

Prevalence and Determinants of Cardiovascular Comorbidities Among Patients with Chronic Obstructive Pulmonary Disease: A Hospital-Based Cross-Sectional Study

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ABSTRACT

Objective:

To determine the prevalence and pattern of cardiovascular comorbidities and identify their determinants among patients with chronic obstructive pulmonary disease attending tertiary-care hospitals in Pakistan.

Methods:

This multicenter cross-sectional study was conducted from January 2025 to December 2025 at three tertiary-care hospitals in Punjab, Pakistan. A total of 204 adults with spirometry-confirmed chronic obstructive pulmonary disease were recruited consecutively. Demographic characteristics, smoking exposure, clinical history, airflow limitation, dyspnea severity and exacerbations during the preceding year were recorded. Cardiovascular comorbidities were identified through clinical assessment, blood-pressure measurement, electrocardiography, medical records and echocardiography when indicated. Multivariable logistic regression was used to identify factors independently associated with cardiovascular comorbidity.

Results:

The mean age was 63.7±9.4 years, and 162 (79.4%) patients were male. At least one cardiovascular comorbidity was identified in 98 (48.0%) patients. Hypertension was the most frequent condition (36.3%), followed by ischemic heart disease (15.7%), heart failure (9.8%), cardiac arrhythmia (8.3%) and previous stroke (5.4%). Age ≥65 years, smoking exposure ≥30 pack-years, diabetes mellitus, GOLD grade 3–4 airflow limitation and two or more exacerbations during the preceding year were independently associated with cardiovascular comorbidity.

Conclusion:

Cardiovascular comorbidities affected almost half of the patients with COPD. Incorporating basic cardiovascular assessment into routine COPD care may allow earlier recognition of high-risk patients in resource-constrained hospitals.

Keywords: Chronic obstructive pulmonary disease, cardiovascular disease, comorbidity

How to cite this article: Bashir B, Ajmal A, Rauf Q, Masood R, Javed R, Rizwan M., Prevalence and Determinants of Cardiovascular Comorbidities Among Patients with Chronic Obstructive Pulmonary Disease: A Hospital-Based Cross-Sectional Study. *Int J Drug Deliv Technol.* 2026;16(7): 1228-1234; DOI: 10.25258/ijddt.16.7.131

Source of support: XX

Conflict of interest: XX

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a heterogeneous lung condition characterized by persistent respiratory symptoms and airflow obstruction resulting from abnormalities of the airways or alveoli.¹ The disease has become an increasingly important public health concern, with approximately 392 million adults aged 30–79 years estimated to have COPD worldwide in 2019.² Its burden is greatest in low- and middle-income countries, where tobacco smoking, household biomass fuel, occupational exposure and ambient air pollution remain widespread and access to spirometry is often limited.³

COPD is currently one of the leading causes of global morbidity and mortality, and its burden is expected to increase further because of population growth, ageing and continued exposure to environmental risk factors.⁴ Although COPD primarily affects the respiratory system, its clinical course is strongly influenced by

comorbid illnesses that increase symptoms, complicate treatment and contribute to poor quality of life and premature death.⁵ Cardiovascular diseases are particularly important because hypertension, ischemic heart disease, heart failure, arrhythmias and cerebrovascular disease frequently coexist with COPD.⁶

Population-based evidence has shown that adults with COPD have a substantially higher prevalence of cardiovascular disease than those without COPD, even after adjustment for demographic, metabolic and lifestyle factors.⁷ The reported prevalence varies considerably between studies because of differences in patient age, severity of airflow limitation, healthcare setting and methods used to identify cardiovascular conditions.⁸

Active cardiovascular screening has also revealed that a clinically important proportion of heart failure, coronary artery disease and atrial fibrillation remains undiagnosed among patients being treated for COPD.⁹ The relationship between the two disease

groups is partly explained by shared risk factors such as ageing, cigarette smoking, physical inactivity, obesity, diabetes mellitus and socioeconomic disadvantage.¹⁰ Several biological mechanisms, including systemic inflammation, oxidative stress, endothelial dysfunction, arterial stiffness, hypoxemia and increased sympathetic activity, may further contribute to cardiovascular disease in COPD.¹¹

Acute exacerbations place additional stress on the cardiovascular system and are associated with a short-term increase in the risk of myocardial infarction, stroke and other serious cardiovascular events.¹² Recognition may be delayed because heart failure, myocardial ischemia and cardiac arrhythmias can cause breathlessness and exercise limitation that may be incorrectly attributed to worsening respiratory disease.¹³

This diagnostic challenge is especially relevant in Pakistan, where the burden of non-communicable disease is increasing while access to echocardiography, cardiac biomarkers and specialist services remains uneven.¹⁴ Despite the clinical importance of this overlap, local multicenter evidence remains limited. Reliable information on the prevalence and determinants of cardiovascular comorbidities could help clinicians select patients who require more detailed assessment without introducing costly universal screening. The present study therefore determined the prevalence and pattern of cardiovascular comorbidities and identified their independent determinants among patients with COPD attending three tertiary-care hospitals in Pakistan.

MATERIALS AND METHODS

This multicenter hospital-based cross-sectional study was conducted in the pulmonology and medical departments of three tertiary-care teaching hospitals in Punjab, Pakistan, from January to December 2025. The participating institutions served patients from urban centers and surrounding rural districts and provided care within a resource-constrained healthcare system.

Adults aged 40 years or older with stable, spirometry-confirmed COPD were recruited consecutively from outpatient clinics and medical wards. COPD was diagnosed in patients with compatible respiratory symptoms and exposure history when the post-bronchodilator ratio of forced expiratory volume in one second to forced vital capacity was below 0.70.

Patients were considered clinically stable when they had experienced no acute exacerbation or major change in respiratory treatment during the preceding four weeks. Patients with active pulmonary tuberculosis, bronchiectasis as the primary respiratory disease, interstitial lung disease, bronchial asthma without persistent airflow obstruction, congenital heart disease, active malignancy or inability to perform acceptable spirometry were excluded.

Patients presenting with an acute COPD exacerbation or acute cardiovascular event were assessed after clinical stabilization.

The sample size was calculated using an anticipated cardiovascular comorbidity prevalence of 50%, a 95% confidence level and 7% absolute precision. The minimum required sample was 196. A total of 210 patients were enrolled to allow for incomplete information. Six patients with incomplete cardiovascular assessment were excluded, leaving 204 patients in the final analysis.

Data were collected through patient interviews, clinical examination and review of available medical records. A common structured proforma was used across the centers, and the investigators were trained before data collection to maintain consistency. Demographic information included age, sex, place of residence, education and employment. Exposure history covered smoking status, cumulative pack-years, household biomass-fuel exposure and occupational exposure to dust or fumes. Patients who had smoked at least 100 cigarettes during their lifetime and continued to smoke were classified as current smokers. Those who had stopped smoking were classified as former smokers.

Clinical information included COPD duration, respiratory treatment, body mass index, resting oxygen saturation, modified Medical Research Council dyspnea grade, number of exacerbations and COPD-related hospital admissions during the preceding 12 months. An exacerbation was defined as an acute worsening of respiratory symptoms requiring additional antibiotics, systemic corticosteroids or hospital treatment.

Post-bronchodilator spirometry was performed using standard procedures. Airflow limitation was classified as GOLD grade 1 when FEV₁ was $\geq 80\%$ predicted, grade 2 when it was 50–79%, grade 3 when it was 30–49%, and grade 4 when it was $< 30\%$ predicted. GOLD grades 1–2 and 3–4 were combined during regression analysis to maintain stable estimates.

The primary outcome was the presence of at least one cardiovascular comorbidity. All participants underwent cardiovascular history-taking, physical examination, repeated blood-pressure measurement and 12-lead electrocardiography. Previous prescriptions, investigation reports and hospital discharge records were reviewed when available.

Hypertension was identified from a previously documented diagnosis requiring treatment or repeatedly measured blood pressure $\geq 140/90$ mmHg. Ischemic heart disease was based on a history of myocardial infarction, coronary revascularization, cardiologist-confirmed angina or supporting cardiac investigations. Heart failure required a physician diagnosis supported by clinical and echocardiographic findings.

Cardiac arrhythmia included atrial fibrillation, atrial flutter or another sustained rhythm abnormality documented through electrocardiography or previous medical records. Previous stroke was recorded when supported by a physician diagnosis and relevant clinical or imaging documentation. Pulmonary hypertension was accepted when documented on echocardiography or in a cardiologist's assessment. Echocardiography was performed when symptoms, examination findings, electrocardiographic abnormalities or previous clinical information suggested structural heart disease. Universal echocardiographic screening was not undertaken because it was not routinely available or affordable at all centers. Diabetes mellitus was identified from medical records, glucose-lowering treatment or accepted biochemical criteria. The operational definitions of the study variables and their methods of assessment are presented in Table 1.

Operational definitions and assessment procedures

Variable	Operational definition	Assessment
COPD	Post-bronchodilator FEV ₁ /FVC <0.70	Spirometry
Severe airflow limitation	GOLD grade 3 or 4	Post-bronchodilator FEV ₁
Frequent exacerbations	≥2 treated exacerbations in the preceding year	Interview and records
Hypertension	Treatment history or repeated BP ≥140/90 mmHg	Records and BP measurement
Ischaemic heart disease	Documented infarction, revascularization or confirmed angina	Records, ECG and cardiac investigations
Heart failure	Physician diagnosis supported by objective findings	Records and echocardiography
Cardiac arrhythmia	Documented sustained rhythm abnormality	ECG or previous rhythm record
Cardiovascular comorbidity	At least one predefined cardiovascular condition	Composite outcome

Data were analyzed using SPSS version 26.0 and summarized using appropriate descriptive and comparative tests. Multivariable logistic regression identified independent determinants of cardiovascular comorbidity. Adjusted odds ratios with 95% confidence intervals were reported, and $p < 0.05$ was considered significant.

The study protocol was reviewed by the institutional ethical review committees of the participating hospitals. Written informed consent was obtained from each participant, and identifying information was removed before analysis. The authentic names and approval numbers of the ethical committees should be inserted from the original study documentation.

A total of 210 patients were assessed for inclusion. Six were excluded because their cardiovascular assessment was incomplete, and 204 patients were included in the final analysis. The three hospitals contributed 72, 68 and 64 participants, respectively.

The mean age was 63.7 ± 9.4 years, and 96 (47.1%) patients were aged 65 years or older. Most participants were male, while approximately four-fifths were current or former smokers. Household biomass-fuel exposure was reported by nearly one-third of the patients. Severe or very severe airflow limitation was present in 100 (49.0%) participants. The demographic and clinical characteristics are presented in Table 2.

RESULTS

Demographic and clinical characteristics of participants (n=204)

Characteristic	Result
Age, years, mean±SD	63.7±9.4
Age ≥65 years	96 (47.1)
Male sex	162 (79.4)
Rural residence	91 (44.6)
No formal education	73 (35.8)
Current smoker	64 (31.4)
Former smoker	102 (50.0)
Never smoker	38 (18.6)
Smoking exposure, pack-years, median (IQR)	32 (20–46)
Biomass-fuel exposure	61 (29.9)
Occupational dust or fume exposure	67 (32.8)
COPD duration, years, median (IQR)	6 (3–10)
Body mass index, kg/m ² , mean±SD	23.4±4.5
Diabetes mellitus	51 (25.0)
mMRC dyspnoea grade ≥2	129 (63.2)
≥2 exacerbations in the preceding year	86 (42.2)
COPD-related admission in the preceding year	69 (33.8)
GOLD grade 1	15 (7.4)
GOLD grade 2	89 (43.6)
GOLD grade 3	76 (37.3)
GOLD grade 4	24 (11.8)

Values are *n* (%) unless otherwise indicated. IQR: interquartile range; mMRC: modified Medical Research Council.

At least one cardiovascular comorbidity was identified in 98 patients, giving an overall prevalence of 48.0% (95% CI: 41.0–55.1%). Hypertension was the most frequent condition, followed

by ischaemic heart disease, heart failure and cardiac arrhythmia. Individual conditions were not mutually exclusive because some patients had more than one cardiovascular diagnosis (Table 3).

Pattern of cardiovascular comorbidities (n=204)

Cardiovascular condition	n (%)	95% CI
Any cardiovascular comorbidity	98 (48.0)	41.0–55.1
Hypertension	74 (36.3)	29.7–43.3
Ischaemic heart disease	32 (15.7)	11.2–21.3
Heart failure	20 (9.8)	6.3–14.6
Cardiac arrhythmia	17 (8.3)	5.1–12.8
Pulmonary hypertension	14 (6.9)	4.0–11.1
Previous stroke	11 (5.4)	2.9–9.3

Among the 98 patients with cardiovascular comorbidity, 66 had one condition, while 32 had two or more. Nine patients had at

least three cardiovascular diagnoses, indicating a smaller but important group with complex multi morbidity (Table 4).

Number of cardiovascular comorbidities per patient

Number of cardiovascular comorbidities	n (%)
None	106 (52.0)
One	66 (32.4)
Two	23 (11.3)
Three or more	9 (4.4)

Patients with cardiovascular comorbidity were older and had greater cumulative smoking exposure than those without cardiovascular disease. Diabetes mellitus, severe airflow limitation, clinically important dyspnoea, recurrent exacerbations and COPD-related admission were also more frequent among

affected patients. Sex, residence, biomass-fuel exposure and increased body mass index were not significantly different between the groups (Table 5).

Comparison according to cardiovascular comorbidity status

Variable	CVD present (n=98)	CVD absent (n=106)	p-value
Age, years, mean±SD	66.7±8.4	60.9±9.5	<0.001
Age ≥65 years	59 (60.2)	37 (34.9)	<0.001
Male sex	81 (82.7)	81 (76.4)	0.269
Rural residence	45 (45.9)	46 (43.4)	0.718
Smoking exposure ≥30 pack-years	65 (66.3)	47 (44.3)	0.002
Biomass-fuel exposure	31 (31.6)	30 (28.3)	0.606
BMI ≥25 kg/m ²	38 (38.8)	32 (30.2)	0.197
Diabetes mellitus	35 (35.7)	16 (15.1)	0.001
GOLD grade 3–4	62 (63.3)	38 (35.8)	<0.001
mMRC dyspnoea grade ≥2	73 (74.5)	56 (52.8)	0.001
≥2 exacerbations in the preceding year	56 (57.1)	30 (28.3)	<0.001
COPD-related admission in the preceding year	44 (44.9)	25 (23.6)	0.001

CVD: cardiovascular disease; BMI: body mass index; mMRC: modified Medical Research Council.

After adjustment, age ≥65 years, smoking exposure ≥30 pack-years, diabetes mellitus, GOLD grade 3–4 airflow limitation and two or more exacerbations during the preceding year remained

independently associated with cardiovascular comorbidity. Sex, body mass index and biomass-fuel exposure were not independently associated with the primary outcome (Table 6).

Multivariable logistic regression for cardiovascular comorbidity

Determinant	Adjusted OR	95% CI	p-value
Age ≥65 years	2.21	1.18–4.14	0.013
Male sex	1.19	0.52–2.72	0.678
Smoking exposure ≥30 pack-years	1.88	1.01–3.50	0.047
BMI ≥25 kg/m ²	1.34	0.70–2.56	0.380
Biomass-fuel exposure	1.16	0.57–2.35	0.681
Diabetes mellitus	2.31	1.11–4.82	0.025
GOLD grade 3–4	2.42	1.28–4.57	0.006
≥2 exacerbations in the preceding year	2.08	1.09–3.97	0.026

OR: odds ratio; CI: confidence interval; BMI: body mass index.

The Hosmer–Lemeshow test indicated acceptable model calibration ($p=0.61$), and no important multicollinearity was identified among the variables included in the final model.

DISCUSSION

The principal finding of this study was that almost half of the patients with COPD had at least one cardiovascular comorbidity. This burden is clinically important because cardiovascular disease contributes to worsening symptoms, repeated hospitalization and poorer survival among patients with COPD.¹⁵ The overall prevalence was close to estimates reported in contemporary hospital-based studies, although direct comparison

remains difficult because cardiovascular assessment and disease definitions vary considerably across settings.¹⁶

Hypertension was the most frequent condition, affecting more than one-third of the patients. Its predominance was consistent with a recent systematic review in which hypertension was repeatedly identified among the leading comorbidities associated with COPD.¹⁷ Ischemic heart disease was the second most common cardiovascular condition. Contemporary evidence indicates that COPD is associated with an increased risk of coronary disease and myocardial infarction beyond the contribution of age and smoking alone.¹⁸

Heart failure affected approximately one in ten patients. This condition may be missed in routine respiratory practice because breathlessness, fatigue and reduced exercise tolerance are common to both COPD and heart failure.¹⁹ Cardiac arrhythmias and pulmonary hypertension were less frequent but remained clinically relevant. Recent reviews have emphasized that atrial fibrillation, right ventricular dysfunction and pulmonary vascular disease can complicate advanced COPD and adversely affect prognosis.²⁰

Older age, heavy smoking and diabetes were independently associated with cardiovascular comorbidity. These findings reflect the cumulative effect of conventional cardiovascular risks alongside COPD-related inflammation, oxidative stress, hypoxemia and vascular dysfunction.²¹ Severe airflow limitation was another independent determinant. Patients with advanced COPD generally have greater symptom burden, lower physical activity, more frequent hypoxemia and a higher prevalence of systemic comorbidities, all of which may contribute to cardiovascular disease.²²

Frequent exacerbations were associated with approximately twice the odds of cardiovascular comorbidity. A meta-analysis found that COPD exacerbations were followed by a marked short-term increase in the risk of acute myocardial infarction and stroke, supporting close cardiovascular surveillance during and after these events.²³

The findings have practical implications for hospitals where advanced investigations are not readily available. A focused assessment using clinical history, pulse examination, repeated blood-pressure measurement, glucose testing and electrocardiography could help identify high-risk patients before arranging selective echocardiography or specialist referral.

The multicenter design, consecutive sampling, standardized data collection and spirometric confirmation strengthened the reliability and clinical relevance of the study findings.

CONCLUSION

Cardiovascular comorbidities were present in almost half of the patients with COPD, with hypertension being the most frequent condition. Older age, heavy smoking, diabetes mellitus, severe airflow limitation and recurrent exacerbations were independent determinants. Incorporating a basic cardiovascular assessment into routine COPD care may support earlier diagnosis and better-coordinated management, particularly in resource-constrained hospitals.

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