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Original Article

Role of Spirometry in the Early Detection of Chronic Obstructive Pulmonary Disease Among Smokers in a Tertiary Care Teaching Hospital

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Abstract:

Background: *Chronic obstructive pulmonary disease is a major cause of morbidity and mortality worldwide and remains under diagnosed, particularly among smokers. Early detection using spirometry may play a pivotal role to improve clinical outcomes and reduce disease progression.*

Objectives: *To evaluate the role of spirometry in the early diagnosis of COPD among smokers in a tertiary care teaching hospital.*

Methods: *This cross-sectional study involved 150 adult smokers who attended Bangladesh Medical College Hospital, Dhaka, from January 2024 to December 2025. Data were collected on demographic characteristics, smoking history, and occupation. COPD was diagnosed by spirometry based on a post-bronchodilator FEV_1/FVC ratio of less than 0.70. Disease severity was graded according to GOLD criteria. Data were analyzed using SPSS version 15.0 software.*

Results: *The mean age of the participants was 46.8 ± 11.2 years, and 88% were male. COPD was detected in 30.7% of the subjects. A significant association was observed between COPD and smoking exposure ($p = 0.013$), as well as occupational status ($p = 0.027$). Most cases were mild to moderate in severity. Approximately 28% of the individuals diagnosed with COPD were asymptomatic.*

Conclusion: *For early detection of COPD among smokers, including those with minimal symptoms spirometry may play an effective tool. To reduce disease burden routine screening among high-risk populations may facilitate timely intervention.*

Keywords: *Airway Obstruction; Early Diagnosis; Occupational Exposure; Pulmonary Function Test, Spirometry;Tobacco Smoking.*

Introduction

Chronic obstructive pulmonary disease (COPD) is a major global public health concern and a leading cause of morbidity and mortality worldwide[1]. It is currently ranked as the third leading cause of death globally, imposing a significant burden on healthcare systems, particularly in low- and middle-income countries. COPD is characterized by persistent respiratory symptoms such as chronic cough, sputum production, and dyspnea, along with irreversible airflow limitation resulting from airway and/or alveolar abnormalities[2]. The disease is progressive in nature and is primarily caused by prolonged exposure to harmful particles or gases, most notably tobacco smoke.

Tobacco smoking remains the most important and well-established risk factor for COPD, accounting for the majority of cases worldwide[2]. Apart from smoking, several other factors also play an important role in the development of COPD like exposure to indoor air pollution, workplace dust, chemical fumes, and environmental pollutants significantly increases the risk of the disease, especially in developing countries[3]. In Bangladesh, Where tobacco use remains common and many households still rely on biomass fuels for cooking and heating, people are often exposed to multiple harmful agents simultaneously. Such combined exposures increase the likelihood of developing chronic respiratory diseases such as COPD[4].

Although COPD is highly prevalent, it is still frequently underdiagnosed, particularly in the early stages of the disease. Many patients initially experience either no symptoms or only mild respiratory complaints, which are often ignored or mistaken for normal aging or other common respiratory conditions[5]. A delay in diagnosis reduces the opportunity for early treatment and prevention of disease progression and may eventually lead to worsening lung function, recurrent exacerbations, and reduced quality of life. Therefore, early detection of COPD is very important to slow disease progression and improve patient outcomes, as interventions such as smoking cessation, appropriate medications, and lifestyle modifications can be beneficial[2].

Spirometry is considered the standard method for diagnosing and evaluating COPD. It provides an objective assessment of lung function by measuring parameters such as forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC), along with their ratio[2]. A post-bronchodilator FEV_1/FVC ratio <0.70 is widely accepted as evidence of persistent airflow limitation. Besides confirming the

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diagnosis, spirometry also helps determine disease severity and monitor progression over time.

One of the major advantages of spirometry is its ability to identify airflow obstruction even before significant symptoms become apparent. This makes it particularly useful for screening individuals who are at high risk, especially smokers[5,6]. However, despite its usefulness, spirometry is still not routinely used in many healthcare facilities, particularly in low-resource settings. Limited availability of equipment, lack of trained personnel, and inadequate awareness among both healthcare providers and patients are some of the major barriers to its wider use[7].

As tertiary care teaching hospitals manage a large number of patients and serve as centers for medical education and training so it can provide an important opportunity for early detection of COPD. Introducing routine spirometric evaluation among smokers in these institutions could improve early detection and allow timely intervention. Such measures may ultimately help reduce the overall burden of COPD in the community.

Objective:

To evaluate the role of spirometry in the early diagnosis of COPD among smokers attending a tertiary care teaching hospital.

Methods

Study Design and Setting: This was a hospital-based cross-sectional observational study conducted at Bangladesh Medical College Hospital, Dhanmondi, Dhaka, Bangladesh. The study was carried out in the Department of Medicine in collaboration with the Respiratory Medicine unit.

Study Period: The study was conducted from January 2024 to December 2025 at Bangladesh Medical College Hospital, Dhanmondi, Dhaka over a period of 2 years.

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Study Population: A total of approximately 150 adult smokers attending the outpatient and inpatient departments of the hospital during the study period were considered as the study population.

Inclusion Criteria

- Individuals aged 18 years or older
- Current or former smokers with a documented history of tobacco use
- Participants who provided informed written consent

Exclusion Criteria

- Previously diagnosed cases of COPD or other chronic respiratory disorders, including bronchial asthma, interstitial lung disease, or active pulmonary tuberculosis
- Presence of acute respiratory illness at the time of evaluation
- Inability to perform acceptable spirometry due to poor patient cooperation or technical difficulties.
- Patients who were critically ill or had unstable clinical conditions.

Sampling Technique: A purposive sampling technique was used to recruit eligible participants attending the hospital during the study period.

Data Collection: Participants fulfilling the eligibility criteria were enrolled in the study after providing written informed consent. Informations were collected using a structured and pretested questionnaire through direct face-to-face interviews conducted by trained healthcare personnel. This approach was followed to maintain consistency and minimize errors during data collection.

The questionnaire included socio-demographic variables such as age, gender, residential status (urban or rural), and occupation. Smoking-related information was obtained in detail, including the form of tobacco consumed, duration of smoking, average daily smoking frequency, and total smoking exposure calculated in pack-years.

Data regarding occupational and environmental exposure were also collected. Particular importance was given to exposure to dust, smoke, chemical fumes, biomass fuel, and other agents that could affect respiratory health. Participants were additionally asked about respiratory complaints, including chronic cough, sputum expectoration, breathlessness, and wheezing. Details about the duration and severity of symptoms were recorded whenever applicable.

A complete clinical evaluation was performed for all participants. This included both general physical examination and examination of the respiratory system. Important clinical parameters such as respiratory rate, pulse rate, and oxygen saturation, where available, were noted. Chest auscultation was carried out carefully to identify abnormal breath sounds, including wheezes and crackles.

To maintain the quality of the study data, all questionnaires were checked immediately after completion for missing or

inconsistent information. The collected data were then coded appropriately and entered into a computerized database for further statistical analysis.

Spirometry Assessment: All participants underwent spirometric evaluation using a standardized spirometer in accordance with standard international spirometry guidelines.

The diagnosis of Chronic Obstructive Pulmonary Disease was established based on post-bronchodilator spirometric criteria, defined as a ratio of forced expiratory volume in one second to forced vital capacity (FEV_1/FVC) of less than 0.70.

Following confirmation of airflow obstruction, the severity of COPD was classified according to the recommendations of the Global Initiative for Chronic Obstructive Lung Disease (GOLD) based on post-bronchodilator FEV_1 expressed as a percentage of the predicted value. The grading system was applied as follows:

- **Mild (GOLD 1):** $FEV_1 \geq 80\%$ of predicted
- **Moderate (GOLD 2):** FEV_1 50% – 79% of predicted
- **Severe (GOLD 3):** FEV_1 30% – 49% of predicted
- **Very Severe (GOLD 4):** $FEV_1 < 30\%$ of predicted

Spirometry was conducted by trained personnel, ensuring compliance to standard procedures, including proper patient positioning, use of nose clips, and obtaining at least three acceptable and reproducible maneuvers. The highest values of FEV_1 and FVC were recorded for analysis.

Outcome Measures: The primary outcome was the early detection of previously undiagnosed COPD among smokers through spirometry. Assessment of disease severity and its association with smoking exposure and clinical symptoms were considered secondary outcomes.

Ethical Considerations: The Institutional Review Board (IRB) of Bangladesh Medical College Hospital granted formal approval for the study. Written informed consent for using clinical and laboratory data was obtained from all participants prior to enrollment. Throughout the study confidentiality and privacy of all participants were strictly maintained.

Statistical Analysis: Statistical analysis was performed using descriptive and inferential statistical methods. Descriptive statistics were used to summarize demographic characteristics, clinical features, and spirometric findings. Continuous variables with a normal distribution were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages.Associations between categorical variables were assessed using the Chi-square test. Comparisons of continuous variables between groups were performed using the Student's t-test, where appropriate. A p-value <0.05 was considered statistically significant.All data were collected using a semi-structured, pre-tested questionnaire and recorded in a standardized data collection form. The collected data were entered into Microsoft Excel and subsequently analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA).Written informed consent was obtained from all participants before enrollment in the study. Confidentiality and privacy of all participant information were strictly maintained throughout the study.

Results:

Baseline Demographic Characteristics: A total of 150 participants were included in the final analysis. The mean age of the study population was 46.8 ± 11.2 years, with participants ranging from 22 to 72 years of age. Analysis of age distribution revealed that nearly half of the participants belonged to the 40–59 years age group (48.0%, n=72). Participants aged 60 years and above comprised 28.7% (n=43) of the study population, while those between 18 and 39 years accounted for 23.3% (n=35). Most participants were middle-aged, a group considered to be at increased risk for smoking-related respiratory disorders. Regarding sex distribution, males constituted the majority of the study population (88.0%, n=132), while females represented only 12.0% (n=18). This marked male predominance may be attributed to the substantially higher prevalence of smoking among men compared with women in Bangladesh.

Table I: Age and Gender Distribution of Study Participants (N = 150)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
18–39	35	23.3
40–59	72	48.0
≥60	43	28.7
Gender		
Male	132	88.0
Female	18	12.0

Place of Residence: Regarding place of residence, 92 participants (61.3%) resided in urban areas, whereas 58 participants (38.7%) were from rural areas. The predominance of urban residents may reflect the hospital's urban catchment area and greater access to tertiary healthcare facilities among urban populations.

Table II: Distribution of Participants by Residence (N = 150)

Residence	Frequency (n)	Percentage (%)
Urban	58	38.7
Rural	92	61.2

Occupational Distribution: Analysis of occupational status showed that service holders constituted the largest occupational group (32.0%), followed by manual labourers (24.0%) and individuals involved in business activities (18.7%). Unemployed participants accounted for 14.7% of the study population, while 10.6% belonged to other occupational categories.

Table III: Occupational Distribution of Participants

Occupation	Frequency (%)
Service	24.0
Manual labor	32.0
Business	18.7
Unemployed	14.7
Others	10.6

Prevalence of COPD: Among 150 participants spirometric assessment revealed airflow limitation consistent with COPD in 46 resulting in an overall prevalence of 30.7%. A considerable burden of COPD among high-risk group of smokers were reflected through the calculated 95% confidence interval ranged from 23.6% to 38.6%.

At the time of assessment, a notable proportion of participants (28.3%, n=13) who did not report significant respiratory symptoms were diagnosed with early COPD. These individuals would likely have remained undetected without spirometric screening, as they were classified as asymptomatic or minimally symptomatic, suggesting the presence of early or subclinical disease. This observation highlights the limitations of relying solely on clinical symptoms for the diagnosis of COPD. It also emphasizes the importance of objective lung function assessment through spirometry for the early detection of COPD, particularly among smokers and other high-risk populations.

Severity Distribution (GOLD Classification): Among the diagnosed COPD cases (n=46):

- Mild: 39.1% (n=18)
- Moderate: 43.5% (n=20)
- Severe: 17.4% (n=8)

No participants were categorized as very severe COPD.

Table IV: Severity of COPD Based on GOLD Classification (n = 46)

Severity	Frequency (n)	Percentage (%)
Mild	18	39.1
Moderate	20	43.5
Severe	8	17.4

Association Between Risk Factors and COPD:

Smoking Exposure: A Chi-square (χ^2) test was performed to assess the association between cumulative smoking exposure and the presence of COPD, which revealed a statistically significant relationship ($p = 0.013$). Participants with greater smoking exposure, measured in pack-years, demonstrated a considerably higher prevalence of airflow limitation than those with lower levels of tobacco exposure.

The findings suggest a dose–response relationship between smoking burden and the development of COPD, indicating that the likelihood of airflow obstruction increases with both the duration and intensity of smoking. Individuals with a higher cumulative exposure to tobacco smoke are more susceptible to chronic inflammatory and structural changes within the airways, which may eventually result in persistent airflow limitation.

The statistically significant association observed in this study provides further evidence that smoking is the most important preventable risk factor for the development of COPD among the study population.

Occupational Status: The Chi-square test was used to analyze the relationship between occupational categories and COPD prevalence which revealed a statistically significant association ($\chi^2 = 9.21$, $p = 0.027$). A higher proportion of COPD cases were observed among participants engaged in manual labour compared to those in service-based or less physically demanding occupations.

This observation suggests that occupational exposure to respiratory irritants, such as dust, chemical fumes, and particulate matter, may be associated with the development of airflow limitation independent of smoking. In combination with smoking, these exposures may exert a synergistic effect, amplifying lung injury and accelerating disease progression. The statistically significant association highlights occupation as an important environmental determinant of COPD in this setting.

Place of Residence: The prevalence of COPD was comparatively higher among participants residing in rural areas than those from urban settings. However, statistical analysis did not demonstrate a significant association between place of residence and COPD ($p > 0.05$).

Although this difference was not statistically significant, the observed trend may be clinically relevant. Rural populations are often exposed to higher levels of indoor air pollution in comparison to urban group particularly due to the usage of biomass fuels for cooking and heating, as well as inadequate ventilation. These environmental factors may contribute to chronic airway inflammation and could potentially increase susceptibility to COPD. However, in the present study, smoking exposure appeared to be the dominant risk factor influencing the development of COPD.

Discussion:

This study demonstrates that spirometry is a highly effective tool for detecting previously undiagnosed Chronic Obstructive Pulmonary Disease (COPD) among smokers in a tertiary care setting. In this study the prevalence of COPD observed (30.7%) was higher than estimates reported for the general population, although it is comparable to findings from studies conducted among smokers and other high-risk groups[4,5,8]. This finding indicates that a substantial proportion of smokers may have undiagnosed airflow limitation, reflecting the hidden burden of COPD in populations with long-term tobacco exposure. A recent systematic review and meta-analysis also demonstrated substantial global variation in COPD prevalence, with higher prevalence observed among smokers and high-risk populations.[8]

Supporting the established role of tobacco smoking as the

leading cause of the disease a statistically significant relationship was found between smoking exposure and COPD ($p = 0.013$).The gradual increase in airflow limitation with higher cumulative smoking exposure demonstrates a dose-dependent effect of tobacco use. Prolonged exposure to tobacco smoke causes chronic airway inflammation, oxidative injury, and structural damage to the lungs, ultimately leading to a progressive decline in pulmonary function[2,6,9].

Previous studies have also reflected that even relatively lower but sustained smoking exposure can increase the likelihood of developing COPD, emphasizing the importance of smoking cessation at an early stage[9].

Occupational exposure was identified as an additional significant risk factor ($p = 0.027$), with manual laborers showing the highest disease prevalence compared to service-based or less physically demanding occupations. Previous studies indicating that exposure to dust, chemicals, and environmental pollutants in occupational settings contributes to the development and progression of COPD, particularly in low- and middle-income countries[7]. Environmental exposures, including air pollution, may further contribute to COPD development and respiratory morbidity.[10] Recent evidence also suggests that environmental exposures, including air pollution and secondhand smoke, further amplify this risk[11].

Another important finding of the present study was the presence of a considerable number of asymptomatic COPD cases. Nearly one-third of participants diagnosed with COPD did not report major respiratory symptoms at the time of assessment. This observation highlights the limitation of diagnosing COPD solely on the basis of symptoms, since early-stage disease may remain clinically silent for a prolonged period. Comparable findings have been reported in population-based studies where many individuals with spirometry-confirmed COPD were previously unaware of their condition.[10] These findings support the importance of spirometry as an effective tool for early detection of airflow limitation among high-risk individuals.

Most of the identified COPD cases were categorized as mild to moderate according to GOLD classification, suggesting that many study population were detected during the earlier stages of the disease. Early diagnosis is clinically important because timely interventions, including smoking cessation, pharmacological treatment, and lifestyle modification, may help slow disease progression, reduce exacerbations, and improve quality of life[2,12].

Although COPD prevalence appeared to be higher among rural participants, the association did not reach statistical significance. Greater exposure to biomass fuel smoke and indoor air pollution in rural households may partly explain this trend, as these factors have previously been associated with COPD development[3,7]. Nevertheless, smoking remained the most important contributing factor in this study population.

This study has several limitations that should be acknowledged. Since the study was conducted at a single tertiary care teaching centre with a relatively small sample size, the findings may not be fully representative of the broader population. In addition, occupational and environmental exposures were assessed based on participant history rather than direct quantitative measurements, which may have limited the accuracy of exposure assessment.

Conclusion

In summary, this study demonstrates that for the early detection of COPD among smokers in a tertiary care setting spirometry is an effective and practical tool. The large proportion of previously undiagnosed COPD cases, especially among individuals with early-stage disease and minimal symptoms, highlights the importance of routine spirometric screening in populations at high risk. Early identification through spirometry may allow timely intervention before significant and irreversible decline in lung function occurs.

Reducing exposure to modifiable risk factors, particularly tobacco smoking and occupational pollutants, is essential for lowering the burden of COPD in Bangladesh. Strengthening smoking cessation programs, improving workplace safety measures, and increasing awareness regarding respiratory health could contribute significantly to the prevention and early management of COPD.

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