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Early Diagnosis of Chronic Obstructive Pulmonary Disease in Smokers Using Spirometry

*Sharmin R[1], Rahman MM[2], Akter S[3]

Abstract

A cross-sectional, observational study was done in the Pulmonology Department of Combined Military Hospital (CMH) Dhaka Cantonment, Bangladesh, from September 2016 to February 2017, to explore the role of spirometry in the early detection of Chronic Obstructive Pulmonary Disease (COPD) among smokers. A total of 70 participants were selected. After taking the detail history, spirometry and chest x-ray were done. The correlation between smoking and COPD was determined. Among the total respondents 44%, 40% and 15.7% had 10-15, 15-20 and >20 pack-year smoking history respectively. Forced expiratory volume in one second/Forced vital capacity (FEV1/FVC) among these three groups of smokers were found 90%/91%, 77%/89%, and 58.4%/88% respectively. Among the participants, 20% had a change in chest X-ray and 23 (32.85%) of respondents had COPD. Among those 23 participants, 13 (18.57%) suffered from mild, 6 (8.57%) suffered from moderate, 3 (4.28%) suffered from severe, and 1 (1.43%) suffered from a very severe level of airway obstruction. Our results suggest that spirometry can be a valuable tool for the early diagnosis of COPD among smokers. Though it was found as a promising option in a small-scale study, further evaluation is necessary through a population screening to confirm its effectiveness.

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Introduction

Chronic obstructive pulmonary disease (COPD) is a significant cause of illness and death worldwide.[1] The overall prevalence of COPD in total population of Bangladesh is 4.32%.[2] Increasing age, sex, smoking duration, and low socioeconomic conditions are independent risk factors.[3] Chronic obstructive pulmonary disease (COPD) is a common disease characterized by airflow limitation that is not fully reversible. The airflow limitation is progressive and associated with abnormal inflammatory responses to noxious particles or gases in the lung (as per the Global Initiative for Chronic Obstructive Lung Disease).[4] The diagnosis of COPD is based on its symptoms, including dyspnea, chronic cough, and chronic sputum production, as well as episodes of exacerbations.[5] Spirometry is an easy and accurate method of measuring the FEV1., which is also helpful for diagnosis of COPD.[5] There are several risk factors for COPD, including cigarette smoking, air pollution, and genetic factors.[6] Worldwide, smoking is the most common risk factor for COPD. Around half of all smokers develop some airflow limitation, and 15%-20% will develop clinically significant disability.[7] The inflammatory and structural changes in the airways increase with disease severity and persist on smoking cessation.[8] Tobacco contains about 4,000 chemicals

1. *Dr. Rifat Sharmin, Graded Specialist, Department of Medicine, Bangladesh Navy, Bangladesh.
2. Dr. Md Mahbubur Rahman, Classified Specialist, Department of Medicine, Bangladesh Navy, Bangladesh.
3. Dr. Shamima Akter, Classified Specialist, Department of Anaesthesiology, Bangladesh Army, Bangladesh.

Address of Correspondence:
Email: subahrif@gmail.com

including nicotine.[9] Nicotine's pharmacological properties play a significant role in the maintenance of smoking habit. A study conducted in Pakistan revealed that 84% of smokers initiate smoking between the ages of 16 and 25.[10] Genetics influence the age of smoking initiation, the daily amount smoked, and nicotine dependence.[11]

Spirometry is a simple, non-invasive test that allows an objective assessment of lung function by measuring the volume of air expelled from fully inflated lungs over time.[12] It provides a comprehensive overview of airflow and lung capacity, and with high-quality measurement, permits an accurate and reliable diagnosis of obstructive airway disease and the degree of reversibility.[13] The two key parameters determined by spirometry are FVC (forced vital capacity) which is the total volume of air forcibly exhaled and represents a measure of lung capacity, and FEV1 (forced expiratory volume) which is the volume of air forcibly exhaled in the first second, and is a measure of airway patency and lung elasticity. The ratio of these two measures is used to assess the degree of a patient's airflow obstruction.[12] Spirometry is generally not administered to patients during routine outpatient visits. This greatly hinders the potential for COPD diagnosis at the early stages of the disease and has direct relevance to prevalence estimates and the clinical practices of COPD.[14]

Spirometry has been demonstrated to be an efficient method for the detection of airway obstruction in specifically targeted higher-risk groups.[15] Except during the earliest stages of the disease, COPD has a great impact on healthcare systems and causes increasing costs to society owing to absence from work, visits to the doctor, surgery, medication, and hospital admissions.[16] Not surprisingly, there is a striking direct relationship between the severity of COPD and the cost of care, and the distribution of costs changes as the disease progresses.[17] Because of the increase in prevalence and mortality of COPD, and its high medical costs, it is important to identify patients and to treat them before they reach the symptomatic and costly stages of the disease.[18] Therefore, the present study aims to explore the role of spirometry in the early detection of COPD among smokers.

Methods

This cross-sectional, observational study was conducted in the Pulmonology Department of Combined Military Hospital (CMH) at Dhaka Cantonment, Bangladesh, from September 2016 to February 2017. Smokers attending the outpatient department or admitted to different wards of the Combined Military Hospital due to any disease other than breathing difficulty, or prolonged cough were considered as the study population. Informed written consent was taken from the patients. A total of 70 participants were selected adopting a purposive sampling technique as per our study inclusion and exclusion criteria.

Inclusion Criteria

1. Patients with smoking history.
2. Patients of >40 years of both genders.
3. Patients who had given consent to participate in the study.

Exclusion Criteria

1. Patients who were already diagnosed as having COPD.
2. Patients who had asthma, heart failure, malignant disease, CLD (chronic liver disease), CKD (chronic kidney disease),

connective tissue diseases, obesity, and neuromuscular diseases.
3. Too ill or aged to perform spirometry.
4. Patients who had advanced lung disease.
5. Patients who did not give consent to participate in the study.

All patients underwent interviews using a standardized questionnaire that contained essential information. Their general medical condition was assessed through comprehensive history-taking, clinical examinations, and necessary laboratory tests. including spirometry and chest x-ray.

Collected data were meticulously reviewed, coded, and then entered into a computer. To determine the significance of spirometry, statistical analyses were conducted, and the p-value was measured using appropriate methods, such as the Chi-square test. The Odds Ratio was employed to assess the strength of the association between spirometry findings and cardiac diseases. A significance level (p-value) of 0.05 and a confidence interval of 95% were utilized. Data analysis was performed using the Statistical Package for Social Sciences (SPSS) version 20.0. The study was approved by the Ethical Review Committee of the Combined Military Hospital (CMH), Dhaka Cantonment, Dhaka, Bangladesh.

Results

In this study, a total of 70 respondents participated, comprising 64 males (91.42%) and 6 females (8.58%). The mean age of the participants was 45.94±8.38 years (Table-I). The largest proportion, 45 individuals (64.29%), fell within the 40-49 years age group, followed by 18 individuals (25.71%) in the 50-59 years age group, 6 individuals (8.58%) in the 60-69 years age group, and 1 individual (1.43%) in the ≥70 years age group. Most of the respondents (32.86%) were employed in the defense sector, while 31.43% were service holders (Table-II). In terms of symptoms, 57.14% of the patients were asymptomatic, 18.58% experienced cough, 11.42% had sputum production, 8.58% reported dyspnea, and 4.28% had more than one symptom (Table-III).

Table-I: Age distribution by gender of the respondents

Gender	Mean(±SD) age in year	
Male	47.4(±8.4)	45.94(±8.38)
Female	44.3(±5.3)	

Table-II: Occupation of the respondents

Occupation	Frequency	Percentage
Defense	23	32.86
Service holder	22	31.43
Unemployed	11	15.71
Service holder	08	11.42
Others	06	8.58

Table-III: Distribution of symptoms

Symptoms	Frequency	Percentage
Asymptomatic	40	57.14
Cough	13	18.60
Sputum	08	11.42
Dyspnea	06	8.58
Symptom >1	03	4.28

Out of the 70 respondents, 23 developed COPD. Among those with a smoking history of 10-15 pack-years, 15-20 pack-years, and >20 pack-years, 2 (6.4%), 10 (35.71%), and 11 (100%) had

respectively. This study indicated a reduction in FEV1 and FVC levels across various respondent groups based on the duration and amount of smoking, but these differences were not statistically significant (Table-IV & V). Among the 23 patients of COPD, 13(18.57%) had mild, 6(8.57%) moderate, 3(4.28%) severe, and 1(1.43%) was with very severe level of airway obstruction (Fig. 1). Out of the total 70 respondents, only 14(20%) exhibited changes in their chest x-ray images.

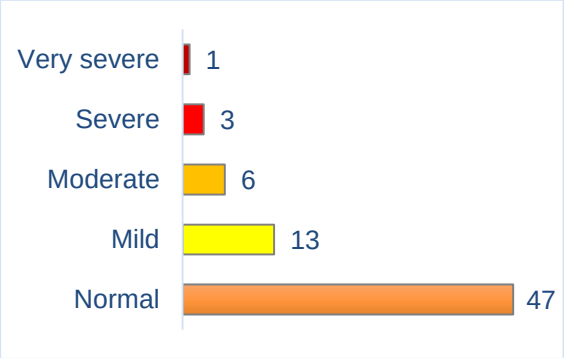

Fig. 1: Level of airway obstruction among respondents during spirometry

Table-IV: Relation of smoking with COPD according to outcome of Spirometry (N=70)

Characteristics		Asymptomatic	Cough	Sputum	Dyspnea	symptom (>1)
		(n = 40)	(n= 13)	(n= 08)	(n= 06)	(n= 03)
10-15 pack year	n	(n= 20)	(n= 06)	(n= 02)	(n= 02)	(n= 01)
	FEV1	92% +6%	88% + 4%	86%+ 3%	84%+ 2%	82%
	FEV1/FVC	>0.70	>0.70	>0.70	<0.70	>0.70
15-20 pack year	n	(n= 18)	(n= 03)	(n= 04)	(n= 02)	(n= 01)
	FEV1	90%+ 4%	86% +6%	84% +2%	82% +2%	80%
	FEV1/FVC	>0.70	<0.70	<0.70	<0.70	<0.70
>20 pack year	n	(n=2)	(n=04)	(n= 02)	(n=02)	(n= 01)
	FEV1	84% +4%	72% +4%	60% +2%	45% +2%	29%
	FEV1/FVC	<0.70	<0.70	<0.70	<0.70	<0.70

Table-V: Mean outcome of spirometry according to smoking history

Duration of smoking	FEV_1	FVC
(pack year*)	Mean (±SD)	Mean (±SD)
15-Oct	90 (±8)	91 (±6)
15-20	77 (±17)	89 (±9)
>20	58.4 (±29)	88 (±6)

*1 pack-year is equal to smoking 20 cigarettes (1 pack)/day for 1 year, or 40 cigarettes/day for half a year. A Chi-square test was done to see the level of significance. P value was >0.05

Discussion

Chronic obstructive pulmonary disease (COPD) is the third leading cause of death worldwide, causing 3.23 million deaths in 2019.[1] Smoking is a major contributor to the prevalence of COPD, and its symptoms generally become apparent in mid to later life. Tobacco smoking accounts for over 70% of COPD cases in high-income countries and 30–40% in low- and middle-income countries (LMIC).[1] Trofor & Frăsilă emphasized the mandatory and beneficial nature of smoking cessation in COPD.[19] In our study, the mean age

of the respondents was 45.94±8.38 years, indicating that the participants were relatively younger. This may be attributed to the trend of younger individuals in your country adopting smoking as a habit. This age distribution contrasts with another study that focused on older subjects, with ages ranging from 54 to 57 years.[20] In the present study, the cough was present in 18.6%, sputum production in 11.4%, and dyspnea in 8.5%, more than one symptom was present in 4.2% of respondents, others were asymptomatic. Bednarek *et al.* showed one-third of examined declared morning cough (36.9%) or sputum production (34.8%), or both symptoms (26.7%).[20] FEV1 level significantly reduces among different groups of respondents according to duration and amount of smoking. Among 70 smokers who had a history of smoking more than 10 packs a year, 23 were affected by mild COPD (18.57%), moderate COPD (8.57%), severe COPD (4.28%), and very severe COPD (1.43%). Our findings were also similar to the study done by Stang *et al.*[21] In this study, the normal population was found as 67.14%, and a total of 32.6% were diagnosed with COPD. In this series, the prevalence of COPD was much higher. Stang et al. also showed that 22% were diagnosed with COPD among smokers.[21] Gingter *et al.* reported that the prevalence of COPD among smokers was 6.9%.[22] Moreover, another study conducted in Turkey showed that 6.9% of the participants (general population) were found to have COPD with the prevalence of COPD being 18.1% in current smokers.[23] A study in Japan showed overall, 22.5% of patients were current smokers.[24] In China, study showed that the smoking rate among COPD patients was significantly higher than that among the controls.[25] A study done by de Godoy *et al.* showed that about 57(36.1%) smokers met the criteria for COPD, out of 158 smokers.[26] Another population-based study done in China showed the overall prevalence of COPD in the general population was 8.2%.[27] Tatsumi stated that 15% of chronic smokers may develop COPD.[28] He also showed a decrease in FEV1/FVC (severe COPD) with an increase in pack years. It supports the hypothesis of a relative correlation between pack-years smoking and the severity of COPD, particularly in the older age group.[28] Rutschmann *et al.* showed that only half of 455 doctors used spirometric criteria to define COPD and only one-third knew the correct GOLD criteria.[29] Hence, an early diagnosis of COPD was missed by the clinicians very often. Early and aggressive attempt to stop smoking is the most appropriate measure for these patients to save lung functions; early diagnosis facilitates targeted warning about the dangers of smoking, which may be more effective than general smoking cessation advice.[30]

However, our study was conducted as an observational, cross-sectional study at a single center. It followed a single-blinded design, had a small sample size, and had a relatively short duration. Importantly, the findings from the study were limited to the specific region or population under investigation and did not represent the entire country.

Conclusion

Spirometry, a pulmonary function test, has emerged as a valuable diagnostic tool for identifying Chronic Obstructive Pulmonary Disease (COPD), especially in individuals with a history of smoking. This non-invasive procedure measures various parameters related to lung

function, including vital capacity, and forced expiratory volume, which can help detect early signs of obstructive airway diseases like COPD. The findings suggest that using spirometry to diagnose COPD in smokers is a promising approach. Still, its widespread implementation requires careful consideration, including the need for further evaluation, standardization, and integration into healthcare practices to maximize its effectiveness in identifying and managing this chronic lung disease.

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