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FREQUENCY OF PULMONARY HYPERTENSION IN COPD PRESENTING TO TERTIARY CARE HOSPITAL

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ABSTRACT

Background;

Chronic obstructive pulmonary disease (COPD) is a major global health concern and is frequently complicated by pulmonary hypertension (PH), which significantly worsens morbidity and mortality. Despite its clinical importance, local data on the frequency of PH among COPD patients in Pakistan remains limited.

Objective;

To determine the frequency of pulmonary hypertension among patients with chronic obstructive pulmonary disease presenting to a tertiary care hospital.

Methods:

This cross-sectional study was conducted at Ayub Teaching Hospital, Abbottabad, over a period of six months from 1st September 2024 to 28th February 2025. A total of 134 patients aged 18–80 years with spirometry-confirmed COPD were enrolled using non-probability consecutive sampling. Patients with other causes of pulmonary hypertension were excluded. Demographic and clinical data were recorded, and pulmonary hypertension was assessed using transthoracic echocardiography, defined as pulmonary artery systolic pressure (PASP) ≥25 mmHg. Data were analyzed using SPSS version 21, and associations were assessed using chi-square test, with $p \leq 0.05$ considered statistically significant.

Results:

The mean age of participants was 58.4 ± 10.6 years, with 53.7% in the 41–60 years age group. Males constituted 68.7% of the study population. Regarding smoking status, 44.8% were current smokers, 29.9% former smokers, and 25.4% never smokers. The majority of patients had moderate COPD (46.3%), followed by severe (29.9%), mild (14.9%), and very severe disease (9.0%).Pulmonary hypertension was present in 43.3% (n=58) of patients. Among these, mild PH was observed in 51.7%, moderate in 31.0%, and severe in 17.3%, with a mean PASP of 33.2 ± 8.5 mmHg. Dyspnea (89.6%), chronic cough (80.6%), and sputum production (70.9%) were the most common symptoms.A statistically significant association of PH was found with age (p=0.03) and smoking status (p=0.01), while gender was not significantly associated (p=0.42). PH was also significantly associated with

comorbidities, including diabetes mellitus (p=0.002), cardiovascular disease (p=0.01), presence of both conditions (p=0.04), and absence of comorbidities (p=0.001). Echocardiographic findings included right ventricular hypertrophy in 29.9%, right atrial enlargement in 26.1%, and tricuspid regurgitation in 20.9% of patients.

Conclusion:

Pulmonary hypertension is a common complication among COPD patients, with a frequency of 43.3% in this study. It is more frequently associated with advancing age, smoking, and comorbid conditions. Early screening using echocardiography in COPD patients may facilitate timely diagnosis and improve clinical outcomes, particularly in resource-limited settings.

Keywords: *Chronic obstructive pulmonary disease; Pulmonary hypertension; Echocardiography; Smoking; Comorbidities; Pulmonary artery pressure; COPD complications.*

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a major global health problem and represents a significant cause of morbidity and mortality worldwide. It is characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response of the airways and lungs to noxious particles or gases. Globally, COPD affects approximately 10–13% of individuals above 40 years of age and is currently ranked as the third leading cause of death, with an increasing burden in low- and middle-income countries such as Pakistan[1,2]. The high prevalence of tobacco smoking, exposure to biomass fuels, and environmental pollution in developing countries further contributes to the rising incidence of COPD.In addition to its pulmonary manifestations, COPD is increasingly recognized as a systemic disease with multiple extrapulmonary complications that significantly influence patient outcomes. Among these, pulmonary hypertension (PH) is one of the most important and clinically relevant complications. PH in COPD develops as a consequence of chronic hypoxia, pulmonary vasoconstriction, vascular remodeling, and destruction of the pulmonary vascular bed[3]. Over time, these changes lead to increased pulmonary arterial pressure, right ventricular strain, and eventually right heart failure, commonly referred to as cor pulmonale.Pulmonary hypertension is defined hemodynamically as a mean pulmonary arterial pressure (mPAP) greater than 20 mmHg at rest, as measured by right heart catheterization[4]. It is classified into five major groups based on etiology, with PH due to lung diseases and/or hypoxia (Group 3) being particularly relevant in COPD patients[5]. Although right heart catheterization remains the gold standard for diagnosis, echocardiography is widely used in clinical practice as a non-invasive and accessible screening tool, especially in resource-limited settings.The development of PH in COPD is usually gradual and often correlates with the severity and duration of the underlying lung disease. However, even patients with moderate airflow limitation may develop significant pulmonary vascular involvement. Chronic alveolar hypoxia plays a central role by inducing sustained vasoconstriction and structural changes in the pulmonary vasculature, including intimal thickening and smooth muscle proliferation[6]. Additional mechanisms such as endothelial dysfunction, inflammation, and loss of capillary beds due to emphysematous destruction also contribute to disease progression.Clinically, the diagnosis of PH in COPD patients is challenging. The symptoms of PH, such as exertional dyspnea, fatigue, and reduced exercise tolerance, often overlap with those of COPD itself, making early recognition difficult. Physical examination findings may also be subtle or obscured due to hyperinflation of the lungs and altered chest mechanics. As a result, PH is frequently underdiagnosed until it reaches an advanced stage, when patients may present with peripheral edema, raised jugular venous pressure, and features of right heart failure[7].The presence of PH in COPD has important prognostic implications. Even mild elevations in pulmonary arterial pressure have been associated with increased risk of hospitalization, reduced exercise capacity, and

decreased survival[8]. Severe PH, although less common, is associated with significantly worse outcomes and may indicate a distinct vascular phenotype of COPD. Early identification of PH in COPD patients is therefore crucial, as it may influence management strategies, including the use of long-term oxygen therapy, optimization of bronchodilator therapy, and closer clinical monitoring.The reported prevalence of PH in COPD varies widely across studies, largely due to differences in diagnostic criteria, study populations, and methods of assessment. Echocardiographic studies have estimated the prevalence to range between 30% and 60%, with higher rates observed in patients with advanced disease[9,10]. However, there is limited local data available regarding the burden of PH among COPD patients in Pakistan, where late presentation and limited access to specialized diagnostic facilities may further complicate the clinical scenario.

Given this background, the present study aims to determine the frequency of pulmonary hypertension among patients with COPD presenting to a tertiary care hospital. Understanding the local prevalence and clinical profile of PH in COPD patients will provide valuable insights into disease burden and may help in developing strategies for early detection and appropriate management. Furthermore, the findings of this study may contribute to improving patient outcomes by highlighting the need for routine screening and integrated care approaches in this high-risk population.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional study was conducted in the Medical Units of Ayub Teaching Hospital, a tertiary care center serving a large population from Khyber Pakhtunkhwa and adjoining regions. The study was carried out over a period of six months, from 1st September 2024 to 28th February 2025, ensuring a diverse and representative patient population.

Sample Size and Sampling Technique

A total of 134 patients were enrolled using a non-probability consecutive sampling technique. The sample size was calculated using the WHO sample size determination software, based on an anticipated prevalence of pulmonary hypertension among COPD patients of 14.7%, with a 95% confidence level and an absolute precision of 6%.

Inclusion and Exclusion Criteria

Patients of either gender, aged 18 to 80 years, with either previously diagnosed or newly diagnosed chronic obstructive pulmonary disease (COPD) were included. COPD diagnosis was established based on clinical features—chronic cough, sputum production, and dyspnea—along with spirometric confirmation of airflow limitation. Airflow obstruction was defined as a post-bronchodilator FEV_1/FVC ratio of <0.70. Disease severity was further classified according to FEV_1 values based on standard guidelines.

Patients were excluded if they had other established causes of pulmonary hypertension, including left-sided heart disease, interstitial lung disease, chronic thromboembolic pulmonary hypertension, connective tissue disorders, congenital heart diseases, portal hypertension, human immunodeficiency virus infection, or drug/toxin-induced pulmonary hypertension. Critically ill patients or those unable to undergo echocardiographic assessment were also excluded.

Data Collection Procedure

After obtaining written informed consent, demographic data including age, gender, smoking status, and duration of illness were recorded using a structured proforma. A detailed clinical history and physical examination were performed, with emphasis on respiratory and cardiovascular systems.Pulmonary function tests were conducted in all patients using a standardized spirometer by trained personnel, following established protocols to ensure accuracy and reproducibility.Pulmonary hypertension was assessed using transthoracic echocardiography, performed by an experienced cardiologist. Pulmonary artery systolic pressure (PASP) was estimated from the tricuspid regurgitation jet velocity using the modified

Bernoulli equation. Pulmonary hypertension was operationally defined as PASP >25 mmHg at rest. Although right heart catheterization remains the gold standard, echocardiography was utilized due to its non-invasive nature, availability, and feasibility in a resource-limited setting.

Data Analysis

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 21. Quantitative variables such as age, body mass index, and pulmonary arterial pressure were expressed as mean ± standard deviation or median with interquartile range, depending on data distribution. Normality was assessed using the Shapiro–Wilk test.Categorical variables such as gender, smoking status, comorbidities (e.g., diabetes mellitus, cardiovascular disease), and presence of pulmonary hypertension were presented as frequencies and percentages.The primary outcome, frequency of pulmonary hypertension among COPD patients, was calculated as a percentage along with 95% confidence interval.Pulmonary hypertension was stratified according to age, gender, smoking status, and severity of COPD to explore its distribution across subgroups. Post-stratification, the chi-square test or Fisher's exact test was applied as appropriate. A p-value ≤0.05 was considered statistically significant

Ethical Considerations

Ethical approval was obtained from the Institutional Review Committee of Ayub Teaching Hospital (Approval code/Ref.No.RC.EA.2024/111). Written informed consent was obtained from all participants prior to enrollment. Patient confidentiality was strictly maintained, and all procedures adhered to the principles outlined in the Declaration of Helsinki.

Operational Definitions

Chronic Obstructive Pulmonary Disease (COPD)

COPD was defined by the presence of chronic respiratory symptoms (cough, sputum production, dyspnea) along with spirometric evidence of airflow limitation, indicated by a post-bronchodilator FEV_1/FVC ratio <0.70 and FEV_1 <80% of predicted.

Pulmonary Hypertension (PH)

Pulmonary hypertension was defined as an estimated pulmonary artery pressure ≥25 mmHg at rest (or ≥30 mmHg during exercise) as assessed by transthoracic echocardiography.

RESULTS

A total of 134 patients diagnosed with chronic obstructive pulmonary disease (COPD) were enrolled in the study. The mean age of the participants was 58.4 ± 10.6 years, with the majority (53.7%) in the 41–60 years age group. Males comprised 68.7% of the study population, while females accounted for 31.3%. The mean body mass index (BMI) was 24.9 ± 3.8 kg/m², with nearly half of the patients having a normal BMI, and the remainder classified as underweight, overweight, or obese .Regarding clinical characteristics, 44.8% of patients were current smokers, 29.9% were former smokers, and 25.4% had never smoked. Comorbidities were present in a considerable proportion, with 20.9% having diabetes mellitus, 26.9% having cardiovascular disease, and 9.0% having both conditions. Forty-three percent of participants had no major comorbidities . The majority of patients had moderate COPD (46.3%), followed by severe (29.9%), mild (14.9%), and very severe disease (9.0%).Pulmonary hypertension (PH) was observed in 43.3% of the study population. Among those with PH, mild PH was most common (51.7%), followed by moderate (31.0%) and severe PH (17.3%), with a mean pulmonary arterial pressure of 33.2 ± 8.5 mmHg. The most frequently reported symptoms at presentation were dyspnea (89.6%), chronic cough (80.6%), and sputum production (70.9%), while fatigue and exercise intolerance were noted in 58.2% of patients. Peripheral edema and chest discomfort were less common, reported in 16.4% and 11.2% of patients, respectively.Analysis of PH severity by age group revealed that mild PH occurred across all age groups, while moderate and severe PH were predominantly observed in patients aged 41–80 years, suggesting increased susceptibility to higher

pulmonary pressures with advancing age. Distribution of PH by smoking status showed that current smokers had the highest prevalence, followed by former smokers, with the lowest prevalence among never smokers. Severe PH was most commonly seen in current smokers, indicating a possible association between smoking and more severe pulmonary hypertension .Echocardiographic evaluation demonstrated right ventricular hypertrophy in 29.9% of patients, right atrial enlargement in 26.1%, and significant tricuspid regurgitation in 20.9%. More than half of the participants (56.7%) had normal right heart structure and function, consistent with the overall proportion of patients without PH.

Table 1: Demographic Characteristics of Study Participants (n = 134)

Variable	Frequency (n)	Percentage (%)
Gender		
Male	92	68.7
Female	42	31.3
Age (years)		
Mean ± SD	58.4 ± 10.6	-
Age groups		
18–40	15	11.2
41–60	72	53.7
61–80	47	35.1
Body Mass Index (BMI)		
Mean ± SD	24.9 ± 3.8	-
BMI categories		
<18.5 (Underweight)	10	7.5
18.5–24.9 (Normal)	65	48.5
25–29.9 (Overweight)	45	33.6
≥30 (Obese)	14	10.4

Table 1: Majority of participants were middle-aged males with normal BMI.

Table 2: Clinical Characteristics and Comorbidities

Variable	Frequency (n)	Percentage (%)
Smoking Status		
Current smoker	60	44.8
Former smoker	40	29.9
Never smoker	34	25.4
Comorbidities		
Diabetes Mellitus	28	20.9
Cardiovascular diseases	36	26.9
Both DM & HTN	12	9.0
None	58	43.3

Table 3: COPD Severity (Based on FEV_1 % Predicted)

COPD Severity	Frequency (n)	Percentage (%)
Mild (FEV_1 ≥80%)	20	14.9
Moderate (50–79%)	62	46.3
Severe (30–49%)	40	29.9
Very Severe (<30%)	12	9.0

Table 4: Pulmonary Hypertension (PH) Among COPD Patients

Variable	Frequency (n)	Percentage (%)
Pulmonary Hypertension		
Present (PASP ≥25 mmHg)	58	43.3
Absent (PASP <25 mmHg)	76	56.7
Severity of PH		
Mild (25–34 mmHg)	30	51.7*
Moderate (35–44 mmHg)	18	31.0*
Severe (≥45 mmHg)	10	17.3*
Mean PASP (mmHg) ± SD	33.2 ± 8.5	

Table 4: PH was present in nearly half of COPD patients, with mild PH being most frequent.

Table 5: Association of PH with Age, Gender, and Smoking Status

Variable	PH Present (n=58)	PH Absent (n=76)	P-value
Gender			0.42
Male	42	50	
Female	16	26	
Age Group (years)			0.03*
18–40	2	13	
41–60	31	41	
61–80	25	22	
Smoking Status			0.01*
Current	35	25	
Former	14	26	
Never	9	25	

Table 6: Association of PH with Comorbidities

Comorbidity	PH Present (n=58)	PH Absent (n=76)	P-value
Diabetes Mellitus	18	10	0.002*
Cardiovascular Disease (CVD)	20	16	0.01*
Both DM & HTN	8	4	0.04*
None	12	46	0.001*

*Significant at p ≤0.05

Table 7: Symptoms at Presentation in COPD Patients

Symptom	Frequency (n)	Percentage (%)
Shortness of breath (Dyspnea)	120	89.6
Chronic cough	108	80.6
Sputum production	95	70.9
Fatigue / exercise intolerance	78	58.2
Peripheral edema	22	16.4
Chest discomfort / palpitations	15	11.2

Observation: Most patients present with classical COPD symptoms; peripheral edema may suggest PH development.

Table 8: Distribution of Pulmonary Hypertension Severity by Age Group

Age Group (years)	Mild PH (25–34 mmHg)	Moderate PH (35–44 mmHg)	Severe PH (≥45 mmHg)	Total PH (n)
18–40	1	1	0	2
41–60	15	10	6	31
61–80	14	7	4	25

Observation: Severe PH is more common in older age groups.

Table 9: Distribution of Pulmonary Hypertension by Smoking Status

Smoking Status	Mild PH	Moderate PH	Severe PH	Total PH (n)
Current Smoker	18	10	7	35
Former Smoker	8	6	0	14
Never Smoker	4	2	3	9

Observation: Current smokers have the highest prevalence of PH.

Table 10: Right Heart Findings on Echocardiography (n=134)

Echocardiographic Finding	Frequency (n)	Percentage (%)
Right ventricular hypertrophy (RVH)	40	29.9
Right atrial enlargement	35	26.1
Tricuspid regurgitation (≥grade 2)	28	20.9
Normal RV size / function	76	56.7

Observation: RV changes correlate with the presence and severity of PH.

Figure 1A: Gender Distribution

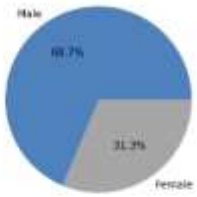


Figure 1B: Age Distribution

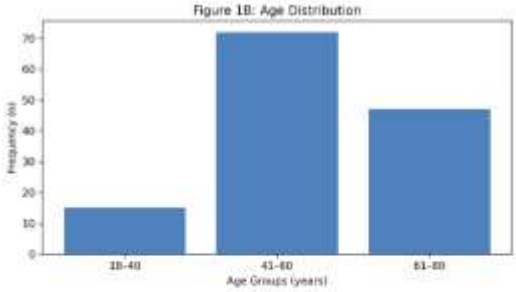


Figure 1C: Smoking Status

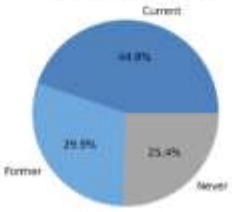


Figure 1D: COPD Severity

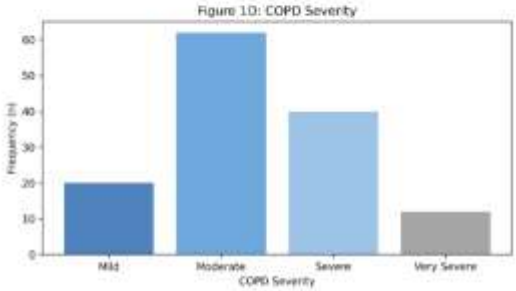


Figure 1E: Pulmonary Hypertension Presence

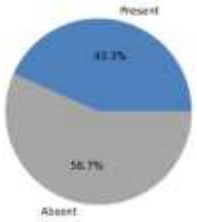


Figure 1F: PH Severity

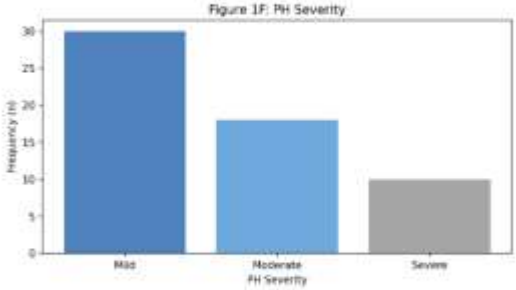


Figure 1G: Symptoms at Presentation

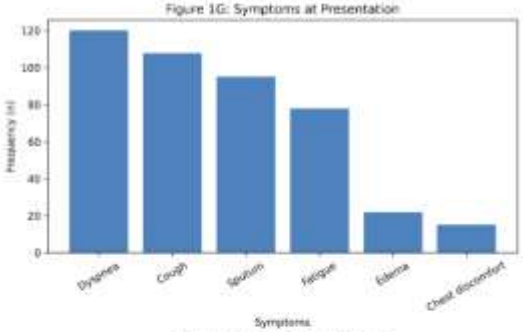


Figure 1H: PH Severity by Age

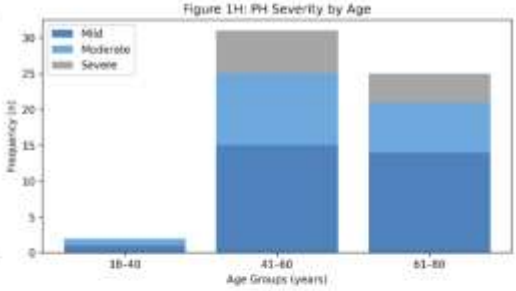


Figure 1I: PH by Smoking Status

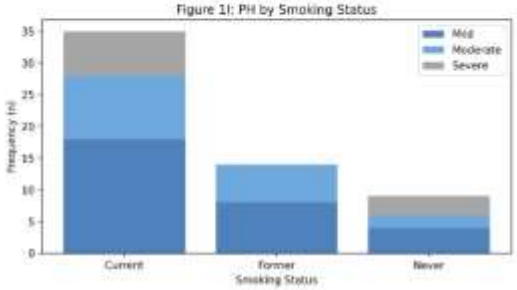
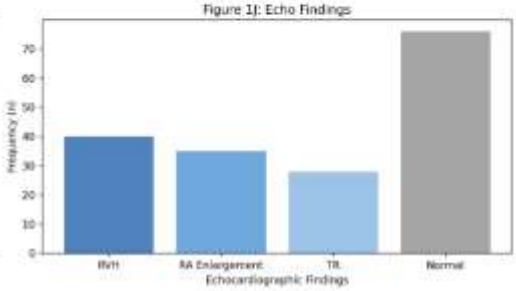


Figure 1J: Echo Findings



DISCUSSION

In this cross-sectional study conducted at a tertiary care hospital, pulmonary hypertension (PH) was found in 43.3% of patients with chronic obstructive pulmonary disease (COPD). This finding is comparable with previously published data. For instance, the systematic review and meta-analysis by Zhang L et al. reported a pooled prevalence of approximately 39% for PH among COPD patients, particularly when assessed using echocardiography[11]. This similarity supports the reliability of our findings and highlights that PH is a common and clinically significant complication in COPD patients presenting to tertiary care centers.The mean age of patients in our study was 58.4 ± 10.6 years, and a higher frequency of moderate to severe PH was observed in older individuals. A similar trend has been described by Tripathi S, who reported increasing pulmonary arterial pressures with advancing age in COPD patients[12]. This may be explained by prolonged exposure to risk factors such as smoking, along with age-related vascular changes that contribute to pulmonary vascular remodeling.In our study population, males constituted the majority, and a significant proportion were current or former smokers. The higher prevalence of PH among current smokers observed in this study is consistent with the findings of Kakar IA et al., who demonstrated a strong association between smoking and pulmonary hypertension in COPD patients[13]. Smoking contributes to endothelial dysfunction, chronic inflammation, and hypoxia, all of which play a role in the pathogenesis of PH.The distribution of COPD severity in our study showed that most patients had moderate to severe disease, and the prevalence of PH increased with disease severity. This observation is in line with the study by Thabut G et al., which demonstrated that pulmonary arterial pressure rises with worsening airflow limitation and is more pronounced in advanced COPD[14]. Chronic hypoxemia remains the central mechanism driving pulmonary vasoconstriction and vascular remodeling in such patients.From a clinical perspective, dyspnea, cough, and sputum production were the most frequently reported symptoms in our patients. These symptoms overlap significantly with those of PH, making early diagnosis challenging. Chaouat A et al. also highlighted that symptoms of PH in COPD are often masked by underlying lung disease, leading to delayed recognition[15]. Peripheral edema, which was less commonly observed in our cohort, typically appears in more advanced stages when right heart failure develops.Echocardiographic findings in our study demonstrated right ventricular hypertrophy and right atrial enlargement in a significant proportion of patients. Similar findings were reported by Gupta NK et al. in their echocardiographic evaluation of COPD patients, where structural cardiac changes were closely associated with elevated pulmonary artery pressures[16]. These findings emphasize the importance of echocardiography as a non-invasive and practical tool for assessing PH in resource-limited settings.When compared with regional data, our results are also consistent. Studies conducted in South Asia, including the work by Samareh Fekri M et al., have reported PH prevalence ranging from 30% to 50% in COPD patients, depending on disease severity and diagnostic criteria[17]. Minor variations may be attributed to differences in patient selection, diagnostic thresholds, and study settings.An important observation in our study was that PH was not limited to smokers alone, as a proportion of non-smokers also exhibited elevated pulmonary arterial pressures. This suggests that additional factors such as biomass fuel exposure, environmental pollution, and recurrent respiratory infections may contribute to pulmonary vascular disease in our population. Such factors are particularly relevant in developing countries, including Pakistan, where indoor air pollution remains a significant health concern.

The findings of this study have important clinical implications. Given the high frequency of PH observed, routine screening using echocardiography in COPD patients, particularly those with moderate to severe disease, may facilitate early detection and timely management[18]. Early identification of PH allows for optimization of treatment strategies, including long-term oxygen therapy and closer follow-up, which may improve patient outcomes.

LIMITATIONS

This study has certain limitations that should be considered. The cross-sectional design limits the ability to establish causal relationships. Echocardiography, although widely used, is not as definitive as right heart catheterization for diagnosing PH. Additionally, detailed assessment of environmental exposures such as biomass fuel use was not performed, which may have provided further insight into disease patterns in this population.

CONCLUSION

The present study demonstrates that pulmonary hypertension is a relatively common finding among patients with chronic obstructive pulmonary disease presenting to Ayub Teaching Hospital Abbottabad, with a frequency of 43.3%. The occurrence of pulmonary hypertension was more frequently observed in older patients, smokers, and those with longer duration of disease, highlighting the progressive nature of COPD and its systemic impact.The overlap of symptoms between COPD and pulmonary hypertension makes early clinical identification difficult, which may lead to underdiagnosis in routine practice. Our findings emphasize the importance of maintaining a high index of suspicion, particularly in patients with worsening dyspnea or signs suggestive of right heart involvement.In our local setting, where patients often present at advanced stages and access to specialized care may be limited, timely screening using echocardiography can play a useful role in early detection. Recognizing pulmonary hypertension in COPD patients is important, as it may influence prognosis and guide more comprehensive management strategies.

Further multicenter studies with larger sample sizes are recommended to better understand the burden and clinical implications of pulmonary hypertension in COPD patients in Pakistan.

Additional information

Conflicts of Interest: None

Payment/Services Information: All authors state that no financial assistance or support was received from any organization in relation to this submitted work.

Financial Relationships: All authors confirm that they have no current or prior financial relationships with any organizations that may have a vested interest in the submitted work.

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Critical Review &Final Approval; Rizwan Haider[1] , Muhammad Usman Sharif [2]

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