–39 years and 20.0% of patients age ≥75 years) and was higher among males than females (9.8% vs. 7.2%) (eTable 2). We also observed some variation in risk of death by race/ethnicity (e.g. 12.2% among patients identifying as non-Hispanic Asian and 6.1% among non-Hispanic Blacks). Among hospitalizations of patients with asthma, when adjusting for covariates, those with COVID-19 had a higher risk of ICU admission (aRR, 1.17 [95% CI, 1.14–1.21]), IMV (aRR, 1.61 [95% CI, 1.50–1.73]), and death (aRR, 5.56 [95% CI, 4.89–6.32]) compared with hospitalizations among patients without COVID-19.

COPD hospitalizations

In hospitalizations among patients with COPD (but not asthma), 47,996 (18.2%) had COVID-19 (Table 1, eTable 3). Females accounted for 47.5% of hospitalizations among patients with COPD and COVID-19, whereas 50.7% of hospitalizations among patients without COVID-19 were female. We observed a higher percentage of patients aged ≥75 years among hospitalizations with COPD and COVID-19, compared with hospitalizations without COVID-19 (45.1% vs. 34.7%). For hospitalizations among patients with COPD and COVID-19, a higher percentage of patients identified as Hispanic (6.3% vs. 4.0%), as well as non-Hispanic Black (14.9% vs. 11.6%) compared with hospitalizations without COVID-19. Median LOS was seven days (interquartile range (IQR), eight days) for hospitalizations with COPD and COVID-19, while median LOS was four days (IQR, five days) for hospitalizations with COPD, but not COVID-19.

Among hospitalizations of patients with COPD and COVID-19, the percentages of ICU admission, IMV, and death were 55.1%, 19.5%, and 21.5%, respectively (Table 2).

Among COPD hospitalizations without COVID-19, the percentage of ICU admission, IMV, and death was 51.7%, 15.1%, and 5.7%, respectively. Among patients with COPD and COVID-19, the percentage of death increased with age (7.0% of patients age 18–39 years and 25.0% of patients age ≥75 years) and was higher among males than females (23.5% vs. 19.2%) (eTable 3). When adjusting for covariates, hospitalizations among patients with COPD and COVID-19 had a higher risk of ICU admission (aRR, 1.08 [95% CI, 1.07–1.09]), IMV (aRR, 1.30 [95% CI, 1.27–1.33]), and death (aRR, 3.53 [95% CI, 3.44–3.62]) compared with hospitalizations among patients with COPD but not COVID-19. These associations were unchanged in our sensitivity analysis that included codes from chronic bronchitis and emphysema (J41 and J43) in the definition of COPD (data not shown).

Asthma–COPD overlap

In addition, 14,635 (4.7%) hospitalizations were among patients with asthma–COPD overlap (2,189 hospitalizations with COVID-19 and 12,446 hospitalizations without COVID-19; eTable 4). For hospitalizations among patients with asthma–COPD overlap and COVID-19, a higher percentage of patients identified as Hispanic (11.5% vs. 9.0%) compared with hospitalizations among patients without COVID-19. Median LOS was seven days (IQR, nine days) for hospitalizations with asthma–COPD overlap and COVID-19, whereas median LOS was four days (IQR, five days) for hospitalizations with asthma–COPD overlap but not COVID-19.

Among hospitalizations with asthma–COPD overlap and COVID-19, the percentages of ICU admission, IMV, and death were 52.9%, 18.1%, and 14.5%, respectively (eTable 5). Among hospitalizations with asthma–COPD overlap but not COVID-19, the percentage of ICU admission, IMV, and death was 43.8%, 10.9%, and 2.3% respectively. Hospitalizations among people with asthma–COPD overlap, like hospitalizations with either asthma or COPD, had a higher risk of severe outcomes if COVID-19 was present during the hospitalization. When adjusting for covariates, patients with asthma–COPD overlap and COVID-19 had a higher risk of ICU admission (aRR, 1.21 [95% CI, 1.15–1.26]), IMV (aRR, 1.67 [95% CI, 1.51–1.86]), and death (aRR, 5.52 [95% CI, 4.68–6.50]) compared with hospitalizations among patients with asthma–COPD overlap but not COVID-19.

Stratified analyses

Adjusted estimates for each severe outcome, stratified by age group, sex, race/ethnicity, and health insurance type, were calculated for hospitalizations among patients with asthma but not COPD, as well as hospitalizations among patients with COPD but not asthma (eTable 6). In general, these stratified analyses revealed that risk for all severe outcomes remained higher among patients with COVID-19 than without COVID-19. Patients age 18–39 years with COVID-19 did not appear to have a higher risk for IMV compared to patients without COVID-19. Patients identifying as non-Hispanic Asian with COVID-19 did not appear to have a higher risk for ICU admission compared to patients without COVID-19. For death, the magnitude of the unadjusted risk among patients with asthma with COVID-19 increased with age (unadjusted RR for patients age 18–39 years, 1.83 [95% CI, 1.24–2.72]; for age 50–64 years, 5.95 [95% CI, 4.64–7.63]; and for age ≥75 years, 7.92 [95% CI, 6.16–10.20]). Each asthma severity category was associated with severe COVID-19 outcomes

(eTable 7). For COPD patients, we observed less variation in the magnitude of association between COVID-19 and risk of severe outcomes by age. For example, the unadjusted risk of death among patients with COPD with COVID-19 did not consistently increase with age (unadjusted RR for patients age 18–39 years, 3.24 [95% CI, 1.71–6.11]; for age 50–64 years, 3.71 [95% CI, 3.50–3.93]; and for age ≥75 years, 3.47 [95% CI, 3.35–3.59]).

Discussion

In our analysis using a large database of electronic health records, hospitalizations among patients with COVID-19 and asthma and/or COPD had a higher risk of severe outcomes (ICU admission, IMV, or death) than hospitalizations among patients with these respiratory conditions without COVID-19. Hospitalizations among patients with COVID-19 and asthma were over five times as likely to result in death as hospitalizations among patients with asthma but not COVID-19. Hospitalizations among patients with COVID-19 and COPD were over three times as likely to result in death as hospitalizations among patients with COPD, but not COVID-19. Moreover, hospitalizations among patients with asthma–COPD overlap and COVID-19 were over five times as likely to result in death as hospitalizations among patients with asthma–COPD overlap but not COVID-19.

A previous study conducted January 2019–May 2020 in one region of Spain on patients with asthma reported increased in-hospital mortality among patients with COVID-19 compared with patients without COVID-19 (12); our study confirms these results in a U.S. population with an approximately 6-fold larger number of patients with COVID-19 (using a definition intentionally designed to assess asthma and/or COPD exacerbations) over a much larger portion of the pandemic, and adds new information about ICU admission and IMV. Similarly, another study conducted March–April 2020 in 4 teaching hospitals in Spain on patients with COPD found increased in-hospital mortality among COPD patients with COVID-19 compared to COPD patients without COVID-19 (34). Our study confirms these results with a substantially larger population from >800 U.S. hospitals over 1 year and shows increased risk of other severe outcomes (i.e. ICU admission and IMV) among asthma or COPD hospitalizations with COVID-19, compared with asthma or COPD hospitalizations without COVID-19.

In our analysis, 47% of asthma hospitalizations with COVID-19 had an ICU admission, higher than the proportion of ICU admission among these patient groups documented by some US studies with smaller sample sizes (35,36). In general, the proportion of asthma and COVID-19 hospitalizations that resulted in IMV or death in previous studies has varied (35–39). For hospitalizations of COPD with COVID-19 in our analysis, 55% had an ICU admission. Other US studies have documented proportions of ICU admissions among hospitalized COPD patients with COVID-19 > 40% (35,40). We found that 21% of hospitalizations with COPD and COVID-19 resulted in death, and some studies have reported similar (40) or higher risks for mortality (41). Differences in the prevalence of severe outcomes across studies for these patient groups could be related to differences in hospital or patient characteristics, sample size, location, and/or time period (earlier vs. later in the pandemic). For patients with COVID-19 in our study, risk of death increased with age and was higher for males than females for both asthma and COPD patient groups.

Asthma hospitalizations in our analysis, both among patients with and without COVID-19, had a similar age distribution as that among people with asthma in the general US population (42). In terms of race/ethnicity, non-Hispanic Black patients made up a greater proportion of our study population than in the general population of US adults with asthma. Other studies have found non-Hispanic Black persons have an increased risk of asthma-related hospitalizations (43). For COPD hospitalizations in our study, patients were older than people with COPD in the general US population (44). Older age has been associated with COPD exacerbations requiring hospitalization (45), which is consistent with the older age distribution found in our COPD study population.

This study on COVID-19 and exacerbations of asthma and/or COPD used one of the largest sample sizes to date (311,215 asthma and/or COPD hospitalizations). Also, we controlled for demographic characteristics and comorbidities associated with severe COVID-19 illness. Another strength of our analysis was our use of case definitions for asthma and COPD hospitalizations (i.e. primary ICD-10-CM diagnosis code or ICD-10-CM code specifying an asthma or COPD exacerbation) that were designed to avoid selecting patients hospitalized for non-respiratory reasons. Previous case studies have reported COVID-19 in patients with asthma–COPD overlap (46,47). Our study is the first to examine the relationship between severe hospital outcomes (i.e. ICU admission, IMV, death) and COVID-19 among patients with asthma–COPD overlap.

Our analysis had several limitations. We were unable to characterize asthma or COPD severity for most patients. ICU admission was relatively high in our analysis among patients without COVID-19, and ICU admission can be indicative of a severe asthma exacerbation (48). The high proportion of ICU admission seen in our analysis may be related to changes in healthcare utilization during the pandemic (i.e. the observed decrease in asthma related hospitalizations) (49,50) or other factors. We were also unable to characterize pre-hospitalization medication use, specific phenotypes or endotypes, and the timing of patients' exposures to SARS-CoV-2 that led to hospitalizations for COVID-19 or severe outcomes measured in our analysis. Our analysis did not include data on medications administered during hospitalizations. We did not assess data on the reason for hospitalization (e.g. rhinovirus-induced exacerbation or medication nonadherence among patients without COVID-19). Studies have documented a decrease in some respiratory viruses associated with asthma exacerbations (e.g. influenza) during the COVID-19 pandemic (51,52). Our use of ICD-10-CM subcodes to identify asthma exacerbations might have missed asthma exacerbations if a hospitalization was not associated with a specific exacerbation-related ICD-10-CM code. We also relied on ICD-10-CM codes instead of laboratory data to define COVID-19; accuracy of hospital diagnosis codes to identify COVID-19 cases has been demonstrated (30). Our analysis might have missed COVID-19 cases if a hospitalization was not associated with an ICD-10-CM code indicating a COVID-19 diagnosis. We were unable to control for many markers of socioeconomic status that may be associated with disease severity. Lastly, the small sample size for some subgroups (such as patients identifying as non-Hispanic Asian and COPD patients aged 18–39 years) may have impacted our ability to assess disease severity in these patient groups.

Conclusion

In our analysis of a large patient population with individuals from across the US, hospitalizations among patients with asthma or COPD with COVID-19 had a higher risk of resulting in an ICU admission, IMV, and death compared with hospitalizations among patients with asthma or COPD but not COVID-19. These results show that hospitalizations among patients with asthma and/or COPD with SARS-CoV-2 infection had a more severe clinical course than hospitalizations among people with asthma and/or COPD exacerbations without SARS-CoV-2 infection. Our results provide additional information on the risks of severe outcomes from COVID-19 for these patient groups. Preventive measures for COVID-19 (including COVID-19 vaccination, use of masks, and practicing social distancing) are effective in preventing COVID-19 disease and severe illness from COVID-19 disease (53,54). Adoption of these measures among patients with asthma and/or COPD could reduce morbidity and mortality from COVID-19 among the millions of US adults with asthma or COPD.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. CDC (Centers for Disease Control and Prevention). Most recent national asthma data. Available from: https://www.cdc.gov/asthma/most_recent_data.htm [last accessed 5 February 2021].
2. CDC (Centers for Disease Control and Prevention). Basics about COPD. Available from: https://www.cdc.gov/copd/basics-about.html [last accessed 5 February 2021].
3. Leung JM, Sin DD. Asthma-COPD overlap syndrome: pathogenesis, clinical features, and therapeutic targets. BMJ 2017;358:j3772. Epub 2017/09/28. doi:10.1136/bmj.j3772. [PubMed: 28947632]
4. Mendy A, Forno E, Niyonsenga T, Carnahan R, Gasana J. Prevalence and features of asthma-COPD overlap in the United States 2007–2012. Clin Respir J 2018;12(8):2369–2377. Epub 2018/06/07. doi:10.1111/crj.12917. [PubMed: 29873189]
5. National Asthma Education and Prevention Program (NAEPP). Expert panel report 3 (EPR-3): guidelines for the diagnosis and management of asthma—full report 2007. NIH Publication No. 07–4051. Bethesda, MD: National Institutes of Health; 2007.
6. Global strategy for the diagnosis, management and prevention of COPD (2020 Report). Global Initiative for Chornic Obstructive Lung Disease, Inc. https://goldcopd.org/gold-reports/.
7. Alqahtani JS, Oyelade T, Aldhahir AM, Alghamdi SM, Almehmadi M, Alqahtani AS, Quaderi S, Mandal S, Hurst JR. Prevalence, severity and mortality associated with COPD and smoking in patients with COVID-19: a rapid systematic review and meta-analysis. PLoS One 2020;15(5):e0233147. Epub 2020/05/12. doi:10.1371/journal.pone.0233147. [PubMed: 32392262]
8. Leung JM, Niikura M, Yang CWT, Sin DD. COVID-19 and COPD. Eur Respir J 2020;56(2):2002108. Epub 2020/08/21. doi:10.1183/13993003.02108-2020. [PubMed: 32817205]
9. Terry PD, Heidel RE, Dhand R. Asthma in adult patients with COVID-19: prevalence and risk of severe disease. Am J Respir Crit Care Med 2021;203(7):893–905. Epub 2021/01/26. doi:10.1164/rccm.202008-3266OC. [PubMed: 33493416]

10. Liu S, Cao Y, Du T, Zhi Y. Prevalence of comorbid asthma and related outcomes in COVID-19: a systematic review and meta-analysis. J Allergy Clin Immunol Pract 2020;9(2):693–701. doi:10.1016/j.jaip.2020.11.054. [PubMed: 33309934]
11. Williamson EJ, Walker AJ, Bhaskaran K, Bacon S, Bates C, Morton CE, Curtis HJ, Mehrkar A, Evans D, Inglesby P, et al. . Factors associated with COVID-19-related death using OpenSAFELY. Nature 2020;584(7821):430–436. doi:10.1038/s41586-020-2521-4. [PubMed: 32640463]
12. Izquierdo JL, Almonacid C, Gonzalez Y, Del Rio-Bermudez C, Ancochea J, Cardenas R, Lumbreras S, Soriano JB. The impact of COVID-19 on patients with asthma. Eur Respir J 2020;57(3):2003142. doi:10.1183/13993003.03142-2020.
13. García-Pachón E, Zamora-Molina L, Soler-Sempere MJ, Baeza-Martínez C, Grau-Delgado J, Padilla-Navas I, Gutiérrez F. Asthma and COPD in hospitalized COVID-19 patients. Arch Bronconeumol (Engl Ed) 2020;56(9):604–606. Epub 2020/06/27. doi:10.1016/j.arbres.2020.05.007. [PubMed: 32586704]
14. Gerayeli FV, Milne S, Cheung C, Li X, Yang CWT, Tam A, Choi LH, Bae A, Sin DD. COPD and the risk of poor outcomes in COVID-19: a systematic review and meta-analysis. EClinicalMedicine 2021;33:100789. Epub 2021/03/25. doi:10.1016/j.eclinm.2021.100789. [PubMed: 33758801]
15. Lee SC, Son KJ, Han CH, Park SC, Jung JY. Impact of COPD on COVID-19 prognosis: a nationwide population-based study in South Korea. Sci Rep 2021;11(1):3735. Epub 2021/02/14. doi:10.1038/s41598-021-83226-9. [PubMed: 33580190]
16. Reyes FM, Hache-Marliere M, Karamanis D, Berto CG, Estrada R, Langston M, Ntaios G, Gulani P, Shah CD, Palaiodimos L. Assessment of the association of COPD and asthma with in-hospital mortality in patients with COVID-19. A systematic review, meta-analysis, and meta-regression analysis. JCM 2021;10(10):2087. Epub 2021/06/03. doi:10.3390/jcm10102087. [PubMed: 34068023]
17. Ssentongo P, Ssentongo AE, Heilbrunn ES, Ba DM, Chinchilli VM. Association of cardiovascular disease and 10 other pre-existing comorbidities with COVID-19 mortality: a systematic review and meta-analysis. PLoS One 2020;15(8):e0238215. Epub 2020/08/28. doi:10.1371/journal.pone.0238215. [PubMed: 32845926]
18. Soeroto AY, Purwiga A, Emmy H, Roesli RMA. Asthma does not increase COVID-19 mortality and poor outcomes: a systematic review and meta-analysis. Asian Pac J Allergy Immunol 2021; Epub 2021/04/19. doi:10.12932/AP-110920-0955.
19. Wang Y, Ao G, Qi X, Xie B. The association between COVID-19 and asthma: a systematic review and meta-analysis. Clin Exp Allergy 2020;50(11):1274–1277. Epub 2020/09/16. doi:10.1111/cea.13733. [PubMed: 32930476]
20. Gulsen A, Konig IR, Jappe U, Dromann D. Effect of comorbid pulmonary disease on the severity of COVID-19: a systematic review and meta-analysis. Respirology 2021;26(6):552–565. Epub 2021/05/07. doi:10.1111/resp.14049. [PubMed: 33955623]
21. Javanmardi F, Keshavarzi A, Akbari A, Emami A, Pirbonyeh N. Prevalence of underlying diseases in died cases of COVID-19: a systematic review and meta-analysis. PLoS One 2020;15(10):e0241265. Epub 2020/10/24. doi:10.1371/journal.pone.0241265. [PubMed: 33095835]
22. Hussein MH, Elshazli RM, Attia AS, Nguyen TP, Aboueisha M, Munshi R, Toraih EA, Fawzy MS, Kandil E. Asthma and COVID-19; different entities, same outcome: a meta-analysis of 107,983 patients. J Asthma 2021;:1–8. Epub 2021/01/29. doi:10.1080/02770903.2021.1881970. [PubMed: 31448976]
23. Shi L, Xu J, Xiao W, Wang Y, Jin Y, Chen S, Duan G, Yang H, Wang Y. Asthma in patients with coronavirus disease 2019: a systematic review and meta-analysis. Ann Allergy Asthma Immunol 2021;126(5):524–534. Epub 2021/02/21. doi:10.1016/j.anai.2021.02.013. [PubMed: 33609770]
24. Sunjaya AP, Allida SM, Di Tanna GL, Jenkins C. Asthma and risk of infection, hospitalisation, ICU admission and mortality from COVID-19: systematic review and meta-analysis. J Asthma 2021;:1–22. Epub 2021/02/09. doi:10.1080/02770903.2021.1888116. [PubMed: 31448976]
25. Polverino F, Kheradmand F. COVID-19, COPD, and AECOPD: immunological, epidemiological, and clinical aspects. Front Med (Lausanne) 2020;7:627278. Epub 2021/02/05. doi:10.3389/fmed.2020.627278. [PubMed: 33537336]

26. Timberlake DT, Strothman K, Grayson MH. Asthma, severe acute respiratory syndrome coronavirus-2 and coronavirus disease 2019. Curr Opin Allergy Clin Immunol 2021;21(2):182–187. doi: 10.1097/ACI.0000000000000720. [PubMed: 33399389]
27. Premier. Premier Healthcare Database (COVID-19): Data that Informs and Performs. Published April 10, 2020. Available from: http://offers.premierinc.com/rs/381-NBB-525/images/PHD_COVID-19_White_Paper.pdf [last accessed 18 February 2020].
28. Pennington AF, Kompaniyets L, Summers AD, Danielson ML, Goodman AB, Chevinsky JR, Preston LE, Schieber LZ, Namulanda G, Courtney J, et al. Risk of clinical severity by age and race/ethnicity among adults hospitalized for COVID-19-United States, March-September 2020. Open Forum Infect Dis 2021;8(2):ofaa638. Epub 2021/02/09. doi:10.1093/ofid/ofaa638. [PubMed: 33553477]
29. Jering KS, Claggett BL, Cunningham JW, Rosenthal N, Vardeny O, Greene MF, Solomon SD. Clinical characteristics and outcomes of hospitalized women giving birth with and without COVID-19. JAMA Intern Med 2021;181(5):714. Epub 2021/01/16. doi:10.1001/jamainternmed.2020.9241. [PubMed: 33449067]
30. Kadri SS, Gundrum J, Warner S, Cao Z, Babiker A, Klompas M, Rosenthal N. Uptake and accuracy of the diagnosis code for COVID-19 among US hospitalizations. JAMA 2020;324(24):2553–2554. doi: 10.1001/jama.2020.20323%JJAMA. [PubMed: 33351033]
31. Rosenthal N, Cao Z, Gundrum J, Sianis J, Safo S. Risk factors associated with in-hospital mortality in a US national sample of patients with COVID-19. JAMA Netw Open 2020;3(12):e2029058. Epub 2020/12/11. doi:10.1001/jamanetworkopen.2020.29058. [PubMed: 33301018]
32. CDC (Centers for Disease Control and Prevention). People with Certain Medical Conditions. Available from: https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html [last accessed 5 February 2021].
33. Zou G A modified poisson regression approach to prospective studies with binary data. Am J Epidemiol 2004;159(7):702–706. Epub 2004/03/23. doi:10.1093/aje/kwh090. [PubMed: 15033648]
34. Cosio BG, Shafiek H, Toledo-Pons N, Iglesias A, Barcelo M, Represas-Represas C, Comeche L, Catalan P, Fernandez-Villar A, Lopez-Campos JL, et al. Characterization of COPD admissions during the first COVID-19 outbreak. COPD 2021;16:1549–1554. Epub 2021/06/12. doi:10.2147/COPD.S312493.
35. Suleyman G, Fadel RA, Malette KM, Hammond C, Abdulla H, Entz A, Demertzis Z, Hanna Z, Failla A, Dagher C, et al. Clinical characteristics and morbidity associated with coronavirus disease 2019 in a series of patients in metropolitan Detroit. JAMA Netw Open 2020;3(6):e2012270. Epub 2020/06/17. doi:10.1001/jamanetworkopen.2020.12270. [PubMed: 32543702]
36. Ho KH, Howell D, Rogers L, Narasimhan B, Verma H, Steiger D. The relationship between asthma, eosinophilia, and outcomes in coronavirus disease 2019 infection. Ann Allergy Asthma Immunol 2021;127(1):42–48. doi:10.1016/j.anai.2021.02.021. [PubMed: 33647451]
37. Robinson LB, Fu X, Bassett IV, Triant VA, Foulkes AS, Zhang Y, Camargo CA, Blumenthal KG. COVID-19 severity in hospitalized patients with asthma: a matched cohort study. J Allergy Clin Immunol Pract 2021;9(1):497–500. Epub 2020/11/10. doi:10.1016/j.jaip.2020.10.021. [PubMed: 33164794]
38. Lovinsky-Desir S, Deshpande DR, De A, Murray L, Stingone JA, Chan A, Patel N, Rai N, DiMango E, Milner J, et al. Asthma among hospitalized patients with COVID-19 and related outcomes. J Allergy Clin Immunol 2020;146(5):1027–1034 e4. Epub 2020/08/11. doi:10.1016/j.jaci.2020.07.026. [PubMed: 32771560]
39. Mather JF, Mosleh W, McKay RG. The impact of asthma on in-hospital outcomes of COVID-19 patients. J Asthma 2021;:1–7. Epub 2021/06/19. doi:10.1080/02770903.2021.1944187. [PubMed: 31448976]
40. Attaway AA, Zein J, Hatipoğlu US. SARS-CoV-2 infection in the COPD population is associated with increased healthcare utilization: an analysis of Cleveland clinic's COVID-19 registry. EClinicalMedicine 2020;26:100515. Epub 2020/09/02. doi:10.1016/j.eclinm.2020.100515. [PubMed: 32869011]

41. Girardin JL, Seixas A, Ramos Cejudo J, Osorio RS, Avirappattu G, Reid M, Parthasarathy S. Contribution of pulmonary diseases to COVID-19 mortality in a diverse urban community of New York. Chron Respir Dis 2021;18:1479973120986806. Epub 2021/02/09. doi:10.1177/1479973120986806. [PubMed: 33550849]
42. CDC (Centers for Disease Control and Prevention). 2019. National Health Interview Survey (NHIS) Data. Available from: https://www.cdc.gov/asthma/nhis/2019/table3-1.htm. [last accessed 1 March 2021].
43. Akinbami LJ, Moorman JE, Bailey C, Zahran HS, King M, Johnson CA, Liu X. Trends in asthma prevalence, health care use, and mortality in the United States, 2001–2010. NCHS Data Brief 2012;(94):1–8. Epub 2012/05/24.
44. Ward BW, Nugent CN, Blumberg SJ, Vahratian A. Measuring the prevalence of diagnosed chronic obstructive pulmonary disease in the United States using data from the 2012–2014 National Health Interview Survey. Public Health Rep 2017;132(2):149–156. Epub 2017/01/31. doi:10.1177/0033354916688197. [PubMed: 28135423]
45. Brown DW, Croft JB, Greenlund KJ, Giles WH. Trends in hospitalization with chronic obstructive pulmonary disease-United States, 1990–2005. COPD 2010;7(1):59–62. Epub 2010/03/11. doi:10.3109/15412550903499548. [PubMed: 20214464]
46. Lau JYC, Khoo HW, Hui TCH, Kaw GJL, Tan CH. Atypical chest computed tomography finding of pre-dominant interstitial thickening in a patient with coronavirus disease 2019 (COVID-19) pneumonia. Am J Case Rep 2020;21:e926781. Epub 2020/09/22. doi:10.12659/AJCR.926781. [PubMed: 32952147]
47. Aksan F, Nelson EA, Swedish KA. A COVID-19 patient with intense burning pain. J Neurovirol 2020;26(5):800–801. Epub 2020/08/12. doi:10.1007/s13365-020-00887-4. [PubMed: 32779108]
48. Camargo CA Jr., Rachelefsky G, Schatz M. Managing asthma exacerbations in the emergency department: summary of the National Asthma Education And Prevention Program Expert Panel Report 3 guidelines for the management of asthma exacerbations. Proc Am Thorac Soc 2009;6(4):357–366. Epub 2009/08/14. doi:10.1513/pats.P09ST2. [PubMed: 19675345]
49. Lam RW, Inselman JW, Jeffery MM, Maddux JT, Rank MA. National decline in asthma exacerbations in United States during coronavirus disease 2019 pandemic. Ann Allergy Asthma Immunol 2021;127(6):692–694. doi:10.1016/j.anai.2021.09.017. [PubMed: 34582946]
50. Xie S, Lynch S, Himes BE. Adult asthma and COPD healthcare utilization during the COVID-19 pandemic. Am J Respir Crit Care Med 2021;203(9). doi:10.1164/ajrccm-conference.2021.203.1_MeetingAbstracts.A3079.
51. Olsen SJ, Azziz-Baumgartner E, Budd AP, Brammer L, Sullivan S, Pineda RF, Cohen C, Fry AM. Decreased influenza activity during the COVID-19 pandemic-United States, Australia, Chile, and South Africa, 2020. Am J Transplant 2020;20(12):3681–3685. Epub 2020/12/03. doi:10.1111/ajt.16381. [PubMed: 33264506]
52. Partridge E, McCleery E, Cheema R, Nakra N, Lakshminrusimha S, Tancredi DJ, Blumberg DA. Evaluation of seasonal respiratory virus activity before and after the statewide COVID-19 shelter-in-place order in northern California. JAMA Netw Open 2021;4(1):e2035281. Epub 2021/01/26. doi: 10.1001/jamanetworkopen.2020.35281. [PubMed: 33492377]
53. Centers for Disease Control and Prevention (CDC). Vaccines for COVID-19. Available from: https://www.cdc.gov/coronavirus/2019-ncov/vaccines/index.html [last accessed 12 April 2021].
54. Centers for Disease Control and Prevention (CDC). COVID-19: Prevent getting sick. Available from: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/index.html [last accessed 4 May 2021].

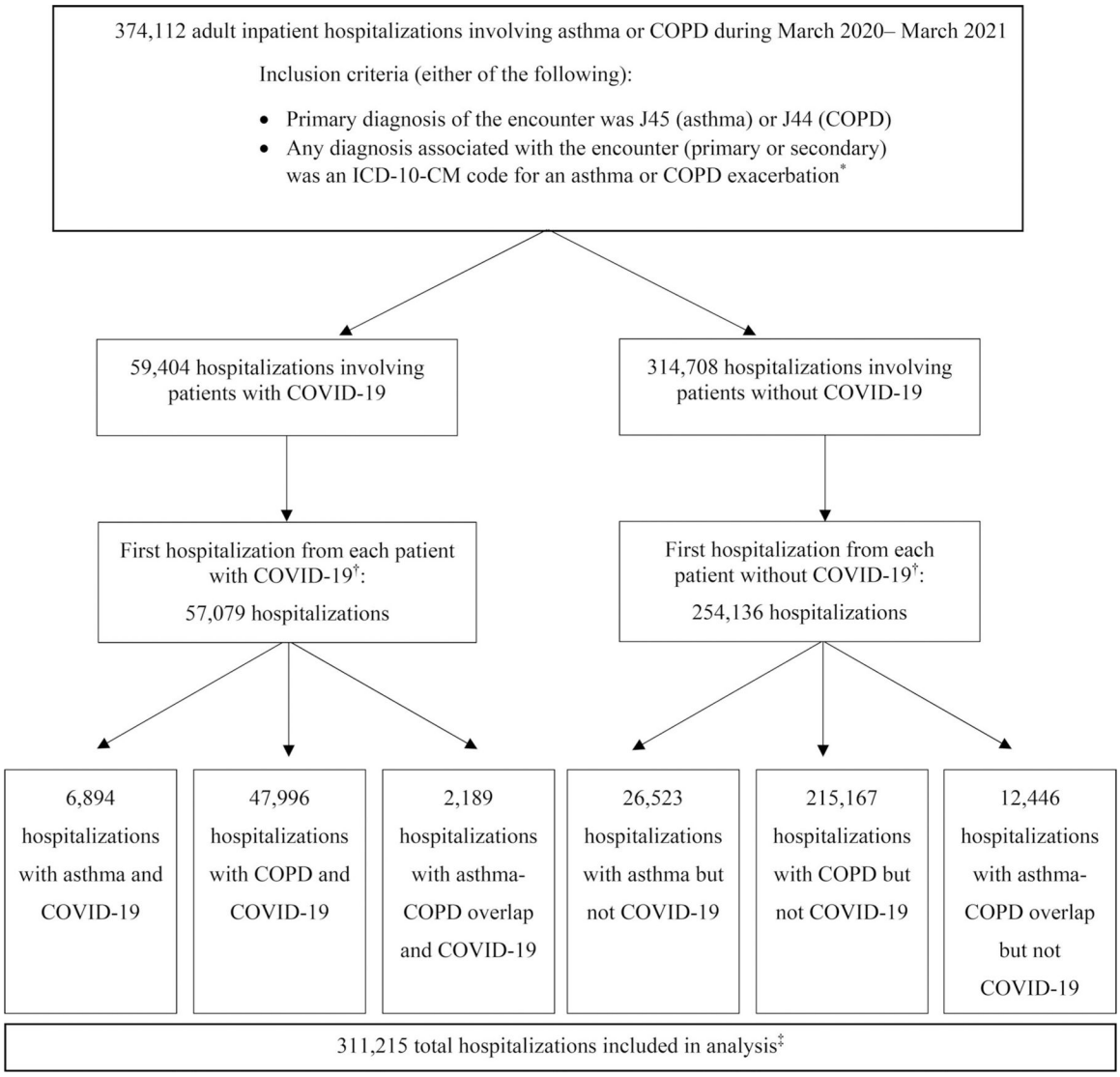

Figure 1.

Definition of study population – Premier Healthcare Database, United States, March 2020–March 2021.

*ICD-10-CM codes for asthma exacerbation: J45.21, J45.22, J45.31, J45.32, J45.41, J45.42, J45.51, J45.52, J45.901, J45.902; ICD-10-CM codes for COPD exacerbation: J44.0, J44.1.

†During study period.

‡Among 304,833 adults (33,142 adults with asthma but not COPD, 257,693 adults with COPD but not asthma, and 14,526 adults with asthma-COPD overlap [528 patients had hospitalizations that were included in >1 asthma/COPD group]). COPD, chronic obstructive pulmonary disease; COVID-19, coronavirus disease 2019; ICD-10-CM, International Classification of Diseases, Tenth Revision, Clinical Modification.

Table 1.

Characteristics of hospitalizations among adults with asthma or chronic obstructive pulmonary disease (COPD) by COVID-19 diagnosis — Premier Healthcare Database, United States, March 2020–March 2021.

	Asthma hospitalizations[a]		COPD hospitalizations[b]	
	With a COVID-19 diagnosis (*n* = 6,894)	Without a COVID-19 diagnosis (*n* = 26,523)	With a COVID-19 diagnosis (*n* = 47,996)	Without a COVID-19 diagnosis (*n* = 215,167)
Characteristic	**No. (%)[c]**	**No. (%)[c]**	**No. (%)[c]**	**No. (%)[c]**
Sex[d]				
Female	4,786 (69.4)	18,441 (69.5)	22,805 (47.5)	109,041 (50.7)
Male	2,102 (30.5)	8,067 (30.4)	25,179 (52.5)	106,093 (49.3)
Age, years [mean (SD)]	53.3 (15.8)	51.6 (18.9)	72.4 (10.6)	69.5 (11.2)
Age, years				
18–39	1,451 (21.0)	8,143 (30.7)	185 (0.4)	1,336 (0.6)
40–49	1,360 (19.7)	4,294 (16.2)	922 (1.9)	7,229 (3.4)
50–64	2,391 (34.7)	6,729 (25.4)	9,944 (20.7)	64,421 (29.9)
65–74	1,026 (14.9)	3,707 (14.0)	15,279 (31.8)	67,461 (31.4)
≥75	666 (9.7)	3,650 (13.8)	21,666 (45.1)	74,720 (34.7)
Race/Ethnicity[e]				
Asian, non-Hispanic	180 (2.6)	617 (2.3)	428 (0.9)	1,593 (0.7)
Black, non-Hispanic	1,632 (23.7)	7,002 (26.4)	7,134 (14.9)	25,052 (11.6)
White, non-Hispanic	3,157 (45.8)	13,430 (50.6)	35,033 (73.0)	171,096 (79.5)
Hispanic	1,291 (18.7)	3,428 (12.9)	3,032 (6.3)	8,567 (4.0)
Other, non-Hispanic	634 (9.2)	2,046 (7.7)	2,369 (4.9)	8,859 (4.1)
Health insurance				
Medicare	2,114 (30.7)	9,523 (35.9)	38,241 (79.7)	159,195 (74.0)
Medicaid	1,361 (19.7)	7,724 (29.1)	3,588 (7.5)	26,384 (12.3)
Private	2,766 (40.1)	6,351 (24.0)	4,253 (8.9)	17,478 (8.1)
Other health insurance[f]	653 (9.5)	2,925 (11.0)	1,914 (4.0)	12,110 (5.6)
Comorbidities				
Cancer	85 (1.2)	794 (3.0)	2,827 (5.9)	24,855 (11.6)

	Asthma hospitalizations[a]		COPD hospitalizations[b]	
	With a COVID-19 diagnosis (*n* = 6,894)	Without a COVID-19 diagnosis (*n* = 26,523)	With a COVID-19 diagnosis (*n* = 47,996)	Without a COVID-19 diagnosis (*n* = 215,167)
Characteristic	**No. (%)[c]**	**No. (%)[c]**	**No. (%)[c]**	**No. (%)[c]**
Chronic kidney disease	2,237 (32.4)	7,190 (27.1)	27,956 (58.2)	101,382 (47.1)
Diabetes (type 2)	2,383 (34.6)	7,147 (26.9)	22,880 (47.7)	82,995 (38.6)
Heart condition[g]	1,138 (16.5)	6,810 (25.7)	28,228 (58.8)	135,593 (63.0)
Obesity (BMI ≥30 kg/m^2)	3,593 (52.1)	9,774 (36.9)	15,264 (31.8)	58,616 (27.2)
Pulmonary fibrosis	50 (0.7)	198 (0.7)	1,028 (2.1)	4,487 (2.1)
Other comorbidities[h]	56 (0.8)	306 (1.2)	324 (0.7)	1,273 (0.6)
Asthma severity[i]				
Mild	1,213 (17.6)	3,058 (11.5)	NA	NA
Moderate	731 (10.6)	3,306 (12.5)	NA	NA
Severe	275 (4.0)	2,535 (9.6)	NA	NA
Other/Unspecified	4,636 (67.2)	17,466 (65.9)	NA	NA
>1 severity code	39 (0.6)	158 (0.6)	NA	NA
Length of stay (median, IQR)	5.0 (7.0)	3.0 (3.0)	7.0 (8.0)	4.0 (5.0)
U.S. Census region				
Midwest	1,371 (19.9)	5,347 (20.2)	13,080 (27.3)	55,561 (25.8)
Northeast	1,406 (20.4)	5,537 (20.9)	6,952 (14.5)	25,468 (11.8)
South	2,919 (42.3)	11,108 (41.9)	22,111 (46.1)	106,335 (49.4)
West	1,198 (17.4)	4,531 (17.1)	5,853 (12.2)	27,803 (12.9)
Facility number of beds				
<100	369 (5.4)	1,698 (6.4)	3,304 (6.9)	18,276 (8.5)
100–299	2,343 (34.0)	9,039 (34.1)	16,277 (33.9)	77,428 (36.0)
300–499	1,994 (28.9)	7,797 (29.4)	15,177 (31.6)	65,824 (30.6)
≥500	2,188 (31.7)	7,989 (30.1)	13,238 (27.6)	53,639 (24.9)
Admission month quarter				
February–March 2020	464 (6.7)	5,196 (19.6)	1,534 (3.2)	39,364 (18.3)
April–June 2020	1,255 (18.2)	5,685 (21.4)	6,548 (13.6)	50,370 (23.4)
July–September 2020	1,215 (17.6)	5,586 (21.1)	7,628 (15.9)	48,244 (22.4)

	Asthma hospitalizations[a]		COPD hospitalizations[b]	
	With a COVID-19 diagnosis (*n* = 6,894)	Without a COVID-19 diagnosis (*n* = 26,523)	With a COVID-19 diagnosis (*n* = 47,996)	Without a COVID-19 diagnosis (*n* = 215,167)
Characteristic	**No. (%)[c]**	**No. (%)[c]**	**No. (%)[c]**	**No. (%)[c]**
October–December 2020	2,461 (35.7)	6,090 (23.0)	20,455 (42.6)	46,256 (21.5)
January–March 2021	1,499 (21.7)	3,966 (15.0)	11,831 (24.6)	30,933 (14.4)

Abbreviations: BMI: body mass index; COVID-19: coronavirus disease 2019; IQR: interquartile range; NA: not applicable.

[a] Primary asthma diagnosis and/or exacerbation specific code; hospitalizations among patients with chronic obstructive pulmonary disease (COPD) were excluded from these data.

[b] Primary COPD diagnosis and/or exacerbation specific code; hospitalizations among patients with asthma were excluded from these data.

[c] Percentages might not add up to 100% because of rounding.

[d] There were 21 asthma hospitalizations with ‘unknown’ sex and 45 COPD hospitalizations with ‘unknown’ sex.

[e] Individuals with Hispanic ethnicity recorded as ‘no’ or ‘unknown’ were defined as ‘non-Hispanic’.

[f] Includes charity, indigent, self-pay, workers compensation, direct employer contract, other government payors, and other.

[g] Includes cardiomyopathies, congestive heart failure, ischemic heart disease, and myocardial infarction.

[h] Includes sickle cell disease, solid organ transplant, and Down syndrome.

[i] Defined by ICD-10-CM diagnosis: mild asthma: J45.2–J45.22 and J45.3–J45.32; moderate asthma: J45.4–J45.42; severe asthma: J45.5–J45.52; Other/unspecified: J45.9, J45.90, J45.901–902, J45.909, J45.99, J45.990–991, J45.998.

Table 2.

Outcomes of hospitalizations among adults with asthma or chronic obstructive pulmonary disease (COPD) by COVID-19 status — Premier Healthcare Database, United States, March 2020–March 2021.

Outcome	No. (%)		Unadjusted RR[c] (95% CI)	Adjusted RR[c,d] (95% CI)
	With COVID-19	Without COVID-19		
Asthma hospitalizations[a]	*n* = 6,894	*n* = 26,523		
ICU admission	3,235 (46.9)	10,805 (40.7)	1.15 (1.12–1.19)	1.17 (1.14–1.21)
IMV	965 (14.0)	2,446 (9.2)	1.52 (1.42–1.63)	1.61 (1.50–1.73)
Death	553 (8.0)	413 (1.6)	5.15 (4.55–5.84)	5.56 (4.89–6.32)
COPD hospitalizations[b]	*n* = 47,996	*n* = 215,167		
ICU admission	26,437 (55.1)	111,267 (51.7)	1.07 (1.06–1.08)	1.08 (1.07–1.09)
IMV	9,348 (19.5)	32,519 (15.1)	1.29 (1.27–1.32)	1.30 (1.27–1.32)
Death	10,304 (21.5)	12,222 (5.7)	3.78 (3.69–3.87)	3.53 (3.44–3.62)

Abbreviations: CI: confidence interval; COVID-19: coronavirus disease 2019; ICU: intensive care unit; IMV: invasive mechanical ventilation; RR: risk ratio.

[a]Primary asthma diagnosis and/or exacerbation specific code; hospitalizations among patients with chronic obstructive pulmonary disease (COPD) were excluded from these data.

[b]Primary COPD diagnosis and/or exacerbation specific code; hospitalizations among patients with asthma were excluded from these data.

[c]Adjusted for correlation by medical facility and person.

[d]Adjusted for age, race/ethnicity, sex, insurance type, admission month, U.S. Census region, and select comorbidities [cancer, chronic kidney disease, heart conditions, obesity, type 2 diabetes, pulmonary fibrosis, and other comorbidities (sickle cell disease, solid organ transplant, and Down syndrome)]. Individuals with missing sex (*n* = 21 among asthma hospitalizations and *n* = 45 among COPD hospitalizations) were excluded from adjusted models.