


# Effects of complications associated with chronic obstructive pulmonary disease on lung function and hospitalization expenses

## A retrospective study

Haibin Chen, MM<sup>a,\*</sup> , Chonghui Jiang, PhD<sup>a</sup>, Ming Zhang, MM<sup>a</sup>, Manyi Liu, MM<sup>a</sup>, Senxiong Huang, MM<sup>a</sup>, Jingwen Xie, MM<sup>a</sup>, Jiangfeng Liu, MM<sup>a</sup>

### Abstract

This study investigates the impact of complications associated with chronic obstructive pulmonary disease (COPD) on pulmonary function and inpatient medical expenditures in the Zhongshan region. A retrospective analysis of data from January 2012 to December 2021 was conducted, focusing on lung function and hospitalization expenses for COPD patients ( $n = 272$ ). The included cases were initially categorized into a simple group (without comorbidities,  $n = 99$ ) and a nonsimple group (with comorbidities,  $n = 173$ ). Changes in lung function within each subgroup over a decade were evaluated, along with the average annual hospitalization rate, average duration of hospital stay, and mean hospitalization cost for COPD patients. A comparison between the simple group and the nonsimple group of COPD patient's uncovered statistically significant distinctions ( $P < .05$ ) in age, extent of lung function alteration, average annual hospitalization frequency, and average hospitalization cost. Moreover, multivariable logistic regression analysis showed that, after adjusted for age, sex, smoking, and hospitalizations, patients with comorbidities (nonsimple group) were independently associated with lung function changes ( $\beta = 4.048$ , 95% CI: 1.435–6.659,  $P = .003$ ) compared to those without comorbidities (simple group). Comorbidities have a substantial impact on the lung function of COPD patients. Furthermore, they are associated with increased hospitalization frequency, elevated hospitalization costs, and a higher economic burden of hospitalization for COPD patients.

**Abbreviations:** COPD = chronic obstructive pulmonary disease, FEV1 = forced expiratory volume in 1 second.

**Keywords:** chronic obstructive pulmonary disease, comorbidities, lung function

### 1. Introduction

Chronic obstructive pulmonary disease (COPD), characterized by persistent airflow limitation, is a chronic condition that is both preventable and treatable.<sup>[1]</sup> It bears substantial disability and mortality rates, contributing to roughly 6% of global deaths, ranking as the third most prevalent cause of mortality on a global scale. Beyond its individual health ramifications, COPD also inflicts a considerable economic burden on societies.<sup>[2]</sup> An examination of pulmonary health within the Chinese adult population unveiled a prevalence of 13.7% among individuals aged 40 and above, projecting a patient population of nearly 100 million in China.<sup>[3]</sup> Worldwide, COPD culminates in an annual economic toll of about 82 billion US dollars, further emphasizing its stature as a significant global public health challenge.<sup>[4]</sup> In the context of global aging and the shift from infectious to noncommunicable diseases, COPD takes center

stage as a notable noncommunicable ailment, alongside others such as diabetes, hypertension, and coronary heart disease. The intricate interplay between these noncommunicable conditions elicits profound adverse effects on human health.<sup>[5]</sup>

Research indicates that noncommunicable diseases such as hypertension, coronary heart disease, diabetes, and cancer are prone to coexist with COPD.<sup>[6]</sup> The confluence of comorbidities in COPD contributes to augmented mortality rates and stands as a pivotal factor influencing prognosis and escalating medical expenditure for COPD patients.<sup>[7]</sup> A distinctive feature of COPD is its persistent pulmonary inflammation, involving key inflammatory cells such as macrophages, neutrophils, and T cells. Noteworthy inflammatory mediators encompass TNF- $\alpha$ , IL-1, IL-6, reactive oxygen species, and proteases.<sup>[8]</sup> These inflammatory cells and mediators intricately interact between COPD and its common comorbidities.<sup>[9,10]</sup> Systemic

The authors have no funding and conflicts of interest to disclose.

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

The conduct of this study was approved by the Zhongshan People's Hospital, approval number 2023-036. Informed consent was waived by the committee because of the retrospective nature of the study.

<sup>a</sup> Department of General Medicine, Zhongshan People's Hospital, Zhongshan, China.

\* Correspondence: Haibin Chen, Department of General Medicine, Zhongshan People's Hospital, Zhongshan 528400, China (e-mail: 77625918@qq.com).

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How to cite this article: Chen H, Jiang C, Zhang M, Liu M, Huang S, Xie J, Liu J. Effects of complications associated with chronic obstructive pulmonary disease on lung function and hospitalization expenses: A retrospective study. *Medicine* 2025;104:18(e42274).

Received: 22 April 2024 / Received in final form: 25 December 2024 / Accepted: 11 April 2025

<http://dx.doi.org/10.1097/MD.00000000000042274>

inflammatory responses might culminate in endothelial impairment and vascular dysfunction. Concurrently, within the emphysematous COPD tissue, an imbalance between elastin degradation and protease-antiprotease accelerates arteriosclerosis.<sup>[11,12]</sup> Recurrent instances of hypoxemia, hypercapnia, and elevated intrathoracic pressure can prompt excessive sympathetic nervous system activation and attenuated baroreceptor sensitivity, contributing to elevated arterial blood pressure.<sup>[9,13]</sup> These mechanisms constitute key factors driving the propensity of COPD patients to concomitantly develop hypertension and coronary heart disease. Furthermore, the systemic inflammation associated with COPD might contribute to the progression of diabetes.<sup>[14–16]</sup> Additionally, the therapeutic side effects of corticosteroid usage in COPD patients increase the risk of developing diabetes; conversely, the coexistence of diabetes heightens susceptibility to bacterial infections in COPD patients, leading to frequent exacerbations and subsequently poorer prognosis.<sup>[17,18]</sup>

COPD patients with additional health conditions have a higher mortality rate compared to COPD patients without such health issues. These accompanying health conditions play a crucial role in affecting the long-term mortality rates among COPD patients. As the number of these accompanying health conditions increases, there is a significant rise in mortality rates over extended periods of observation.<sup>[19,20]</sup> Despite the fact that COPD is negatively impacted by various accompanying health conditions, it also influences the outlook for these health issues. This creates a reciprocal relationship in the development and prognosis of both COPD and its associated accompanying health conditions.<sup>[9,21]</sup> Evaluating the condition of COPD patients includes an essential consideration of lung function. As outlined in the “2019 GOLD Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease,”<sup>[22]</sup> the percentage of forced expiratory volume in 1 second (FEV1) after using a bronchodilator in relation to the predicted value (%) indicates the severity of airflow restriction in COPD.<sup>[1]</sup> Numerous studies have shown that sudden exacerbations of COPD symptoms (Acute Exacerbation of Chronic Obstructive Pulmonary Disease) hasten the decline in lung function.<sup>[21,23]</sup> In the context of COPD, the presence of accompanying health conditions such as high blood pressure, coronary heart disease, diabetes, or systemic inflammatory reactions tends to worsen the disease, leading to the occurrence of Acute Exacerbation of Chronic Obstructive Pulmonary Disease.<sup>[9]</sup>

Hence, it becomes necessary to explore whether COPD patients with comorbidities experience a more rapid decline in lung function and whether their healthcare expenditures during hospitalization are higher, necessitating further investigation. This study aims to investigate the impact of comorbidities on lung function and inpatient medical expenses among COPD patients in the Zhongshan region, contributing to an enhanced understanding of these dynamics.

## 2. Materials and methods

### 2.1. Study design

Patients admitted to Zhongshan People's Hospital between January 2012 and December 2021 were selected as subjects for this study. Inclusion criteria were as follows: COPD patients aged 40 or above with concurrent coronary heart disease, hypertension, or diabetes. COPD patients who had undergone lung function tests twice within a 10-year period, with a time interval of 3 to 4 years between tests. All patients met the diagnostic criteria for COPD. Diagnostic criteria were aligned with the following guidelines: COPD diagnosis was based on the “2019 GOLD Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease,”<sup>[22]</sup> characterized by chronic and progressive dyspnea, cough,

and sputum production; history of exposure to risk factors; post-bronchodilator lung function test with FEV1/forced vital capacity ratio <0.7, indicative of airflow limitation while excluding other diseases.<sup>[3]</sup> The diagnosis of coronary artery atherosclerotic heart disease (coronary heart disease), hypertension, and diabetes was established by attending clinicians during hospitalization, with relevant diagnostic evidence documented in medical records. Specifically, the diagnosis of coronary artery atherosclerotic heart disease followed the “2019 ESC Guidelines for the Diagnosis and Management of Chronic Coronary Syndromes”<sup>[24]</sup>; hypertension diagnosis adhered to the “2018 ESC/ESH Guidelines for the Management of Arterial Hypertension”<sup>[25]</sup>; and the diagnosis of diabetes was in accordance with the “2020 ADA Standards of Medical Care in Diabetes.”<sup>[26]</sup> Although the study period was 2012 to 2021, those guidelines were used for uniformity. The raw test results from the patient charts were used to classify all patients using the same systems. Exclusion criteria encompassed: patients concurrently experiencing conditions such as bronchial asthma, bronchiectasis, pulmonary tuberculosis, or lung cancer; patients with advanced cancer undergoing radiotherapy or chemotherapy; patients with chronic liver or kidney dysfunction; patients lost to follow-up; patients with irregular follow-up or non-standard medication usage, and patients whose lung function test results were compromised due to inadequate cooperation during testing.

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### 2.2. Experimental grouping and data collection

General information was collected as follows: Basic information on COPD patients admitted to Zhongshan People's Hospital from January 2012 to December 2021 was provided by the hospital's statistical office. Patient gender, age, smoking history, FEV1 as a percentage of predicted value for 2 separate lung function tests within a 10-year period with a 3- to 4-year interval, average annual hospitalization frequency (for COPD acute exacerbations), average length of hospital stay, and average hospitalization costs were collected using the hospital's electronic medical record system. The included cases were initially categorized into a simple group (without comorbidities) and a nonsimple group (with comorbidities). The nonsimple group was further subdivided into 7 subgroups based on specific comorbidities (hypertension, diabetes, coronary heart disease): hypertension group, diabetes group, coronary heart disease group, hypertension and coronary heart disease group, hypertension and diabetes group, diabetes and coronary heart disease group, and hypertension, diabetes, and coronary heart disease group.

### 2.3. Data analysis

Data analysis was performed using SPSS 20.0 software. Skewed continuous data were presented as median (interquartile range), denoted as M (P25, P75). The Wilcoxon test, a nonparametric test, was employed to compare changes in lung function before and after treatment within each group. The Kruskal-Wallis test, another nonparametric test, was utilized to assess differences among groups. Multivariable linear regression analysis was performed to explore the association between comorbidities and lung function changes, adjusting for confounders (baseline variables with  $P < .05$  between the 2 groups). All statistical tests were considered significant at  $P < .05$ . To mitigate false-positive results, Bonferroni correction was applied to post hoc multiple comparison results.

### 3. Results

#### 3.1. Comparison of general characteristics, lung function, and hospitalization status between COPD patients with and without comorbidities

A comparison between the simple group and the nonsimple group of COPD patients uncovered statistically significant distinctions ( $P < .05$ ) in age, extent of lung function alteration, average annual hospitalization frequency, and average hospitalization cost. Nevertheless, no noteworthy differences were noted concerning smoking history, initial FEV1 as a percentage of predicted value, second FEV1 as a percentage of predicted value, and average length of hospital stay (refer to Table 1).

#### 3.2. Comparison of lung function and hospitalization status among COPD patients with different comorbidities

The nonsimple group was divided into 7 groups based on the comorbidities. Significant statistical differences ( $P < .05$ ) were observed in the comparison of initial FEV1 as a percentage of predicted value, average annual hospitalization frequency, and average hospitalization cost among COPD patients with different comorbidities (refer to Table 2 and Fig. 1A–C). However, no significant differences were found in terms of second FEV1 as a percentage of predicted value and average length of hospital stay (refer to Table 2 and Fig. 1D, E).

Significant differences were found between COPD patients with comorbid hypertension and diabetes and those with only comorbid hypertension regarding initial FEV1 as a percentage of predicted value ( $P < .05$ ; refer to Fig. 1A). Moreover, COPD patients with comorbid hypertension and diabetes, as well as those simultaneously facing comorbid hypertension, coronary heart disease, and diabetes, exhibited significant differences in average annual hospitalization frequency when contrasted with the simple group ( $P < .05$ ; refer to Fig. 1B). Furthermore, a substantial distinction in average hospitalization cost was evident for COPD patients with comorbid hypertension and coronary heart disease when compared to the simple group ( $P < .05$ ; refer to Fig. 1C).

#### 3.3. Comparison of lung function before and after treatment among COPD patients with different comorbidities

No significant differences were observed in the comparison of lung function before and after treatment for both simple group COPD patients and those with comorbid diabetes. However, for the other 5 groups (nonsimple group, comorbid hypertension, comorbid coronary heart disease, comorbid

hypertension and coronary heart disease, comorbid hypertension and diabetes, comorbid hypertension, coronary heart disease, and diabetes), significant differences were found in lung function before and after treatment ( $P < .05$ ; refer to Table 3 and Fig. 2).

#### 3.4. Multivariable analysis

Multivariable linear regression analysis showed that, after adjusted for age, sex, smoking, and hospitalizations, nonsimple group (with comorbidities) were independently associated with lung function changes ( $\beta = 4.048$ , 95% CI: 1.435–6.659,  $P = .003$ ) compared to simple group (without comorbidities; Table 4).

### 4. Discussion

This retrospective study investigated the impact of complications associated with COPD on pulmonary function and inpatient medical expenditures in the Zhongshan region. The results suggested differences in the decline of pulmonary function between COPD patients with comorbidities of hypertension and diabetes compared to those with hypertension and coronary heart disease. In addition, the number of hospitalizations for COPD patients with specific comorbidities differed from the simple cohort, and the average hospitalization cost for COPD patients with both hypertension and coronary heart disease was higher than that of COPD patients without comorbidities. Taken together, the results suggest that comorbidities have a substantial impact on the pulmonary function of COPD patients, resulting in increased hospitalization frequency, elevated hospitalization costs, and a higher economic burden of hospitalization for COPD patients.

In this study, the average age of COPD patients in the nonsimple group was slightly higher than that in the simple group, although the disparity was not substantial. Additionally, the nonsimple group displayed elevated averages in both annual hospitalization frequency and hospitalization cost in comparison to the simple group. Existing research underscores the substantial role of comorbidities in influencing the prognosis of COPD patients. A rise in the number of comorbidities has been associated with heightened rates of hospitalization and mortality during extended follow-up periods. Furthermore, comorbidities stand out as pivotal determinants of medical expenses for COPD patients.<sup>[7,27]</sup> Conditions such as hypertension, coronary heart disease, diabetes, or systemic inflammatory responses have been linked to an increased likelihood of acute exacerbations in COPD patients.<sup>[28]</sup> The findings of this study underscore the potentially significant impact of comorbidities on alterations in lung function among COPD patients. Furthermore, these comorbidities might contribute to escalated annual hospitalization

**Table 1**  
Pulmonary function and hospitalization characteristics of COPD patients with or without comorbidities.

	Simple group (99 cases)	Nonsimple group (173 cases)	$t/c^2/u$	$P$
Age (yr)	67.67 ± 0.880	72.36 ± 0.582	−4.618	<.001
Gender	86 (13)	146 (27)	0.308	.579
Smoking	29 (70)	48 (125)	0.074	.785
Initial FEV1 (%)	42.6 (31.43, 54.8)	44.47 (34.395, 57.93)	−1.336	.182
Second FEV1 (%)	39.07 (28.39, 51.96)	38.1 (29.15, 50.33)	−0.443	.658
Degree of lung function decline	1.4 (−4.48, 6.57)	4.92 (−0.12, 12.1)	−4.127	<.001
Average annual hospitalizations	0.33 (0.11, 0.44)	0.44 (0.22, 0.78)	−4.808	<.001
Average length of stay (d)	7.67 (6, 9.5)	8.5 (6.36, 10.67)	−1.812	.07
Average hospitalization cost	10,808.32 (7971.43, 14,565.86)	12,885.33 (9693.315, 20,386.87)	−2.990	.003

COPD = chronic obstructive pulmonary disease, FEV1 = forced expiratory volume in 1 second.

**Table 2**  
Comparison of pulmonary function and hospitalization characteristics in COPD patients with different comorbidities.

	Simple group	COPD with hypertension	COPD with diabetes	COPD with coronary heart disease	COPD with hypertension and coronary heart disease	COPD with hypertension and diabetes	COPD with diabetes and coronary heart disease	COPD with hypertension, diabetes, and coronary heart disease	H	P
Initial FEV1 (%)	42.6 (31.43, 54.8)	40.96 (29.76, 53.2)	39.86 (33.875, 56.378)	46.6 (36.882, 67.75)	48.5 (37.9, 59.7)	52.335 (43.7, 69.405)	—	40.28 (28.75, 60.648)	14.043	.029
Second FEV1 (%)	39.07 (28.39, 51.96)	32.86 (26.91, 44.66)	37.95 (29.005, 59.675)	42.37 (30.9, 52.35)	39.845 (28.865, 50.115)	42.015 (30.985, 52.068)	—	38.36 (27.575, 50.885)	6.303	.39
Degree of lung function decline	1.4 (−4.48, 6.57)	4.53 (−1.6, 10.88)	2.7 (−4.4775, 9.155)	5.63 (−0.5825, 15.13)	6.835 (1.905, 12.8975)	9.05 (−0.085, 20.4775)	—	3.34 (0.975, 7.92)	24.602	<.001
Average annual hospitalizations	0.33 (0.11, 0.44)	0.44 (0.22, 0.78)	0.33 (0.22, 0.6425)	0.44 (0.22, 0.78)	0.44 (0.22, 0.67)	0.725 (0.2475, 1.3025)	—	0.78 (0.5875, 1.275)	33.533	<.001
Average length of stay (d)	7.67 (6, 9.5)	8.33 (6, 10.56)	8.84 (6.5, 10.99)	7.03 (5.83, 10.13)	8.33 (6.96, 9.47)	10.15 (7.37, 12.71)	—	8.4 (6.66, 11.17)	7.853	.249
Average hospitalization cost	10,808.32 (7971.43, 14,565.86)	11,574.69 (8811.53, 18,619.29)	12,051.51 (10,081.33, 16,185.985)	12,083.26 (8736.2825, 21,999.22)	15,334.735 (10,786.43, 26,321.825)	13,045.71 (10,285.91, 17,395.6)	—	13,421.745 (11,021.83, 32,095.515)	16.892	.01

COPD = chronic obstructive pulmonary disease, FEV1 = forced expiratory volume in 1 second.

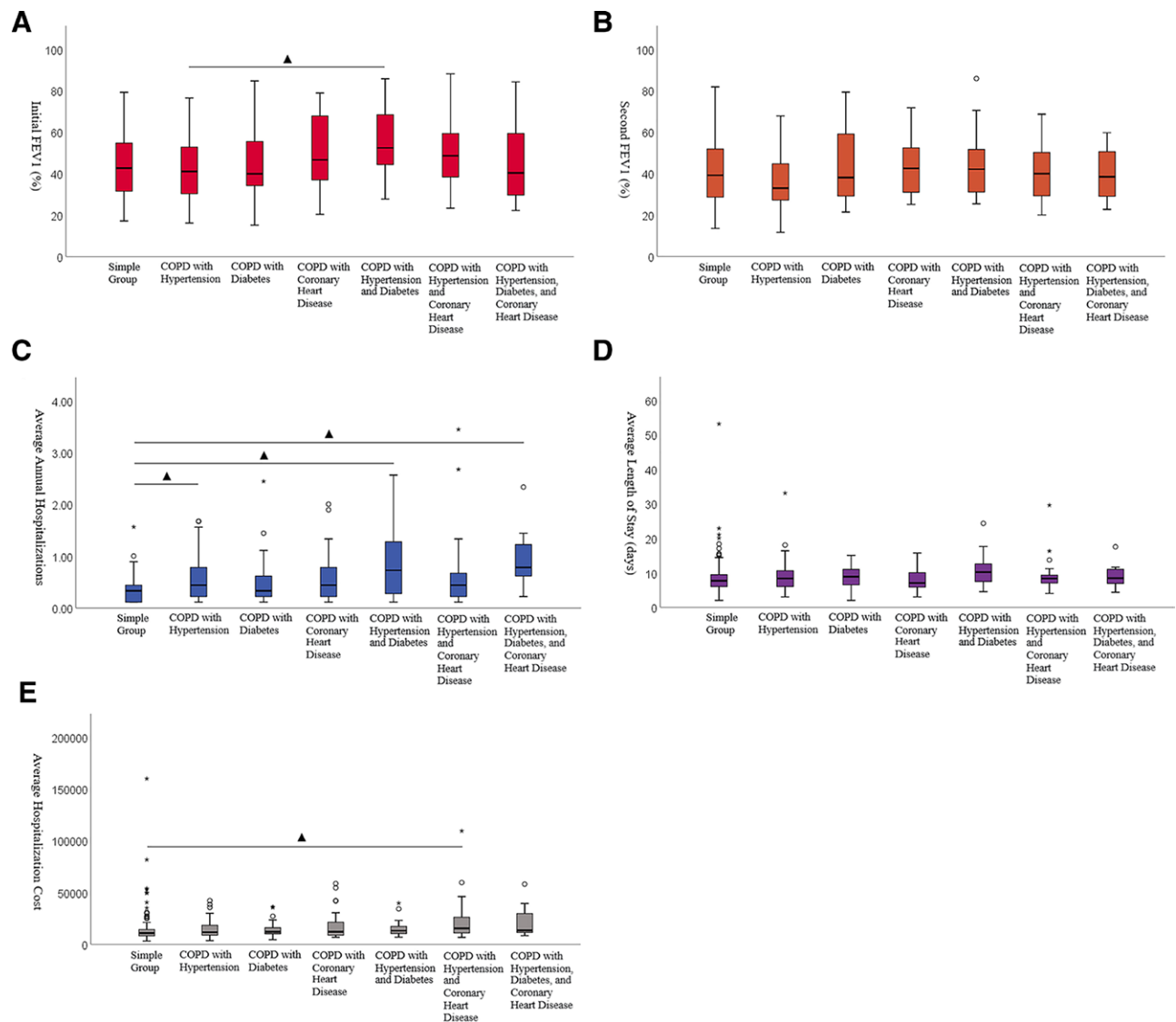
frequency and higher hospitalization costs for individuals with COPD.

This study found that, apart from COPD patients with both hypertension and diabetes who displayed a higher initial FEV1 as a percentage of predicted value than those with only hypertension, no significant differences were noted among the other groups. This outcome is in line with the intended research design. However, COPD patients with comorbid hypertension and diabetes, as well as those with comorbid hypertension and coronary heart disease, demonstrated more pronounced lung function alterations when compared to the simple group COPD patients. These differences were statistically significant ( $P < .05$ ). This suggests that the influence of multiple chronic conditions on the extent of lung function changes in COPD patients might be more noticeable. It's important to acknowledge that among COPD patients with comorbid hypertension, coronary heart disease, and diabetes, a significant number exhibited severely compromised lung function or concomitant multi-organ impairments like stroke and fractures. These factors often posed challenges to their ability to participate in lung function assessments, resulting in their exclusion from the study cohort. Consequently, the sample size was smaller than initially intended. For future investigations, a larger and more diverse group of cases is required to further validate and reinforce these findings.

COPD patients with comorbid hypertension, those with both hypertension and diabetes, and individuals with hypertension, coronary heart disease, and diabetes displayed elevated average annual hospitalization frequencies when compared to the simple group COPD patients. These differences were statistically significant ( $P < .05$ ). Moreover, COPD patients with comorbid hypertension and coronary heart disease exhibited higher average hospitalization costs compared to the simple group COPD patients, with statistically significant distinctions ( $P < .05$ ). These findings suggest that comorbidities potentially contribute to heightened frequencies of acute exacerbations and hospitalizations among COPD patients, thereby exacerbating the economic burden associated with hospital stays. Previous research has also indicated that comorbidities can elevate the occurrence of acute exacerbations and hospitalization rates in COPD patients.<sup>[18,29]</sup> Comorbidities wield substantial influence in determining the health status, medical expenditures, and prognosis of COPD patients.<sup>[6,7]</sup> COPD represents a chronic ailment characterized by a prolonged course, gradual advancement, and recurrent acute episodes. Acute exacerbations often necessitate hospitalization, and consistent long-term medication adherence is paramount for maintaining control. Prioritizing and encouraging regular lung function assessments can facilitate the early identification, diagnosis, and treatment of COPD. Enhanced interdisciplinary communication within medical facilities, guided by clinical guidelines, holds crucial importance in providing rational treatment and management recommendations for COPD patients grappling with comorbidities. Such an approach can contribute to the reduction of average hospitalization durations and frequencies, thereby alleviating the financial burden borne by patients.

In this study, the results of multifactor regression analysis of lung function change showed that there was an independent correlation between complication and lung function change. In addition, in the comparison of pulmonary function before and after the 2 COPD patients with different complications, there were differences in the pulmonary function before and after the 2 COPD patients (nonsimple group and the group with hypertension and the group with coronary heart disease and the group with hypertension, the group with coronary heart disease and the group with hypertension, the group with diabetes and the group with hypertension, coronary heart disease and diabetes), and the differences were statistically significant. These findings suggest that comorbidities are likely to exert a notable impact on lung function changes in COPD patients, with hypertension possibly being the most influential among the various comorbidities. COPD is





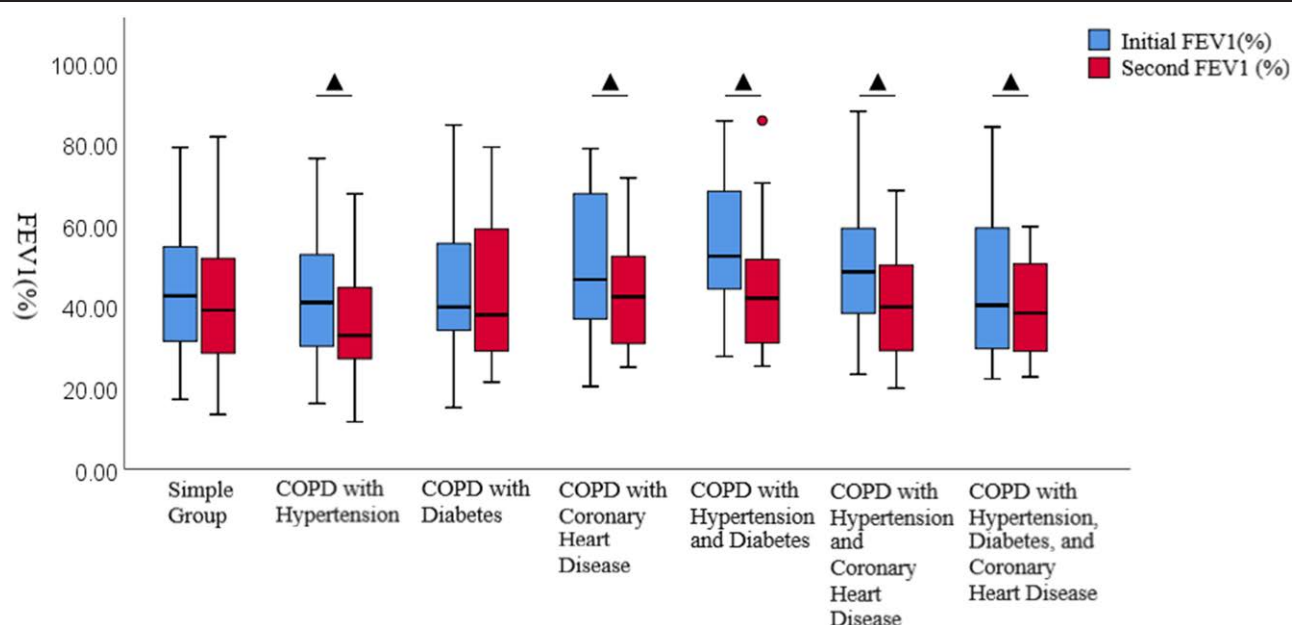
**Figure 1.** Comparison of lung function and hospitalization status among COPD patients with different comorbidities. (A) Initial FEV1 as a percentage of predicted value among COPD patients with different comorbidities. (B) Second FEV1 as a percentage of predicted value among COPD patients with different comorbidities. (C) Average annual hospitalization frequency among COPD patients with different comorbidities. (D) Average length of hospital stay among COPD patients with different comorbidities. (E) Average hospitalization cost among COPD patients with different comorbidities. Bonferroni correction with  $P < .05$  was set for significance. COPD = chronic obstructive pulmonary disease, FEV1 = forced expiratory volume in 1 second.

**Table 3**

**Comparison of pulmonary function before and after 2 different comorbidities among COPD patients.**

Group	Number of cases	Initial FEV1, % (I)	Second FEV1, % (J)	Lung function decline (I-J)	u	P
Simple group	99	42.6 (31.43, 54.8)	39.07 (28.39, 51.96)	1.4 (−4.48, 6.57)	−1.466	.143
Nonsimple group (with comorbidities)	173	44.47 (34.395, 57.93)	38.1 (29.15, 50.33)	4.92 (−0.12, 12.1)	−8.086	<.001
COPD with hypertension	55	40.96 (29.76, 53.2)	32.86 (26.91, 44.66)	4.53 (−1.6, 10.88)	−4.441	<.001
COPD with diabetes	20	39.86 (33.875, 56.378)	37.95 (29.005, 59.675)	2.7 (−4.4775, 9.155)	−1.605	.108
COPD with coronary heart disease	26	46.6 (36.882, 67.75)	42.37 (30.9, 52.35)	5.63 (−0.5825, 15.13)	−2.933	.003
COPD with hypertension and coronary heart disease	34	48.5 (37.9, 59.7)	39.845 (28.865, 50.115)	6.835 (1.905, 12.8975)	−4.556	<.001
COPD with hypertension and diabetes	24	52.335 (43.7, 69.405)	42.015 (30.965, 52.068)	9.05 (−0.085, 20.4775)	−3.486	<.001
COPD with diabetes and coronary heart disease	2	—	—	—	—	—
COPD with hypertension, diabetes, and coronary heart disease	12	40.28 (28.75, 60.648)	38.36 (27.575, 50.885)	3.34 (0.975, 7.92)	−2.51	.012

COPD = chronic obstructive pulmonary disease, FEV1 = forced expiratory volume in 1 second.



**Figure 2.** Comparison of lung function before and after treatment among COPD patients with different comorbidities. Bonferroni correction with  $P < .05$  was set for significance. COPD = chronic obstructive pulmonary disease.

**Table 4**

Multivariate linear regression analysis for lung function changes.

Variables	$\beta$ value	Standard error of $\beta$ value	Standardized $\beta$ value	t	P value	95% CI	
						Lower limit	Upper limit
Constant	6.063	5.82		1.042	.298	-5.396	17.522
Age	-0.040	0.075	-0.034	-0.533	.594	-0.188	0.108
Sex	-0.379	1.897	-0.013	-0.200	.842	-4.113	3.355
Smoking	-1.302	1.498	-0.059	-0.869	.386	-4.252	1.648
Hospitalizations	0.156	0.142	0.07	1.093	.275	-0.124	0.435
Comorbidities	4.048	1.327	0.195	3.051	.003	1.435	6.659

Men, no smoking, no complications were used as references.

often accompanied by other comorbidities such as hypertension, diabetes, coronary heart disease, and cancer. Among these, hypertension is the most common. These comorbidities significantly affect the progression of COPD and have adverse effects on hospitalization rates.<sup>[3,30]</sup> Managing comorbidities in COPD can help slow the progression of lung function impairment. Emerging evidence indicates that diabetes frequently co-occurs with COPD and is associated with worse outcomes compared to COPD without comorbidities.<sup>[31]</sup> The presence of COPD in hospitalized diabetes patients might increase the likelihood of severe outcomes, prolong hospital stays, and lead to higher mortality rates.<sup>[14,32]</sup> Diabetes is also related to decreased lung function and quality of life in COPD patients.<sup>[33,34]</sup> This study did not confirm the impact of comorbid diabetes on lung function changes in COPD patients, possibly due to a limited sample size. Further research with a larger sample size is needed to investigate this aspect in more detail in the future.

Implementing standardized treatments for comorbidities in COPD proactively holds the potential to delay the decline in lung function, diminish the likelihood of acute exacerbations and hospitalizations, enhance patients' quality of life, and mitigate their financial strain. Envisioning comprehensive basic medical insurance systems from governments for patients grappling with multiple chronic conditions remains a hopeful prospect. The study's modest sample size and the prevailing perception among certain clinical practitioners that pulmonary ventilatory function tests are purely diagnostic tools have

indirectly impacted the sample size of pertinent research. The data collection spanned an extended period during which clinical pathways were not entirely established, leading to some gaps in the collected data. In addition, the data were only from the hospital's electronic chart system, and healthcare resource utilization outside the hospital could not be determined. Because many patients and their families return home when critically ill, mortality could not be assessed in this study. In the future, we intend to delve further into the determinants influencing the economic burden of hospitalization among COPD patients with comorbidities. Our aim is to intervene actively based on these determinants, with the aspiration of alleviating the financial strain borne by these patients.

## 5. Conclusion

In conclusion, this study found that comorbidities likely have a significant impact on lung function changes in COPD patients. Comorbidities might increase the frequency of hospitalizations and associated costs for COPD patients, exacerbating their economic burden.

## Author contributions

**Conceptualization:** Haibin Chen.

**Data curation:** Haibin Chen, Chonghui Jiang, Ming Zhang, Manyi Liu, Jingwen Xie, Jiangfeng Liu.

**Formal analysis:** Haibin Chen, Chonghui Jiang, Senxiong Huang.

**Methodology:** Haibin Chen, Manyi Liu.

**Project administration:** Haibin Chen.

**Resources:** Jiangfeng Liu.

**Software:** Ming Zhang, Senxiong Huang, Jingwen Xie.

**Supervision:** Manyi Liu.

**Visualization:** Ming Zhang, Senxiong Huang, Jingwen Xie.

**Writing – original draft:** Haibin Chen, Chonghui Jiang.

**Writing – review & editing:** Haibin Chen, Chonghui Jiang.

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