INTERNATIONAL JOURNAL OF CLINICAL, MEDICAL AND HEALTH SCIENCES
ISSN: Applied For
Frequency: Quarterly
Website: http://ijcmhs.com/

Original Research Article

CLINICAL AND RADIOLOGICAL PROFILE OF PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND ITS ASSOCIATION WITH PULMONARY FUNCTION PARAMETERS: A HOSPITAL-BASED OBSERVATIONAL STUDY

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Received: 11-01-2025
Accepted: 29-01-2025
Published: 16-02-2025

ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is a heterogeneous chronic respiratory disorder characterized by persistent respiratory symptoms and airflow limitation. Clinical manifestations and structural abnormalities on chest imaging vary substantially among affected individuals, and their relationship with spirometric impairment may provide useful information for disease characterization. The present study evaluated the clinical and radiological profile of patients with COPD and examined associations between imaging findings and pulmonary function parameters in a tertiary-care hospital.

Methods: This hospital-based cross-sectional observational study included 150 patients with COPD evaluated in the Department of Pulmonology during January 2024–December 2024. Demographic characteristics, smoking and environmental exposure history, symptoms, exacerbation history, comorbidities, radiological findings, and spirometric parameters were recorded. Pulmonary function was assessed using FEV1, FVC, FEV1/FVC ratio, and percentage-predicted values. Patients were categorized according to spirometric GOLD grades. Continuous variables are presented as mean ± standard deviation and categorical variables as frequencies and percentages. Associations were assessed using independent-samples t-test, chi-square test, and Pearson correlation, as appropriate.

Results: The mean age was 60.56 ± 8.89 years, and 124 (82.7%) participants were men. Current smokers constituted 79 (52.7%) patients and former smokers 57 (38.0%), with mean smoking exposure of 36.72 ± 20.45 pack-years. Dyspnea was present in 129 (86.0%), chronic cough in 117 (78.0%), and sputum production in 93 (62.0%). Hyperinflation was the most frequent radiological abnormality, observed in 90 (60.0%) patients, followed by emphysematous changes in 70 (46.7%), flattened diaphragm in 68 (45.3%), and airway-wall thickening in 60 (40.0%). Mean FEV1 was 1.69 ± 0.62 L and mean FEV1/FVC ratio was 0.572 ± 0.059. Radiological abnormalities were associated with significantly lower FEV1 percentage predicted values: hyperinflation (56.15% vs 70.84%, $p<0.001$), emphysematous changes (54.71% vs 68.43%, $p<0.001$), flattened diaphragm (55.73% vs 67.25%, $p<0.001$), and airway-wall thickening (55.30% vs 66.51%, $p=0.001$).

Conclusion: In this cohort, COPD was predominantly observed in older men with substantial tobacco exposure and was commonly associated with dyspnea and chronic cough. Hyperinflation and emphysematous changes were frequent imaging findings and showed significant associations with impaired spirometric function. Integrating clinical assessment, chest imaging, and pulmonary function testing may improve phenotypic characterization and severity assessment of COPD.

Keywords*: chronic obstructive pulmonary disease; COPD; spirometry; FEV1; FEV1/FVC; emphysema; hyperinflation; radiology; pulmonary function; smoking.*

INTRODUCTION

Chronic obstructive pulmonary disease is a common, preventable and treatable chronic respiratory disease associated with persistent respiratory symptoms and airflow limitation resulting from abnormalities of the airways and/or alveoli. The disease develops through complex interactions between genetic susceptibility and long-term exposure to noxious particles and gases. Tobacco smoke remains the dominant risk factor in many populations, although biomass fuel smoke, occupational dusts and fumes, air pollution, and recurrent respiratory insults may also contribute substantially to disease development and progression.

The clinical presentation of COPD is heterogeneous. Some patients have predominantly chronic bronchitic symptoms with cough and sputum production, whereas others exhibit more prominent exertional dyspnea and emphysematous manifestations. Wheezing, reduced exercise tolerance, recurrent exacerbations, and previous respiratory hospitalizations may further influence disease burden. Comorbid conditions, including cardiovascular and metabolic disorders, are also frequent and can modify symptoms, functional limitation, and prognosis.

Spirometry remains central to the objective assessment of persistent airflow limitation. A reduced post-bronchodilator FEV1/FVC ratio supports the diagnosis of airflow obstruction, while FEV1 and percentage predicted FEV1 provide an estimate of the degree of physiological impairment. Nevertheless, spirometry alone does not fully capture the structural heterogeneity of COPD. Patients with similar spirometric impairment may have different distributions of emphysema, airway-predominant disease, and lung hyperinflation.

Chest radiography and, where clinically indicated, computed tomography can demonstrate structural consequences of COPD. Hyperinflation, increased lung lucency, diaphragmatic flattening, vascular attenuation, emphysematous destruction, bullous change, and airway-wall abnormalities may provide complementary information. Imaging findings may also help explain differences in symptoms and pulmonary function. In particular, emphysema and hyperinflation can reduce effective gas exchange and mechanical efficiency, contributing to dyspnea and exercise limitation.

Understanding the relationship between radiological manifestations and pulmonary function is therefore relevant in routine clinical practice. In hospital-based populations, the pattern of symptoms, exposures, imaging abnormalities, and spirometric severity may also differ according to local demographic and environmental characteristics. The present study was undertaken to describe the clinical and radiological profile of patients with COPD attending a tertiary-care pulmonology department and to evaluate the association of major radiological findings with pulmonary function parameters.

AIM AND OBJECTIVES

Aim: To evaluate the clinical and radiological profile of patients with COPD and determine its association with pulmonary function parameters.

Objectives: (1) To describe the demographic, smoking, environmental exposure, symptom, exacerbation, and comorbidity profile of patients with COPD. (2) To characterize the major radiological abnormalities observed in the study population. (3) To assess pulmonary function using FEV1, FVC, FEV1/FVC ratio, and percentage-predicted values. (4) To determine the relationship between radiological findings and spirometric impairment, including GOLD spirometric grade.

MATERIALS AND METHODS

Study design and setting

A hospital-based cross-sectional observational study was conducted in the Department of Pulmonology of a tertiary-care centre over a period of 12 months, from January 2024 to December 2024. The study included 150 patients with established COPD who underwent clinical evaluation, pulmonary function testing, and radiological assessment as part of their routine evaluation.

Study population and sample size

The study population comprised adult patients diagnosed with COPD and evaluated during the study period. A total of 150 patients were included for analysis. The study sample was selected from patients attending the pulmonology service during the defined study period and meeting the study eligibility criteria.

Eligibility criteria

Patients aged 18 years or older with a clinical diagnosis of COPD and available spirometric assessment were eligible. Patients were excluded when spirometry was technically unacceptable or unavailable, when a major alternative pulmonary diagnosis was considered responsible for the airflow limitation, or when essential clinical or radiological information required for analysis was missing.

Clinical assessment

A structured clinical assessment was used to document age, sex, smoking status, cumulative tobacco exposure in pack-years, biomass-fuel exposure, occupational exposure, respiratory symptoms, previous exacerbations, previous hospitalization, and comorbidities. Respiratory symptoms assessed in the dataset included dyspnea, chronic cough, sputum production, and wheezing.

Pulmonary function testing
Spirometric variables included FEV1 in litres, FVC in litres, FEV1/FVC ratio, FEV1 percentage predicted, and FVC percentage predicted. The spirometric severity categories in the dataset were recorded as mild, moderate, severe, and very severe according to the applicable GOLD spirometric classification framework. The recorded values were used for descriptive and comparative analysis.

Radiological assessment
Radiological evaluation focused on structural abnormalities commonly encountered in COPD. The dataset recorded the presence or absence of hyperinflation, emphysematous changes, flattened diaphragm, airway-wall thickening, and bullous changes. These findings were analyzed individually and in relation to pulmonary function parameters and spirometric severity.

Statistical analysis
Data were analyzed using descriptive and inferential statistical methods. Continuous variables were summarized as mean ± standard deviation, while categorical variables were summarized as frequency and percentage. The independent-samples t-test was used to compare mean FEV1 percentage predicted between patients with and without individual radiological abnormalities. Associations between categorical radiological findings and GOLD spirometric grade were examined using the chi-square test. Pearson correlation was used to assess linear relationships between age or cumulative smoking exposure and FEV1 percentage predicted. A two-sided p value <0.05 was considered statistically significant.

RESULTS

Demographic and exposure profile
The study included 150 patients with COPD. The mean age was 60.56 ± 8.89 years (range 43–79 years). Men accounted for 124 (82.7%) participants and women for 26 (17.3%). Regarding smoking status, 79 (52.7%) were current smokers, 57 (38.0%) were former smokers, and 14 (9.3%) had never smoked. The mean cumulative smoking exposure was 36.72 ± 20.45 pack-years. Biomass-fuel exposure was reported in 37 (24.7%) patients, while occupational exposure was reported in 48 (32.0%).

Clinical profile
Dyspnea was the most frequent respiratory symptom, occurring in 129 (86.0%) patients. Chronic cough was reported by 117 (78.0%), sputum production by 93 (62.0%), and wheezing by 69 (46.0%). A previous exacerbation history was present in 59 (39.3%) patients, while 33 (22.0%) had a history of previous hospitalization. Comorbidity information showed hypertension in 31 patients, diabetes mellitus in 26, combined hypertension and diabetes in 25, and other comorbidities in 22 patients.

Pulmonary function profile
The mean FEV1 was 1.69 ± 0.62 L, while mean FVC was 2.98 ± 1.11 L. The mean FEV1/FVC ratio was 0.572 ± 0.059. Mean FEV1 percentage predicted was 62.03 ± 20.74% and mean FVC percentage predicted was 81.01 ± 25.89%. Based on recorded GOLD spirometric grades, 32 (21.3%) patients had mild disease, 72 (48.0%) moderate disease, 36 (24.0%) severe disease, and 10 (6.7%) very severe disease. Thus, moderate airflow limitation represented the largest severity category.

Radiological profile
Hyperinflation was the most frequent radiological finding, identified in 90 (60.0%) patients. Emphysematous changes were present in 70 (46.7%), flattened diaphragm in 68 (45.3%), and airway-wall thickening in 60 (40.0%). Bullous changes were less common and were observed in 23 (15.3%) patients.

Association between radiological findings and pulmonary function
Patients with radiological evidence of hyperinflation had a significantly lower mean FEV1 percentage predicted than those without hyperinflation. Emphysematous changes were also strongly associated with lower FEV1 percentage predicted. Similar significant differences were observed for flattened diaphragm and airway-wall thickening. Bullous changes showed a smaller but statistically significant difference in mean FEV1 percentage predicted.

Radiological findings were also associated with spirometric severity. Hyperinflation showed a significant association with GOLD grade (p=0.001), as did emphysematous changes (p=<0.001), flattened diaphragm (p=0.012), and airway-wall thickening (p=0.001). The association between bullous changes and GOLD grade was not statistically significant (p=0.092).

Pearson analysis demonstrated no significant linear correlation between pack-years and FEV1 percentage predicted (r=-0.035, p=0.671). Age showed a weak positive correlation with FEV1 percentage predicted (r=0.223, p=0.006); this finding should be interpreted cautiously because the relationship was modest and the study was cross-sectional.

Table 1. Demographic and exposure characteristics of the study population (n=150)

Variable	Value
Age (years)	60.56 ± 8.89
Male sex	124 (82.7%)
Female sex	26 (17.3%)

Current smoker	79 (52.7%)
Former smoker	57 (38.0%)
Never smoker	14 (9.3%)
Pack-years	36.72 ± 20.45
Biomass-fuel exposure	37 (24.7%)
Occupational exposure	48 (32.0%)

Table 2. Clinical characteristics of the study population

Clinical variable	n (%)
Dyspnea	129 (86.0%)
Chronic cough	117 (78.0%)
Sputum production	93 (62.0%)
Wheezing	69 (46.0%)
Previous exacerbation	59 (39.3%)
Previous hospitalization	33 (22.0%)
Hypertension	31 (20.7%)
Diabetes mellitus	26 (17.3%)
Hypertension + diabetes	25 (16.7%)
Other comorbidity	22 (14.7%)

Table 3. Pulmonary function parameters and spirometric severity

Parameter	Value
FEV1 (L)	1.69 ± 0.62
FVC (L)	2.98 ± 1.11
FEV1/FVC ratio	0.572 ± 0.059
FEV1 % predicted	62.03 ± 20.74
FVC % predicted	81.01 ± 25.89
Mild GOLD grade	32 (21.3%)
Moderate GOLD grade	72 (48.0%)
Severe GOLD grade	36 (24.0%)
Very severe GOLD grade	10 (6.7%)

Table 4. Radiological profile of COPD patients

Radiological finding	n (%)
Hyperinflation	90 (60.0%)
Emphysematous changes	70 (46.7%)
Flattened diaphragm	68 (45.3%)
Airway-wall thickening	60 (40.0%)
Bullous changes	23 (15.3%)

Table 5. Association of radiological findings with FEV1 percentage predicted

Radiological finding	FEV1 % predicted: Yes	FEV1 % predicted: No	p value
Hyperinflation	56.15 ± 20.43	70.84 ± 18.03	<0.001
Emphysematous changes	54.71 ± 17.06	68.43 ± 21.63	<0.001
Flattened diaphragm	55.73 ± 19.46	67.25 ± 20.43	<0.001
Airway-wall thickening	55.29 ± 20.65	66.51 ± 19.66	0.001
Bullous changes	53.83 ± 18.98	63.51 ± 20.77	0.034

Table 6. Distribution of radiological findings across GOLD spirometric grades

Finding	Mild +	Moderate +	Severe +	Very severe +	Mild −	Moderate −	Severe −	Very severe −	p value
Hyperinflation	13	39	29	9	19	33	7	1	0.001
Emphysematous changes	2	38	24	6	30	34	12	4	<0.001
Flattened diaphragm	9	30	24	5	23	42	12	5	0.012

Airway-wall thickening	5	29	18	8	27	43	18	2	0.001
Bullous changes	1	11	9	2	31	61	27	8	0.092

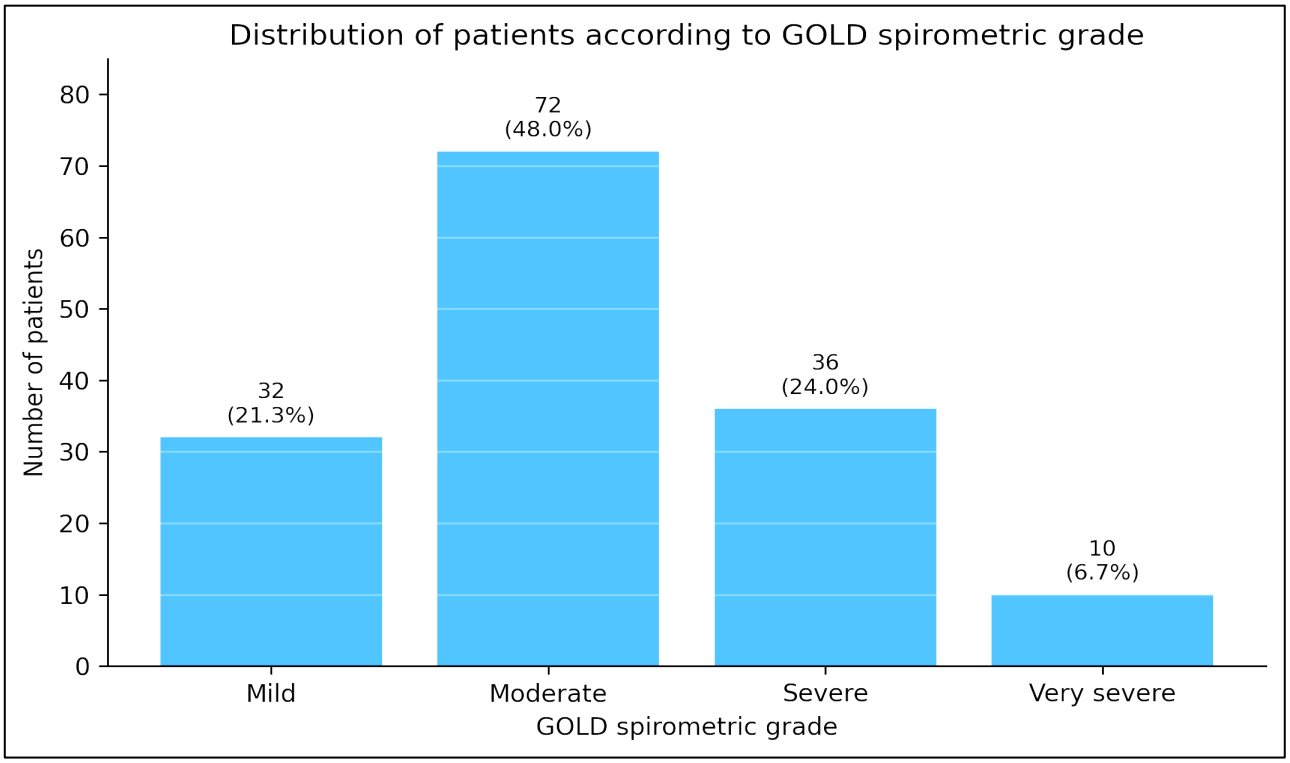

Figure 1. Distribution of patients according to GOLD spirometric grade. Moderate COPD was the most frequent category (72/150, 48.0%), followed by severe (36/150, 24.0%), mild (32/150, 21.3%), and very severe disease (10/150, 6.7%).

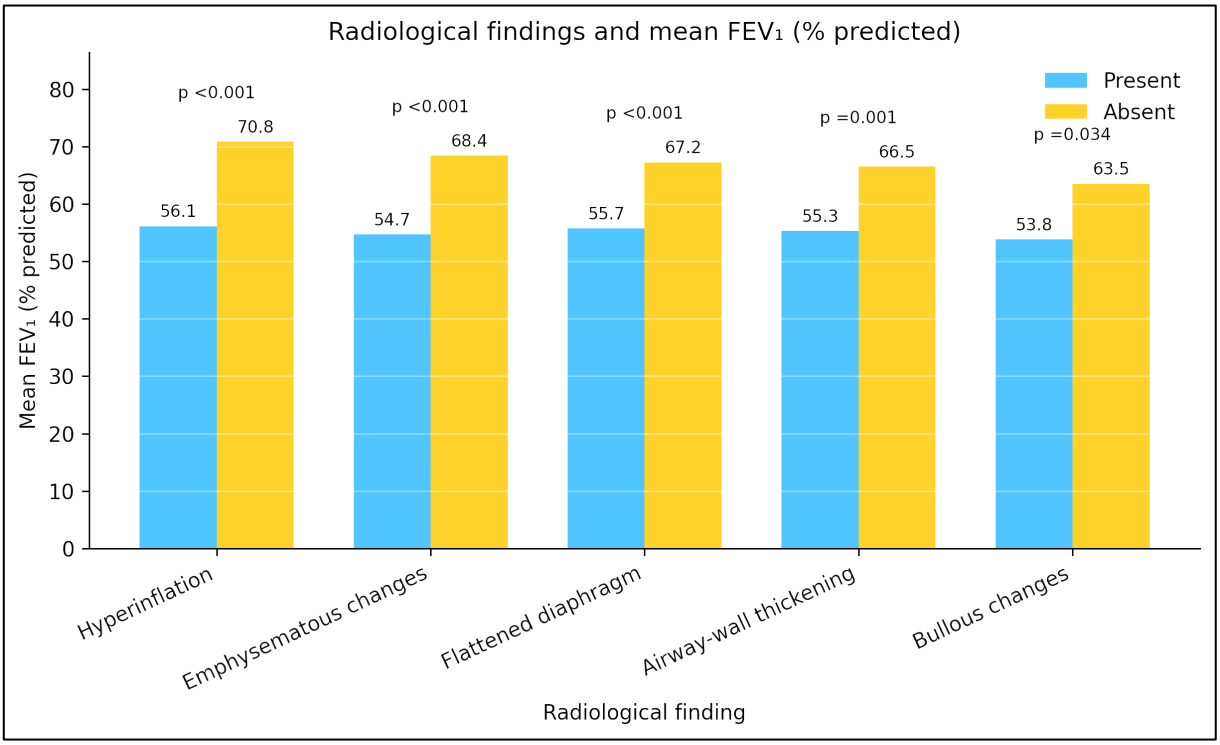

Figure 2. Association of radiological findings with FEV_1 (% predicted). Bars represent mean FEV_1 (% predicted) in patients with the radiological finding present versus absent; p values are from independent-samples t-tests.

DISCUSSION

The present hospital-based study provides an integrated description of clinical symptoms, exposure history, pulmonary function, and radiological abnormalities among 150 patients with COPD. The cohort was characterized by a predominance of older men, a high frequency of current or previous smoking, substantial cumulative tobacco exposure, and frequent respiratory symptoms. Hyperinflation and emphysematous changes were common radiological manifestations and were associated with lower FEV1 percentage predicted, supporting the value of imaging as a complementary component of COPD phenotyping.

The mean age of the participants was 60.56 years, and more than four-fifths were men. The male predominance is consistent with the large contribution of tobacco exposure to COPD in many hospital-based cohorts, particularly where smoking prevalence among men remains considerably higher than among women. In the present dataset, 90.7% of participants were current or former smokers. Nevertheless, 14 patients had never smoked, emphasizing that COPD cannot be attributed exclusively to active tobacco exposure. Biomass-fuel exposure and occupational exposure were also documented, indicating the importance of considering non-tobacco inhalational risks during clinical assessment.

Dyspnea was the dominant symptom, followed by chronic cough and sputum production. This symptom pattern is clinically plausible because progressive expiratory airflow limitation and dynamic hyperinflation can increase the work of breathing and reduce ventilatory reserve. Chronic cough and sputum reflect airway inflammation and mucus hypersecretion, which are particularly relevant to airway-predominant COPD phenotypes. The presence of wheezing in nearly half of the cohort further demonstrates the clinical heterogeneity of airflow obstruction.

Approximately two-fifths of patients had a previous exacerbation history, and about one-fifth had been hospitalized previously. Exacerbations are important events in the natural history of COPD because they may accelerate functional decline, impair quality of life, and increase future healthcare utilization. The relatively frequent history of exacerbation in this tertiary-care population may reflect referral patterns, as patients with more symptomatic or complicated disease are more likely to reach specialist services.

Spirometry demonstrated a mean FEV1/FVC ratio of 0.572, with a mean FEV1 of 1.69 L. Moderate spirometric severity represented nearly half of the study population, while severe and very severe categories together accounted for 30.7%. This distribution indicates that a substantial proportion of patients presenting to tertiary pulmonology services have clinically meaningful physiological impairment. Importantly, spirometric severity should not be interpreted as a complete surrogate for symptom burden or structural disease, since COPD comprises multiple interacting physiological and anatomical abnormalities.

Hyperinflation was the most frequent radiological finding in this cohort. It was present in 60% of patients and was associated with a marked reduction in FEV1 percentage predicted compared with patients without hyperinflation. Hyperinflation reflects increased end-expiratory lung volume resulting from expiratory flow limitation, incomplete lung emptying, and altered respiratory mechanics. As disease severity increases, static and dynamic hyperinflation can contribute to exertional dyspnea and reduced exercise capacity. The significant association observed in this study is therefore physiologically coherent.

Emphysematous changes were identified in 46.7% of patients and were associated with substantially lower FEV1 percentage predicted. Emphysema involves destruction of alveolar walls and loss of elastic recoil, which can reduce expiratory driving pressure and promote small-airway collapse. Structural emphysema may therefore be accompanied by more pronounced airflow limitation. The strong association between emphysema and GOLD grade in the present analysis further supports the concept that imaging-visible structural destruction is related to, although not identical with, spirometric impairment.

Flattening of the diaphragm was another frequent finding and was associated with reduced FEV1 percentage predicted. Diaphragmatic flattening is a radiological marker of lung hyperinflation and altered thoracic configuration. A flattened diaphragm operates at a mechanical disadvantage, which can increase the effort required for ventilation. Its association with worse spirometric function in this cohort reinforces the usefulness of simple radiological signs as indicators of advanced mechanical consequences of obstructive lung disease.

Airway-wall thickening was present in 40% of patients and was also associated with lower FEV1 percentage predicted and with GOLD grade. Airway-wall thickening can reflect chronic airway inflammation and remodeling. Unlike emphysema, which represents predominantly parenchymal destruction, airway-predominant abnormalities may contribute to obstruction through increased airway resistance and reduced luminal caliber. Recognition of both airway and parenchymal components is important because COPD phenotypes may differ considerably among individuals.

Bullous changes were less common, occurring in 15.3% of patients. Although patients with bullous changes had lower mean FEV1 percentage predicted than those without such changes, the difference was smaller and the association with GOLD grade was not statistically significant. The limited number of patients with bullous disease reduces statistical power and illustrates why less common structural abnormalities may not demonstrate clear categorical relationships in a moderate-sized cohort.

The lack of a significant correlation between cumulative pack-years and FEV1 percentage predicted in this cohort deserves cautious interpretation. Smoking exposure is an important risk factor for COPD, but individual susceptibility to tobacco smoke varies widely. Duration and intensity of exposure may not capture genetic susceptibility, occupational exposures, biomass exposure, childhood respiratory insults, or cumulative environmental pollution. Furthermore, pack-years may be affected by recall error. Therefore, absence of a simple linear relationship in a cross-sectional hospital sample does not negate the established causal role of smoking in COPD.

The observed relationship between age and FEV1 percentage predicted was weak. Age-related changes in lung function and survivor effects may influence this relationship, and cross-sectional associations cannot establish temporal causality. The primary strength of the present analysis lies instead in the concordance between several structural radiological abnormalities and impaired pulmonary function.

From a clinical perspective, the findings support a multimodal approach to COPD assessment. Spirometry provides objective evidence of airflow limitation and allows standardized grading, while imaging can demonstrate the anatomical substrate and identify hyperinflation, emphysema, airway changes, and bullous disease. Clinical history provides additional information on symptom burden, exposures, exacerbations, and comorbidity. Combining these domains can improve characterization of patients whose disease cannot be adequately described by a single physiological measurement.

The findings should also be interpreted in light of the study setting. A tertiary-care hospital population may have greater symptom burden and more advanced disease than a community-based screening population. Consequently, the prevalence of radiological abnormalities and the distribution of GOLD grades observed here should not automatically be generalized to the wider community. Nevertheless, the study reflects the practical profile of patients encountered in specialist pulmonology care and demonstrates clinically meaningful associations that may be relevant to similar hospital settings.

STRENGTHS OF THE STUDY

The study has several strengths. It evaluates COPD using complementary clinical, exposure, radiological, and spirometric variables. The sample size of 150 patients provides a reasonable basis for descriptive characterization and subgroup comparisons. The analysis evaluates multiple distinct imaging findings rather than treating COPD as a single radiological phenotype. In addition, the use of FEV1 percentage predicted and GOLD spirometric grade allows structural findings to be related to clinically interpretable measures of physiological impairment.

LIMITATIONS

The cross-sectional design prevents determination of temporal or causal relationships between radiological abnormalities and pulmonary function. The study was conducted at a single tertiary-care centre, which may limit generalizability because of referral and selection effects. Radiological findings were analyzed as binary variables rather than using quantitative CT measures such as emphysema percentage, airway-wall dimensions, or lung-volume indices. Symptom severity scores such as CAT or mMRC and detailed exacerbation frequency were not available in the dataset. Potential confounders such as medication use, nutritional status, eosinophil count, and cardiovascular functional limitation were not incorporated. Future prospective multicentre studies using standardized quantitative imaging and longitudinal spirometry would help clarify the clinical significance of the observed associations.

CONCLUSION

This hospital-based observational study demonstrates that COPD patients commonly present with dyspnea and chronic cough and have substantial exposure to tobacco smoke and other inhalational risks. Hyperinflation was the most frequent radiological abnormality, followed by emphysematous changes, flattened diaphragm, and airway-wall thickening. Several of these structural abnormalities were significantly associated with lower FEV1 percentage predicted and greater spirometric severity. These findings emphasize that COPD assessment is best approached through integration of clinical history, spirometry, and radiological evaluation. Recognition of structural phenotypes may provide useful additional information for disease characterization and clinical management, particularly in patients evaluated at tertiary-care respiratory services.

Availability of data

The underlying study dataset is available from the corresponding author subject to institutional and ethical restrictions.

Conflict of interest

The authors declare no conflict of interest.

Funding

No external funding was received for this study.

Authors' contributions

All authors should contribute appropriately to study conception, data acquisition or analysis, manuscript drafting or critical revision, and approval of the final version.

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