Original Article

Chin Med Sci J
2023; 38(3): 228-234
doi:10.24920/004252

In-hospital Mortality and Hospital Outcomes among Adults Hospitalized for Exacerbations of Asthma and COPD in Southern Thailand (2017-2021): A Population-Based Study

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ABSTRACT

Background Hospitalizations for asthma and chronic obstructive pulmonary disease (COPD) exacerbations frequently occur in Thailand. National trends in hospital outcomes are essential for planning preventive strategies within the healthcare system. We examined temporal trends in in-hospital outcomes, including mortality rate, length of stay (LOS), and expenses for reimbursement in adults hospitalized for asthma and COPD exacerbations in southern Thailand.

Methods A retrospective, population-based study on adults hospitalized for exacerbations of asthma and COPD was carried out using data from the National Health Security Office in southern Thailand. Baseline demographic and in-hospital outcome assessments were conducted on 19,459 and 66,457 hospitalizations for asthma and COPD, respectively, between 2017 and 2021.

Results Significant reductions in hospital admissions for exacerbations of asthma and COPD were observed over time, particularly in 2020/2021. From 2017 to 2021, the in-hospital mortality rate for asthma rose from 3.2 to 3.7 deaths per 1,000 admissions ($P<0.05$). The rates for COPD admissions, on the other hand, reduced from 20.3 to 16.4 deaths per 1,000 admissions between 2017 and 2020, but subsequently increased to 21.8 in 2021 ($P<0.05$). The prominent contributor to the higher mortality rate was found to be increasing age. Nonetheless, the average LOS for both asthma and COPD decreased slightly over the study period. The total expenses for reimbursing exacerbations of asthma and COPD per hospitalisation have risen significantly each year, with a particularly notable increase in 2020/2021.

Conclusion During 2017-2021, exacerbations of asthma and COPD in Thailand continued to account for significant in-hospital mortality rates and reimbursement expenses, despite the overall decrease in hospitalizations and slight fluctuations in the LOS.

Key words: asthma; COPD; hospitalization; mortality; exacerbation; Thailand

INTRODUCTION

For decades, asthma and chronic obstructive pulmonary disease (COPD) have been major airway diseases and challenges for healthcare systems. Although asthma and COPD guidelines are updated yearly to raise public and professional awareness and improve clinical outcomes[1,2], exacerbations of asthma and COPD are still a problem that not only persists but on the rise[3-5]. Exacerbations are directly responsible for significant morbidity, mortality, and health care expenditures[3-5]. The incidence varies widely among studies[3-7], reflecting differences in individual phenotype, clinical response to medication, patient compliance, and local guidelines. In Thailand, there are several barriers, in-

Received May 5, 2023; accepted June 26, 2023; published online July 23, 2023.
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cluding inaccessible advances in therapy, unavailable spirometers, and even inadequate pulmonary specialists, to achieve ultimate outcomes in asthma or COPD management. Over the past few years, several studies reported a substantial reduction in asthma and COPD exacerbations[8-11] during the ongoing COVID-19 pandemic. These studies also reported in-hospital mortality and length of stay (LOS) in different countries. However, none of these studies included the Thai population. In Thailand, in-hospital outcomes, including mortality, LOS, and reimbursed costs, of adults hospitalized with asthma and COPD exacerbations during the COVID-19 pandemic have not been extensively described. This study aimed to investigate trends in hospital admissions and in-hospital outcomes related to asthma and COPD exacerbations during the 5-year study period, 2017-2021.

PATIENTS AND METHODS

This retrospective, population-based study assessed the number and outcomes of asthma and COPD exacerbations requiring hospitalization from October 2017 to September 2021. We extracted and analyzed data from the Thai National Health Security Office database, which covers approximately 3 million inhabitants in seven provinces of southern Thailand. This database contains information on hospital admissions for asthma and COPD exacerbations, determined by the primary diagnosis by the International Statistical Classification of Diseases and Related Health Problems 10 (codes J45.0-J45.9 and J46 for asthma and code J44 for COPD) documented in the discharge summary. Upon inclusion in the study, the personal identification number of each subject was replaced with a study identification number. All study subjects aged over 15 years. The variables hold essential patient data such as age, gender, admission and discharge dates, discharge status, financial claim cost, and primary hospital outcomes including death and total LOS. Furthermore, the study collected the total number of discharges for each month and year. The study was approved by the Institutional Medical Ethics Committee of Hat Yai Hospital (approval number 061-65-01), which waived the need for patient consent.

Outcomes and assessments

The study outcomes were the number and pattern of hospital admissions for asthma and COPD exacerbations, mortality rates, LOS, and reimbursement expenses over the 5-year study period. The total hospital admissions for asthma and COPD were calculated per 100,000 population each fiscal year. Age-adjusted mortality rates and case fatality rates were used to define asthma- and COPD-related deaths. LOS was measured in days and grouped according to hospitalization duration. Total expenses for reimbursement per fiscal year and hospital admission were evaluated according to cost expenditures.

Statistical analysis

The investigation of 19,459 hospital admissions for asthma and 66,457 admissions for COPD was sorted by the year of hospital discharge. Essential characteristics were demonstrated. Continuous variables were presented as mean ± standard deviation or interquartile range, and categorical variables were presented as percentages. We computed the crude mortality and hospitalisation rates for each year by dividing the number of asthma and COPD fatalities and admissions by the respective population. Subsequently, we standardized the mortality and hospitalization rates per 100,000 population by utilising the standard population. Also, we calculated the case fatality rate to evaluate the severity of asthma and COPD exacerbations by defining the total number of deaths as a proportion of reported asthma and COPD at a specific time, defined as death per thousand admissions in each fiscal year. Multivariate logistic regression models were used for categorical dependent variables like mortality and fatality rates. We also estimated annual rates by age group for case fatality data. A significance level of $P < 0.05$ was used to indicate statistical significance.

RESULTS

General characteristics of asthma and COPD hospital admissions

From October 2017 to September 2021, the study identified 19,459 asthma hospital discharge records and 66,457 COPD hospital discharge records in the Thai National Health Security Office databases (**Table 1**). Of all admissions over a 5-year study period, 9,486 patients were hospitalized for asthma and 19,767 for COPD. A significant decline in total hospital admission for asthma and COPD happened in 2020 and 2021. Of the patients admitted due to asthma, 15,138 (77.8%) were for females, and 7,956 (40.9%) were aged be-

tween 41 and 60 years. For COPD admissions, 52,057 (78.3%) were males, and 31,061 (46.7%) aged 61-75 years. **Fig. 1** shows the age distribution of asthma and COPD inpatients over a 5-year study period. The age was 51.8±17.7 years in patients admitted due to asthma and 69.5±11.3 years in those due to COPD.

Study outcomes for asthma

As shown in **Table 2**, the average annual rate of age-adjusted asthma hospitalization over the 5-year study period was 130 admissions per 100,000 population. This rate declined from 145 to 95 per 100,000 population between 2019 and 2021 ($P<0.05$). With respect to in-patient mortality, the age-adjusted asthma mortality rate per 100,000 population was highest in 2020, 0.47 death per 100,000 population; however, these rates had not significantly changed throughout the study period ($P=0.59$). From 2017 to 2021, the annual case fatality rate showed a significant trend ($P<0.05$), rising from 3.2 to 3.7 deaths per thousand admissions. Patients over the age of 75 had the highest rate, with a nearly two-fold increase from 10.6 deaths per thousand admissions in 2020 to 19.2 deaths per thousand admissions in 2021. The average LOS in asthma was 2.77 days, with approximately 30% (6,023) staying for only one day (**Fig. 2**). From 2017 to 2021, there was an increasing trend in the annual expenses for reimbursement per hospitalization. The highest cost per admission of 6,227 Baht was observed in 2021.

Table 1. Characteristics and overall admissions for asthma and COPD exacerbations in southern Thailand during 2017–2021

Iterms	All	Asthma					All	COPD				
		2017	2018	2019	2020	2021		2017	2018	2019	2020	2021
Total hospital admission (*n*)	19,459	4,126	4,182	4,316	3,958	2,877	66,457	14,419	14,558	14,692	12,499	10,289
Total patients admitted (*n*)	9,486	2,838	2,889	2,989	2,707	2,013	19,767	6,780	6,883	6,902	6,166	5,127
Age [yrs, mean (SD)]	51.8	51.5	51.4	51.9	51.5	52.7	69.5	69.9	69.5	69.2	69.2	69.1
	(17.7)	(17.1)	(18.4)	(17.4)	(18.2)	(17.5)	(11.3)	(11.2)	(17.1)	(11.2)	(11.5)	(11.5)
Age group (yrs, *n*)												
15-40	5,085	1,046	1,132	1,074	1,093	740	662	116	142	137	158	111
41-60	7,956	1,759	1,700	1,807	1,551	1,139	13,148	2,693	2,818	3,971	2,572	2,904
61-75	4,649	957	964	1,050	940	738	31,061	6,731	6,893	6,909	5,771	4,757
> 75	1,769	364	386	387	374	260	21,586	4,881	705	4,675	3,998	3,327
Gender (%)												
Male	22.2	20.9	21.3	21.3	23.3	25.3	78.3	76.9	77.0	78.3	79.5	80.1
Female	77.8	79.1	78.7	78.7	76.7	74.7	21.7	23.1	23.0	21.7	20.5	29.9

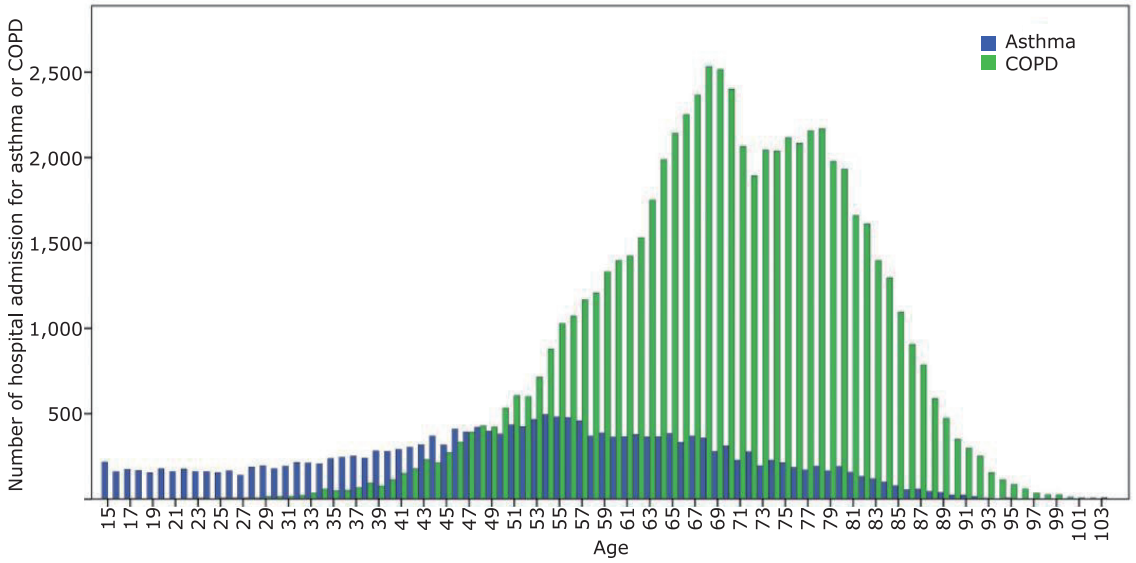

Figure 1. Age distribution in patients hospitalized for asthma and COPD exacerbations during 2017–2021.

Table 2. The in-hospital outcomes of asthma exacerbation in Southern Thailand (2017-2021)

Items	Average	Fiscal year				
		2017	2018	2019	2020	2021
Age-adjusted asthma hospitalization per 100,000 population	130	139	141	145	132	95
Age-adjusted asthma mortality rate per 100,000 population	0.44	0.41	0.44	0.44	0.47	0.43
Case fatality rate per 1,000 hospital admissions	3.4	3.2	2.9	3.3	3.7	3.7
15-40 years	3	4.7	1.7	4.6	0	4.1
41-60 years	3.4	1.7	2.9	1.1	2.5	8.7
61-75 years	3.8	2.1	3.1	1.9	6.3	5.4
>75 years	10.7	5.5	7.7	10.3	10.6	19.2
Length of stay [d, mean (range)]	2.77 (1-95)	2.82 (1-57)	2.82 (1-37)	2.76 (1-39)	2.68 (1-95)	2.74 (1-48)
Reimbursement per admission [Baht, mean (range)]	5,084 (963-232,454)	4,696 (963-232,454)	4,601 (1,116-209,531)	5,059 (1,089-216,163)	5,197 (1,102-216,916)	6,227 (1,254-131,309)
Total reimbursement of the year (Baht)	NA	19,368,452	19,242,761	21,835,004	20,571,843	17,916,073

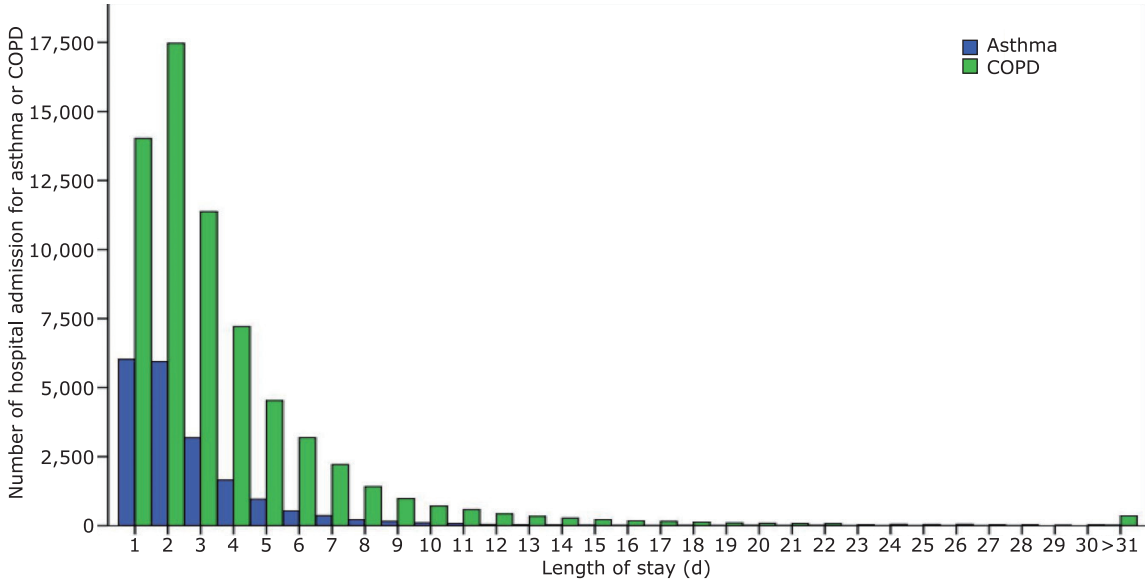

Figure 2. Distribution of the length of stay in hospitalization for asthma and COPD exacerbations during 2017–2021.

Study outcomes for COPD

As shown in Table 3, the average annual rate of age-adjusted COPD hospitalization over the 5-year study period was 446 admissions per 100,000 population. This rate dropped to 340 per 100,000 population in 2021 (P<0.05). Over the course of five years, 1,239 (1.9%) individuals died. The age-adjusted COPD mortality rate had a significantly decreasing trend, and this rate was lowest in 2021 (P<0.05), with 6.6 death per 100,000 population. The case fatality rate decreased from 20.3 in 2017 to 16.4 death per thousand admissions in 2020 but experienced a rising trend to 21.8 in 2021. Approximately 26% (17,467 hospitalizations) were discharged within two days (**Fig. 2**). The average

Table 3. The in-hospital outcomes of COPD exacerbation in southern Thailand (2017-2021).

Iterms	average	Fiscal year				
		2017	2018	2019	2020	2021
Age-adjusted COPD hospitalization per 100,000 population	446	487	492	494	417	340
Age-adjusted COPD mortality rate per 100,000 population	8.3	10.2	8.7	8.8	7.2	6.6
Case fatality rate per 1,000 hospital admission	18.6	20.3	17.6	17.8	16.4	21.8
15-40 years	3.7	8.7	1.4	2.2	6.3	0
41-60 years	9.2	11.5	7.4	9.7	9.7	7.6
61-75 years	16.2	17.3	15.3	15.6	17.3	15.7
>75 years	27.9	31.5	27.4	25.8	22.5	33.1
Length of stay [d, mean (range)]	3.98 (1-228)	4.10 (1-228)	4.01 (1-200)	3.93 (1-196)	3.84 (1-186)	3.85 (1-95)
Reimbursement per admission [Baht, mean (range)]	10,045 (1,111-509,763)	9,158 (1,020-275,488)	9,537 (1,111-276,488)	10,259 (1,188-255,559)	9,868 (860-251,559)	12,148 (1,252-509,763)
Total reimbursement of the year (Baht)	NA	131,905,909	138,708,376	150,689,175	123,288,259	123,005,492

COPD, chronic obstructive pulmonary disease.

LOS was 3.98 days, and the reimbursable expenses per hospitalisation exhibited an upward trend. The highest cost (12,148 Baht per admission) was also noted in 2021.

DISCUSSION

This large-scale population study analyzes recent hospital admissions for asthma and COPD exacerbations as well as in-hospital mortality, LOS, and reimbursement expenses in southern Thailand between 2017 and 2021. In these five years, there has been a significant decrease in hospitalizations for patients with asthma and COPD exacerbations, particularly in 2020 and 2021. The trend of death rate in individuals with asthma and COPD exacerbation seems to have declined over time. However, the case fatality rate, a measure of the severity of both conditions, seems to have increased, particularly in 2020 and 2021. This study also discovered a significant upward trend of reimbursement costs per hospitalization in asthma and COPD, despite no change in the hospital LOS. To the best of our knowledge, this is the first study in Thailand investigating the burden of asthma and COPD exacerbations and assessing their public health implications in terms of in-hospital mortality and cost.

Of note, while the mortality rate for asthma exacerbation remained steady at an average speed of 0.44 per 100,000 population, this rate for COPD exacerbation continually decreased from 10.2 in 2017 to 6.6 in 2021 per 100,000 population. This decline could be due to a dilution effect, as the proportion of the total population was calculated and only mortality associated with an exacerbation event was focused on, which may not be similar to all-cause mortality. The variability in symptoms and easy access to hospital care among asthma patients may provide an explanation for this population-level trend.

The fatal cases hospitalized for asthma exacerbation grew from 2.8 to 3.7 per thousand admissions between 2018 and 2021. In contrast, a US-based study estimated the in-hospital mortality rate in patients hospitalized for asthma exacerbation to be 5 per thousand admissions[6]. Regarding COPD exacerbation, we observed an average in-hospital mortality of 18.6 per thousand admissions, rising to 21.8 in 2021; however,

this rate was 62-74 per thousand admissions when compared to the primary data[10]. These differences demonstrate improved awareness and treatment of asthma and COPD exacerbations in Thailand. Effective control of the COVID-19 pandemic in Thailand, which was praised by the World Health Organization (WHO), may also be a crucial factor in promoting the healthcare system's ability to manage the acute deterioration of chronic diseases. However, it is possible that the rising number of fatal cases is due to the severity of exacerbation, the strain on hospitals caused by the COVID-19 pandemic, an overburdened health system, and the age of patients, particularly elderly individuals. Additionally, studies have found that increasing age is an independent risk factor associated with higher mortality rates for asthma and COPD exacerbations[3, 5, 12, 13]. Further study is warranted to determine the exact factors contributing to the increasing trend of mortality-related exacerbations.

Several studies have demonstrated a significant reduction in exacerbation-related hospital admissions for asthma and COPD, peaking in 2020/2021[8-11]. Although this study was unable to confirm the presence of COVID-19 infection in those experiencing exacerbations, the pandemic period may have contributed to this reduction. As far as we know, pandemic-related self-protection, universal use of masks, and social distancing are critical in reducing the incidence of respiratory viral infections that trigger exacerbations. In addition, a possible shift from hospital to community care, early recognition of aggravating symptoms, and self-management could aslo contribute to a decline in the incidence of exacerbations. These findings were consistent with an earlier meta-analysis that reported a 50% reduction in admissions for COPD exacerbations in 2020/2021[11]. Additionally, the global hospital admission rate for asthma also has significantly fallen[14]. However, several meta-analyses and systemic reviews demonstrated that COPD was associated considerably with COVID-19-related hospital admission, ICU admission, and mortality, but asthma was not associated with adverse COVID-19-related health outcomes[15,16]. The authors propose conducting a longitudinal cohort study in Thailand to evaluate the effects of asthma and COPD exacerbations following the easing of COVID-19 restrictions, due to increased concerns about these burdens.[17].

Hospitalization significantly increases overall costs in asthma and COPD [3, 18-20]. Our study observed growing expenses per hospitalization for asthma and COPD exacerbations, particularly in 2020/2021. Probable reasons for this rise include the complicated nature of cases and frequent comorbidities that contribute to a significant disease burden. The overwhelming healthcare utilization during the COVID-19 pandemic and medication costs also play a crucial role. However, previous studies in the Asia-Pacific region have focused on the economic burden associated with increased disease severity and poor overall health status in urgent care of asthma and COPD [21, 22]. These findings may inform public policies on expense reimbursement by the federal government and highlight the importance of disease burden in asthma and COPD exacerbations.

Our study supports the availability and accessibility of high-quality care for asthma and COPD exacerbations in adults as a crucial policy and advocacy measure to enhance population health and well-being. However, there are some limitations to this study. As the dataset originated from southern Thailand, our findings must be corroborated by national data before they can be deemed more accurate. Based on the ICD-10 codes employed for the primary analysis, it may be necessary to enhance the accuracy of data regarding the diagnosis, especially when performing spirometry to distinguish between asthma and COPD. The subgroup of patients under 15 years old was excluded; hence, caution should be taken when applying our results to childhood asthma management. Finally, the study requires additional external validity to assess other healthcare systems outside of Thailand.

Conclusions

Within the Thai health dataset from 2017 to 2021, we have identified a trend of rising in-hospital mortality rates in patients admitted for exacerbations of asthma and COPD, despite a significant decline in the total number of exacerbation-related hospital admissions for asthma and COPD, particularly during the COVID-19 pandemic. The increase in the in-hospital mortality rate was largely due to advanced age, especially in patients aged over 75 years. Also, we noted an increase in reimbursement expenses for both asthma and COPD, while the hospital LOS remained stable over time. Subsequent investigations should explore in-hospital mortality in COVID-19 infection-related admissions with asthma and COPD exacerbations as well as future trends after the easing of COVID-19 restrictions.

Competing interests

The authors declare no conflicts of interest.

Authors' contributions

Nakwan N had full access to all of the data in the study and took responsibility for the integrity of the data, the accuracy of the data analysis, study design, data analysis and interpretation, and the writing of the manuscript. Suansan K took responsibility for the data's integrity and accuracy of the data analysis.

Availability of data and material

The data set used in the study is available from the author upon request.

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(Edited by Liang-Jun Gu)

论著

泰国南部因哮喘和慢性阻塞性肺疾病加重而住院的成人的院内死亡率和住院结果（2017–2021 年）：基于人口的研究

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摘要

背景 泰国因哮喘和慢性阻塞性肺疾病（COPD）恶化而住院的情况时有发生。住院治疗结果的全国性趋势对于医疗保健系统内预防策略的规划至关重要。本文研究了泰国南部因哮喘和 COPD 加重而住院的成人的住院结果的时间趋势，包括死亡率、住院时间（LOS）和报销费用。

方法 利用泰国南部国家卫生安全办公室提供的数据，对因哮喘和 COPD 加重而住院的成人进行了一项基于人群的回顾性研究。对 2017 年至 2021 年期间分别因哮喘和 COPD 住院的 19,459 例患者和 66,457 患者进行了基线人口统计学和住院结果评估。

结果 随着时间的推移，因哮喘和 COPD 加重而住院的人数显著减少，尤其是在 2020/2021 年。从 2017 年到 2021 年，哮喘的院内死亡率从每 1,000 例住院患者中有 3.2 例死亡上升到 3.7 例（P<0.05）。另一方面，COPD 的入院死亡率在 2017 年至 2020 年期间从每 1000 例住院患者 20.3 例死亡降至 16.4 例，但随后在 2021 年又增至 21.8 例（P<0.05）。死亡率上升的主要原因是年龄的增长。不过，在研究期间，哮喘和 COPD 的平均住院时间都略有缩短。哮喘和 CP{D 每次住院的总费用显著增加，2020/2021 年的增幅尤为明显。

结论 2017-2021 年间，泰国哮喘和 COPD 加重继续在院内死亡率和报销费用中占据重要地位，但住院人数总体有所减少，住院时间也略有波动。

关键词：住院；死亡率；加重；泰国

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