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Association between Body Mass Index and Spirometric Measurements of Patients with Chronic Obstructive Pulmonary Disease

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Abstract

Introduction: *Chronic obstructive pulmonary disease (COPD) is a major cause of chronic morbidity and mortality throughout the world. It is a preventable and treatable disease with significant extra pulmonary effects that may contribute to the severity in individual patients. Body mass index (BMI) is an important indicator that can well reflect nutritional status of patients, and low BMI is an independent risk factor for mortality in patients with COPD. The decline in BMI in patients with COPD is a marker of advanced disease. This study is undertaken to investigate the relationship between BMI and pulmonary function of COPD patients.* ***Objectives:*** *To investigate the relationship between BMI and spirometric measurements of COPD patients.* ***Methods:*** *This was an observational descriptive cross-sectional study carried out in inpatient and outpatient Departments of Medicine of Rajshahi Medical College Hospital, Rajshahi, from Dec. 2010 to Dec. 2011. According to inclusion and exclusion criteria, a total of 82 patients diagnosed with COPD, based on history, physical examination and spirometric examination were selected for study.* ***Results:*** *Of the 82 patients, 20(24.39%) were of normal weight, 22(26.82%) were underweight, 25(30.48%) were overweight, 15(18.29%) were obese. FEV1/FVC and FEV1% predicted were lowest in the underweight patients and highest among the obese and overweight patients. A positive correlation between BMI and FEV1/FVC, FEV1% predicted was observed (correlation coefficient (r) was 0.788, 0.802 respectively, both P values were <0.05).* ***Conclusion:*** *BMI alterations are common in COPD patients. A high proportion of patients with COPD experience a significant weight loss which is associated with increased morbidity and mortality. Such patients should be alert to adhere to maintain nutritional status of the body so that they can avoid weight loss for better survival.*

Keywords: *Body Mass Index, Spirometric Measurements and Chronic Obstructive Pulmonary Disease.*

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Introduction:

Chronic obstructive pulmonary disease (COPD) is a major cause of chronic morbidity and mortality throughout the world. It is a preventable and treatable disease with significant extra pulmonary effects that may contribute to the severity in individual patients. It is characterized by airflow limitation that is not fully reversible[1]. The chronic air flow limitation of COPD is caused by a mixture of small airway disease (obstructive bronchiolitis) and parenchymal destruction (emphysema), the relative contribution of which vary from person to person[2]. As COPD occurs in middle aged longtime smokers, patients have a variety of other disorders related to either smoking or aging in addition to the extrapulmonary or systemic effect of COPD. Among risk factors, tobacco smoking either active or passive, current or ex-smoking-all have a higher respiratory symptoms and lung function abnormalities, a greater annual rate of decline in FEV1 and a greater COPD mortality rate than non-smokers. It is unusual for a person to have clinically apparent COPD without history of smoking for at least 10 pack year. 3 Not all smokers develop clinically significant COPD, which suggests that genetic factor determines susceptibility. Other factors includes occupational dusts and chemicals, indoor and outdoor air pollution, sex (almost equal in men and women in developed countries), childhood infection and socio-economic status (risk of developing COPD is inversely related to socio-economic status). It is a major public health problem worldwide. Although prevalence vary across countries, it is appreciably higher in smokers and ex-smokers compared with non-smokers, in those older than 40 years compared with those younger than 40 years and in men compared with women[3]. COPD is the 4th of the most important causes of death and is predicted to the 3rd most common cause of death and 5th most common cause of disability world wide by 2020[4]. COPD is a costly disease. In United states in 2002, the direct costs of COPD were $18 bilion and indirect costs totaled $14.1 billion (National Heart, Lung, and Blood institute, 2004)[5]. According to a study, known as BOLD-BD (Burden of obstructive lung disease in Bangladesh) study, on COPD conducted by Bangladesh lung foundation, burden of COPD in Bangladeshis are as follows:

- Prevalence in >40 years of age is 21.24%
- Prevalence in general population is 4.3%
- Total burden of COPD patients is about 6 million[6].

Initial diagnosis of COPD should be considered in any patient over age 40 who has history of dyspnoea, chronic cough or sputum production and/or a history of exposure to risk factor and then confirmed by spirometry.

- Smoking >10 pack years (20 cigarettes/day for 1 year =1pack year) is the cause in 65-70% cases of COPD in people aged 40 years or more in Bangladesh. Smoker is 10 times more likely to die from COPD than a non-smoker. In Bangladesh, smoke from biomass fuel burning is an important risk factor for COPD particularly in rural and sub-urban housewives[7].
- Other histories including past medical history of asthma, allergy, sinusitis, nasal polyps, childhood respiratory infection, family history of COPD or other chronic respiratory disease, history of exacerbation or previous hospitalization for respiratory disorder, presence of comorbidities such as heart disease, malignancy, osteoporosis and musculoskeletal disorders-should be enquired.
- Physical examination is rarely diagnostic of COPD. Physical signs of airflow limitation has a relatively low diagnostic role until significant impairment of lung function has occurred.2 However, barrel shaped chest, use of accessory muscle of respiration, reduction of cricosternal distance (tracheal tug), paradoxical indrawing of the lower ribs on hollowing of supraclavicular fossa, pursed lip breathing, hyper resonant lung field, prolongation of expiration especially forced expiration >5 seconds and audible wheeze may be present. Though none of these sign's are specific to COPD and do not correlate very well with the severity of COPD, their presence should alert physician to the possible diagnosis of COPD and emphasizes the need of objective diagnosis of COPD[8]. Among investigations- spirometry, a critical tool to identify COPD with reference to appropriate normal values as per age, sex, height, weight and race. Post bronchodilator value of FEV1/FVC <70% indicates COPD and thus diagnose COPD adequately and early. Other tests like chest x-ray, arterial blood gas analysis, haemoglobin and packed cell volume, electrocardiography, echocardiography, 1 antitrypsin assay etc can be done to help diagnosis. Spirometric classification of COPD based on post bronchodilator FEV1 is done in the flowing way[9].

Materials and Methods:

This cross-sectional descriptive study was conducted in the Department of Medicine, indoor and outdoor, Rajshahi Medical College Hospital, Rajshahi from December, 2010 to December, 2011 (01 year). A total of 82 COPD patients were selected using purposive sampling. Inclusion criteria included -Age more than 40 years, Patients of both sexes and Established patients of COPD with or without cor pulmonale evidenced by spirometry and echocardiography. Exclusion criteria were Patients who did not agree to be included in this study, Age less than 40 years and Patients having active or old pulmonary tuberculosis, bronchiectasis, malignant disease, chronic liver disease, diabetes mellitus. All patients were under gone through complete history taking, physical examination and spirometric examination. Spirometry was done firstly without using bronchodilator inhalation. Those who showed obstruction, they were also undergone through post bronchodilator spirometry to confirm irreversible obstruction i.e. COPD. Staging of COPD was done according to GOLD's criteria. BMI was categorized as underweight (<20kg/m^2), overweight (25.0-29.9kg/m^2), and obese >or=30.0kg/m^2. Analysis was done by ANOVA test.

Results:

Results regarding age, education, occupation, monthly income, smoking pattern (pack years) in COPD patients, BMI recording, spirometric findings– all were studied and presented in the following pages.

Age distribution among patients with COPD:

Maximum number of mild, moderate, severe and very severe COPD patients were in age group 41-50 yrs (15), 61-70 yrs (11),61-70yrs(8) and >70 yrs (8) respectively.Maximum number of total COPD 28(34.14%) were in age group 51-60 yrs and minimum number of COPD 10(12.19%) were in age group >70 yrs. Number of very severe COPD in age group 51-60 years were 01 , 61-70 years were 01 and >70yrs were 06. So, number of very severe COPD had increased with the increasing of age.

Table I: Age distribution among patients with COPD

Age groups	Stage of COPD				Total	
(yrs)	Mild	Moderate	Severe	Very Severe	No	(%)
41-50	15	1	2	0	18	21.95
51-60	12	9	6	1	28	34.14
61-70	6	11	8	1	26	31.71
>70	0	0	4	6	10	12.20
Total	33	21	20	8	82	

Occupational status among patients with COPD: Maximum number of patients with COPD 50(60.96%) were farmers and minimum number of patients with COPD 2(2.44%) were service holders.

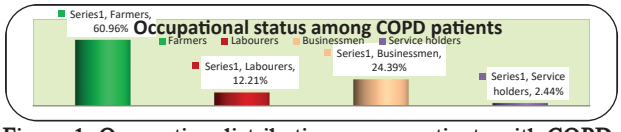

Figure 1: Occupation distribution among patients with COPD

Educational status among patients with COPD (n=82)

Among patients with COPD, 42(51.22%) were illiterate, 32(39.02%) were primarily educated, 6(7.32%) had passed SSC and 2(2.44%) had passed HSC. So, COPD was found to be more prevalent in the relatively less qualified person.

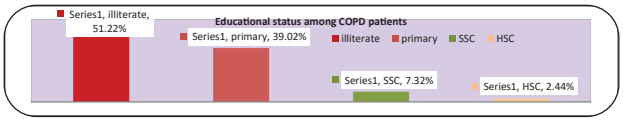

Figure 2: Educational status among patients with COPD

Monthly income among patients with COPD

Maximum number of patients with COPD 44(53.66%) had monthly income <3000 Tk. and minimum number of patients with COPD 6(7.31%) had monthly income 6000 to 10,000 Tk. So, low income groups were more prone to develop COPD.

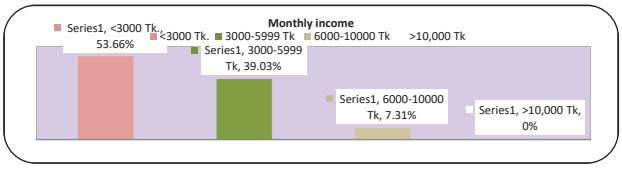

Figure 3: Monthly income among patients with COPD

Smoking pattern among patients with COPD (n=82)

Maximum number of smokers with COPD 56(68.29%) having mild, moderate and severe COPD had smoked >20 pack years and minimum number of smokers with COPD 26(31.71%) having mild, moderate and severe COPD smoked 10-20 pack years.

Table II: Smoking pattern among patients with COPD

Pack year	Stage of COPD				Total	
(py)	Mild	Moderate	Severe	Very Severe	No	(%)
10-20 py	18	5	2	1	26	31.7
>20 py	15	16	18	7	56	68.3
Total	33	21	20	8	82	100

The comparison of ex-smokers and current smokers for BMI

Table III: Comparison of ex-smokers and current smokers for BMI

	Ex-smokers (n=44)	Current smokers (n=38)	p-value
BMI	25.6±2.4	23.4±3.5	0.041

Here table shows that BMI was significantly lower in current smokers than in ex-smokers (P = 0.041).

Respiratory symptoms and positive physical sign of airflow limitation distribution among patients with COPD (n=82)

Maximum number of smokers with COPD had suffered from chronic cough 80(97.56%) but minimum number of them showed physical sign of airflow limitation 18(21.95%) out of 82.

Table IV Respiratory symptoms and positive physical sign of airflow limitation distribution among patients with COPD

Symptom and sign	Number	Percentage (%)
Chronic cough (>3 weeks)	80	97.56
Chronic sputum	60	73.17
Dyspnoea	22	26.83
Airflow limitation	18	21.95

Staging of COPD cases

Out of 82 smokers diagnosed to have COPD, 33(40.25%) had mild COPD, 21(25.60%) had moderate COPD, 20(24.40%) had severe COPD and 8(9.75%) had very sever COPD.

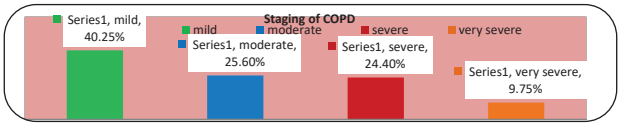

Figure 4: Staging of COPD

Table V Relation between BMI and spirometric measurements of patients with COPD

Variables	Obese (BMI ≥30) (n=15)	Overweight (BMI ≥25-29.9) (n=25)	Normal weight (BMI ≥18.5-24.9) (n=20)	Underweight (BMI <18.5) (n=22)	P-value
FEV_1% predicted	69.7±3.3	67.5±2.2	61±2.8	41.5±3.1	0.002
FEV_1/FVC (%)	64.8±3.5	63.5±3.3	59.2±2.7	43.4±4.6	0.016
BMI	31.5±2.96	27.3±1.21	20.9±1.86	17.07±2.26	0.024

Results of statistical analysis of values of spirometric parameters i.e. FEV1, FVC and FEV1/FVC among patients, values of FEV1 and FEV1/FVC were significant (p value 0.002 and 0.016 respectively).

Of the 82 patients- 25(30.48%) were overweight, 15(18.29%) were obese, 20(24.39%) were of normal weight, and

22(26.82%) were underweight. FEV1/FVC (43.4±4.6) and FEV1% (41.5±3.1) predicted were lowest in the underweight group and highest among the obese and overweight group. A positive correlation between BMI and FEV1/FVC, FEV1% predicted was observed (correlation coefficient (r) was 0.788, 0.802 respectively and P-values was 0.013 and 0.019 respectively which was statistically significant.

Discussion:

Chronic Obstructive Pulmonary Disease (COPD) is a leading cause of morbidity and mortality world-wide and leads to an economic and social burden that is both substantial and increasing. Prevalence and morbidity data greatly underestimate the total burden of COPD because the disease is usually not diagnosed until the patients already have had symptoms for some time and the disease is then often already quite advanced[10-12]. The study had been intended to investigate the relationship between BMI and pulmonary function of COPD patients. According to GOLD (Global Initiative for chronic obstructive lung disease) in its Global strategy for diagnosis, management and prevention-excecutive summery, updated 2009, the risk of developing COPD is inversely related to socioeconomic status ie. COPD occurs more in lower education, occupation and income groups of people in risk. Our study result was consistent with this because our study showed that COPD had occured more in illiterate (51.22%), farmers (60.96%) and low income group earning <3000 Tk/month (53.56%). GOLD has mentioned any of chronic cough, sputum production and dyspnoea as a key indicator of COPD. In our study, all these symptoms were present singly or in combination among smokers having COPD (Cough 97.56%, Chronic sputum 73.17%, Dysponea 26.83%). According to a study conducted in Bangladesh on burden of obstructive lung diseases in Bangladeshi, the main age group involved by COPD is 40-50 years (42.06%). For the age group 51-60 years (26.64%), 61-70 years (20.72%)[7]. But in our study, it was 41-50yrs (21.95%), 51-60yrs (34.14%) and 61-70yrs (31.71%) respectively. In NICE study conducted by Fukuchi Y et al[13], in Japan, COPD is significantly more prevalent in older people. 3.5% in 40-49 years old Vs. 24.4% in those >70 years of age and this increasing prevalence with increasing age is consistent with our study upto age of 60 years after which their was a decline in our study. In BOLD-BD study, it has been shown that about 80% smokers need to smoke only around 10 pack years to catch the disease and the study has considered this finding as more alarming than the international findings, where 20 pack-years are set as a bench mark in developing COPD[7]. But our study showed that maximum number smokers with COPD 56(68.3%) smoked >20 pack years where as the minimum numbers of smokers 26(31.7%) had smoked 10-20 pack years and finding was consistent with international finding. Tsai CL and C A Camargo, Jr[14] showed in their study in North America that COPD patients attending at emergency departments, 13% were underweight, 37% normal weight, 27% overweight and 23% were obese whereas in our study we have found that 26.82% were underweight, 24.39% were normal weight, 30.48% overweight, and 18.29% were obese. So this finding was nearly consistent with international finding. But here limitation is that we have studied about stable COPD patients. A previous study of stable COPD reported that 10% of the patients were underweight 104 an estimate that is nearly three times less than to ours (26.82%). It may reflect poor nutritional status of our population as a whole or poor nutrional status of our COPD patients-demands further study about this matter. If one uses a general older population as a comparator (55 years and older), the prevalence of underweight is extremely low in this healthier population—approximately 1%. 105 This suggests that low BMI may be the result of wasting in chronic diseases, such as COPD[15]. KARADAG F et al[16] showed in their study in Turkey that 45% of the COPD patients had severe (FEV 1 < 50%) and 55% had mild–moderate (FEV 1 ≥ 50%) airway obstruction. Mean BMI was 24.82 ± 3.46 in the study population. BMI was lower in COPD patients with severe airways obstruction.The result of our study showed that BMI positively. Related to FEV1/FVC and FEV1% predicted, which was in line with previous studies[17]. Other factors such as cigarette smoking, gender and age might affect pulmonary function. Research showed that patients with COPD are more likely to be underweight[18]. Loss of body weight in COPD is of multifactorial origins. First, substantial proportion of patients with moderate to severe COPD exhibit an elevated resting metabolic rate[19]. Second, systemic inflammation can induce excessive apoptosis of skeletal muscle[20]. Third, the presence of hypoxia and the more frequent use of systemic corticosteroids can cause skeletal muscle diminishing[21]. Vandenbergh et al[22] had already highlighted a relation between weight loss and mortality in patients with end stage COPD. The effect of BMI on pulmonary function is mediated in part by its effect on respiratory muscles. Arora and Rochester[23] showed that nutritional depletion reduced respiratory muscle strength in patients without lung disease, and can also cause respiratory muscle wasting, as demonstrated by diaphragm weight in emphysematous patients being lower than expected for body weight[24].

In summary, we have found that BMI is positively related to spirometric measurements of COPD patients.

Conclusion:

Because of the emerging role of BMI in COPD patients, we should be alert on the evaluation of all patients with stable COPD as part of the multidimensional assessment for staging COPD. This study underlines the importance of examining nutritional status and monitoring weight changes in patients with severe COPD. As COPD is a disease that is not possible to cure, it is important to try to treat the factors that can improve any aspect of life for COPD patients.

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