**Indian Journal of Health Care, Medical & Pharmacy Practice** (Vol 7, Issue 2, July-December 2026)
**Home page of the journal:** https://ijhmp.com/Home

Research Article

# ASSESSMENT OF SPIROMETRY IN EARLY DETECTION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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**DOI:** https://doi.org/10.59551/IJHMP/25832069/2026.7.2.154

**How to cite this article:** Darji N, Dhar R. Assessment of Spirometry in Early Detection of Chronic Obstructive Pulmonary Disease. *Indian J. Health Care, Med. Pharm. Pract.* 2026;7(2):358-363.



Received: 15 June, 2026, Decision for Acceptance: 21 Aug, 2026

## ABSTRACT

**Background:** Chronic obstructive pulmonary disease (COPD) is frequently diagnosed after clinically important airflow limitation has developed. Spirometry provides objective assessment of airflow and is essential for confirming COPD in the appropriate clinical context.

**Methods:** This observational cross-sectional study was conducted in the Medicine and TB & Chest Departments of National Institute of Medical Sciences & Research, Jaipur, from July 2024 to December 2025. One hundred adults aged ≥40 years with COPD and relevant exposure histories were enrolled. Demographic characteristics, smoking history, occupational exposure, respiratory symptoms, pulse oximetry, chest radiography and spirometric parameters were recorded. Spirometry was performed using a calibrated computerized spirometer according to ATS/ERS standards, and airflow limitation was classified using GOLD criteria.

**Results:** The mean age was 46.0±5.9 years and 60% of participants were male. Mean smoking exposure was 24.84±8.00 pack-years. Farmers, factory workers, mechanics, tailors, carpenters and welders were prominent occupational groups. Breathlessness with cough was the most common symptom combination (18%), followed by cough with sputum production (17%). Mean room-air oxygen saturation was 94.81±1.77%. Mean FEV1 was 1.90±0.32 L, FVC 3.66±0.41 L and FEV1/FVC ratio 51.58±3.41%. All participants demonstrated an obstructive spirometric pattern. GOLD stage 2 disease was most common (47%), followed by GOLD stage 1 (28%) and GOLD stage 3 (25%).

**Conclusion:** In this hospital-based cohort of adults with established COPD, spirometry demonstrated substantial airflow limitation, with moderate disease predominating. The findings support the value of quality-controlled spirometry for objective characterization and staging of airflow obstruction in individuals with respiratory symptoms and established risk factors. Broader population screening should be distinguished from targeted case-finding because the present study did not include a non-COPD comparison group.

**KEYWORDS:** Chronic Obstructive Pulmonary Disease, COPD, Spirometry, FEV1, FVC, Airflow Obstruction, Smoking, Occupational Exposure, GOLD.

# Introduction

COPD is a common, preventable and treatable chronic respiratory disease characterized by persistent respiratory symptoms and airflow limitation resulting from airway and/or alveolar abnormalities, usually after exposure to harmful particles or gases. It is a major cause of morbidity, mortality and healthcare utilization worldwide[1,2].

Tobacco exposure remains a major risk factor, but COPD also occurs in never-smokers and is associated with occupational dusts and fumes, household and outdoor air pollution, and other early-life or host-related factors. Population-based studies have demonstrated substantial variation in COPD prevalence across regions and have highlighted the contribution of both smoking and non-smoking exposures[3,4].

Symptoms such as chronic cough, sputum production and exertional dyspnoea may develop gradually and can be attributed to smoking, aging or occupational exposure. Consequently, clinically important airflow limitation may remain unrecognized. Spirometry provides an objective assessment of lung function and is central to confirming COPD when interpreted in the appropriate clinical context. Current GOLD guidance requires post-bronchodilator spirometric evidence of persistent airflow obstruction for confirmation of COPD[1,5].

High-quality spirometry depends on standardized equipment, patient preparation, operator training and acceptable and repeatable manoeuvres. The 2019 ATS/ERS technical statement provides internationally accepted standards for acquisition and quality assurance, while updated ERS/ATS interpretive standards emphasize appropriate reference equations and limits of normal[6,7].

At the same time, the concept of 'early COPD' or mild airflow limitation has received increasing attention. Patients may have clinically relevant physiological impairment before advanced symptoms develop, but spirometry alone should not be equated with universal population screening. The US Preventive Services Task Force recommends against screening asymptomatic adults for COPD because evidence has not demonstrated a net benefit; targeted case-finding in people with symptoms or substantial risk factors is a different clinical strategy[8,9].

The present study therefore evaluated the demographic, exposure, clinical, radiological and spirometric characteristics of adults with COPD attending a tertiary-care hospital, with particular emphasis on the pattern and severity of airflow limitation identified by spirometry.

# Materials and Methods

## Study Design and Setting

An observational cross-sectional study was conducted in the Medicine and TB & Chest Departments of National Institute of Medical Sciences & Research and Hospital, Jaipur, Rajasthan, between 1 July 2024 and 31 December 2025.

## Sample Size

The planned sample size was 100 participants, calculated using a 95% confidence level, an assumed COPD prevalence of 7% and a 5% margin of error.

## Eligibility

Adults aged ≥40 years with a confirmed diagnosis of COPD were eligible. Participants had either a smoking history of at least 20 pack-years or passive-smoking exposure and provided informed consent. Patients unable or unwilling to consent, those with restrictive lung disease, those receiving immunosuppressive treatment, patients with acute myocardial infarction, cerebrovascular infarction or transient ischemic attack within the preceding 6 months, and patients with asthma were excluded.

## Data Collection

A semi-structured proforma was used to record age, sex, smoking history expressed in pack-years, occupation, family history, respiratory symptoms and relevant clinical findings. Physical examination, pulse oximetry at room air, chest radiography, complete blood count, ESR, liver function tests and renal function tests were documented.

## Spirometry

Spirometry was performed using a calibrated computerized spirometer in accordance with ATS/ERS technical standards. FEV1, FVC and FEV1/FVC were recorded. The study protocol states that COPD was confirmed using a post-bronchodilator FEV1/FVC ratio <0.70 and that airflow limitation was staged according to GOLD criteria[5,6].

## Statistical Analysis

Data were summarized using descriptive statistics, including means with standard deviations and frequencies with percentages. The source record states that statistical analysis was performed under the supervision of a statistician; detailed inferential test results, confidence intervals and correlation coefficients were not reported in the available study record.

## Ethics

Approval was obtained from the Scientific and Ethics Committee of National Institute of Medical Sciences & Research, Jaipur. Written informed consent was obtained from all participants after explanation of the study procedures.

# Results

A total of 100 participants were included. The mean age was 46.0±5.9 years. Sixty participants (60.0%) were male and 40 (40.0%) were female. Mean smoking exposure was 24.84±8.00 pack-years, indicating substantial cumulative tobacco exposure in the cohort.


ISSN 2583-2069

**Table 1: Baseline demographic and exposure characteristics**

| Characteristic | Finding |
|---|---|
| Sample size | 100 |
| Age, mean±SD | 46.0±5.9 years |
| Male sex | 60 (60.0%) |
| Female sex | 40 (40.0%) |
| Smoking exposure, mean±SD | 24.84±8.00 pack-years |
| Positive family history | 53 (53.0%) |
| Room-air SpO2, mean±SD | 94.81±1.77% |

occupational category (11%), followed by factory workers (9%), mechanics and tailors (8% each), and carpenters, clerks, teachers and welders (7% each). The study therefore included participants with a range of potential dust, fume and particulate exposures.

Respiratory symptoms were heterogeneous. Breathlessness with cough was the most frequent combination (18%), followed by cough with sputum production (17%). Chronic cough alone and cough with wheezing each occurred in 15%. Breathlessness alone was reported by 8%, while chronic cough with breathlessness and chronic cough with wheezing were each reported by 7%.

Chest radiography was normal in 29% of participants. Hyperinflation was reported in 28%, radiographic features described as mild COPD in 19%, infiltrates in 14% and mild emphysematous changes in 10%.

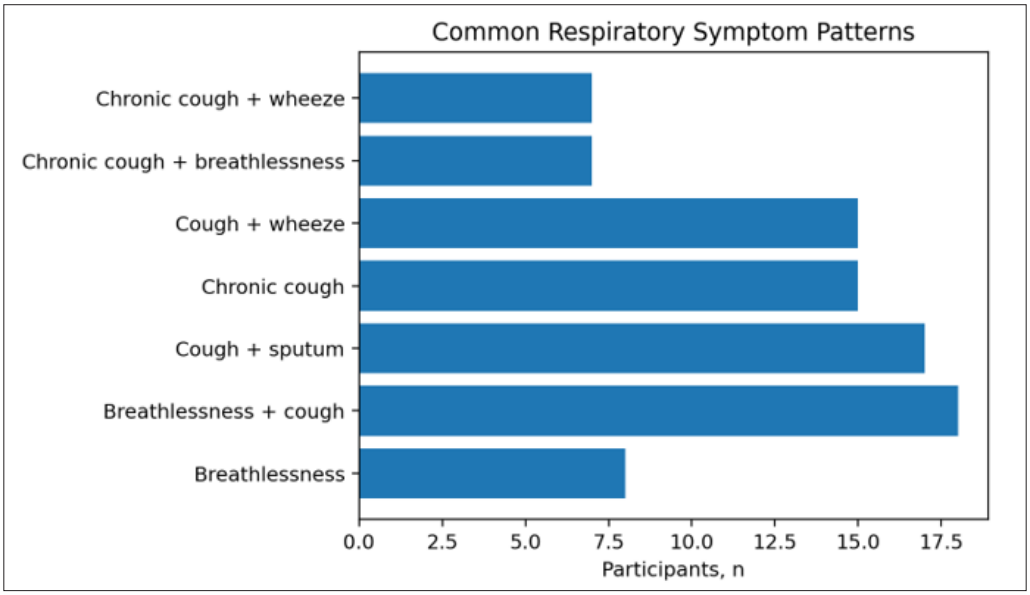


**Figure 1.Selected respiratory symptom patterns reported in the study cohort**

**Table 2. Radiological and spirometric findings**

| Parameter | Finding |
|---|---|
| Normal chest X-ray | 29 (29.0%) |
| Hyperinflation | 28 (28.0%) |
| Mild COPD changes | 19 (19.0%) |
| Infiltrates | 14 (14.0%) |
| Mild emphysema | 10 (10.0%) |
| FEV1, mean±SD | 1.90±0.32 L |
| FVC, mean±SD | 3.66±0.41 L |
| FEV1/FVC, mean±SD | 51.58±3.41% |
| Obstructive pattern | 100 (100%) |

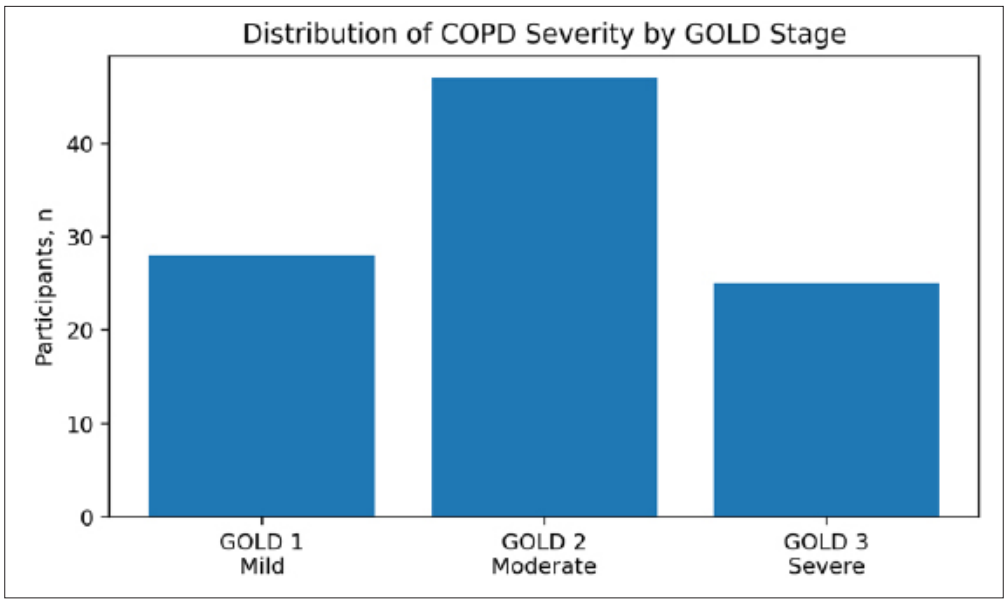


**Figure 2. Distribution of COPD severity according to reported GOLD stage**

Mean FEV1 was 1.90±0.32 L and mean FVC was 3.66±0.41 L. The mean FEV1/FVC ratio was 51.58±3.41%, demonstrating marked airflow obstruction at the group level. All 100 participants were classified as having an obstructive spirometric pattern. According to the reported GOLD staging, 28 participants (28.0%) had GOLD 1 disease, 47 (47.0%) had GOLD 2 disease and 25 (25.0%) had GOLD 3 disease; no participant was reported as GOLD 4.

The mean haemoglobin level was 13.15±0.71 g/dL and mean total leukocyte count was 8761±820.18 cells/mm³. ESR was 26.96±6.64 mm/h. Liver function tests were normal in 94% and mildly elevated in 6%, while renal function tests were normal in 80% and mildly elevated in 20%.

## Discussion

The principal finding of this study was the high burden of objectively demonstrated airflow obstruction in a tertiary-care cohort of adults with COPD. The mean FEV1/FVC ratio of 51.58% and the finding that all 100 participants had an obstructive pattern are consistent with substantial airflow limitation. The predominance of GOLD 2 disease (47%) suggests that moderate airflow limitation was the most common stage in this cohort.

The study population was relatively young for a disease traditionally associated with older age, with a mean age of 46 years. This is clinically relevant because tobacco exposure and other inhalational exposures can produce physiologic abnormalities well before late-life presentation. Population-based studies have shown that COPD prevalence rises with age and smoking exposure, but have also demonstrated meaningful disease burden among individuals below the oldest age groups[3,4].

Smoking exposure was substantial, with a mean of 24.84 pack-years. The relationship between cumulative tobacco exposure and airflow obstruction is well established, and the present findings reinforce the importance of exposure history when selecting patients for targeted pulmonary evaluation[3]. Importantly, however, smoking is not the only relevant exposure. The occupational distribution in this cohort included agriculture, factory work, construction, mining, mechanics, welding and other occupations potentially involving dusts, fumes or particulates. Occupational studies have demonstrated increased odds of COPD across several industrial and service occupations even after adjustment for smoking[10].

More than half of participants had a reported positive family history. A family history may reflect shared environmental exposures, genetic susceptibility or both. Alpha-1 antitrypsin deficiency is the best-established genetic risk factor for COPD, although the present study did not evaluate genetic or biochemical susceptibility. Therefore, the family-history finding should be interpreted as a risk marker rather than evidence of a specific inherited cause.

Respiratory symptoms were generally nonspecific. Breathlessness with cough was the most common combination, followed by cough with sputum production. This pattern is consistent with the clinical spectrum of COPD, in which chronic cough, sputum and dyspnoea may occur in varying combinations. Importantly, symptoms alone do not reliably quantify the degree of airflow obstruction, which supports objective pulmonary function testing when COPD is clinically suspected[1,5].

Chest radiography was normal in 29% of participants despite spirometric obstruction in the entire cohort. This finding illustrates the complementary rather than interchangeable roles of imaging and spirometry. Spirometry directly quantifies expiratory airflow, whereas plain radiography may be normal or show nonspecific changes, particularly in less advanced disease. Standardized spirometry is therefore central to objective confirmation of COPD[5,6].


ISSN 2583-2069

The mean FEV1 was 1.90 L with a relatively preserved mean FVC of 3.66 L, resulting in a substantially reduced FEV1/FVC ratio. The pattern is compatible with obstructive ventilatory impairment. Interpretation of spirometry, however, should incorporate age, sex, height, reference equations and test quality rather than relying on isolated numerical values. Updated ERS/ATS interpretive standards emphasize the use of appropriate reference populations and limits of normal[7].

The finding that all participants had obstruction must be interpreted in relation to the study design. The inclusion criteria required a confirmed diagnosis of COPD, so the cohort was not a screening sample containing both COPD and non-COPD individuals. Consequently, the study cannot estimate the sensitivity, specificity, positive predictive value or diagnostic yield of spirometry for detecting COPD in an unselected high-risk population. Likewise, the study cannot establish that spirometry 'detected' previously undiagnosed COPD in the epidemiological sense. Its strongest contribution is the characterization of spirometric severity and associated clinical features within a clinically selected COPD cohort.

This distinction is important when discussing early detection. The USPSTF recommends against screening asymptomatic adults for COPD because available evidence does not demonstrate a net benefit[8]. In contrast, GOLD recommends considering COPD in individuals with symptoms or relevant risk factors and requires spirometric confirmation[5] Thus, the practical implication of the present findings is better framed as supporting quality-controlled spirometry for targeted case-finding and objective characterization among high-risk or symptomatic individuals, rather than universal screening of asymptomatic adults.

The predominance of GOLD 1 and GOLD 2 disease in the cohort is nevertheless relevant to early clinical recognition. Mild and moderate airflow limitation can be associated with relatively modest symptoms, and the concept of mild or early COPD has received substantial attention[11]. Identifying airflow limitation at this stage creates an opportunity to address modifiable exposures, particularly smoking, and to institute appropriate guideline-based management.

Overall, the study supports spirometry as an essential objective tool in COPD evaluation, while also highlighting the need for careful interpretation of what a hospital-based cross-sectional cohort can demonstrate. Larger prospective studies including both COPD and non-COPD high-risk participants, with standardized bronchodilator testing, symptom scores, smoking exposure, occupational exposure and longitudinal outcomes, would be required to directly assess the diagnostic effectiveness of spirometry for early case detection.

## Conclusion

This hospital-based study found substantial airflow obstruction among adults with established COPD, with a mean FEV1/FVC ratio of 51.58% and an obstructive pattern in all 100 participants. Moderate airflow limitation (GOLD 2) was the most frequent category, followed by mild and severe disease. The cohort also demonstrated substantial smoking exposure and diverse occupational risk profiles. These findings reinforce the importance of quality-controlled spirometry for objective confirmation and staging of COPD in patients with relevant symptoms or risk factors. However, because all enrolled participants already had confirmed COPD, the study does not establish the diagnostic sensitivity of spirometry as a population screening test. Future prospective studies should evaluate targeted case-finding in high-risk populations using COPD and non-COPD comparison groups and longitudinal clinical outcomes.

## Ethics Statement

The study received approval from the Scientific and Ethics Committee of National Institute of Medical Sciences & Research, Jaipur. Written informed consent was obtained from all participants.

## Financial Support and Sponsorship

None

## Conflict of Interest

None

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ISSN 2583-2069