ORIGINAL RESEARCH PAPER

Pulmonary Medicine

EVALUATION OF PULMONARY FUNCTION TEST IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS

KEY WORDS: Chronic obstructive pulmonary disease, Spirometric staging, GOLD Staging, 6 minute walk

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ABSTRACT

Chronic obstructive pulmonary disease (COPD) is a progressive inflammatory disease that affects the airways, alveoli, and pulmonary vasculature, leading to irreversible airflow limitation and loss of elastic recoil. This disease is highly prevalent in clinical practice, affecting approximately 10% of adults over 40 years of age, and it is expected to become the third leading cause of death by 2030. The study was conducted on 54 COPD patients diagnosed based on GOLD guidelines. The study observed a statistically significant association between Spirometric staging and the duration of symptoms. The mean value of FEV1/FVC, FEV1 in %, and 6MWD in meters decreased significantly as the grade of GOLD stage increased from stage II to stage III and stage IV. The study showed that COPD is associated with various co-morbidities, including hypertension, diabetes mellitus, hypothyroidism, and coronary artery disease. The study concludes that FEV1, BMI, MMRC grading, and the 6-minute walk test are significant predictors of morbidity among COPD patients. The study recommends early detection and management of COPD to prevent its progression and associated morbidity.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a progressive inflammatory disease that affects the airways, alveoli, and pulmonary vasculature, leading to irreversible airflow limitation and loss of elastic recoil. The disease causes a gradual decline in the expiratory flow, leading to increased end-expiratory volume and dynamic hyperinflation, making it challenging to manage due to its highly heterogeneous nature in clinical features and underlying pathophysiological mechanisms.

Global prevalence estimates suggest that approximately 10% of adults over 40 years of age suffer from this disease, with almost 2.9 million global deaths in 2010 alone. COPD is a highly prevalent disease in clinical practice, currently affecting around three million subjects worldwide. Research indicates that it will become the third leading cause of death by 2030, with an evident impact on healthcare public expenditure.[1] Different smoking habits, air pollution, and occupational exposure are some of the factors that contribute to the disease's high prevalence. However, COPD is a heterogeneous disease, and pulmonary function tests alone cannot explain the disease heterogeneity.

In order to assess the core functioning of the lungs, Pulmonary Function Test (PFT) is essential, particularly for patients complaining of shortness of breath. It can be useful to recognize early-stage abnormalities in asymptomatic adult smokers since the clinical features of COPD are frequently present later in the course of the disease. However, at present, PFTs are only suggested for patients with positive pulmonary symptoms. Spirometry, a measurement of the volume of air inhaled and exhaled regarding function over time, is an effective method of determining the severity of COPD. Thus, it can confirm the presence of COPD even in the mild or moderate stages. Low body mass index (BMI) has been shown to be an independent marker of poor prognosis.

COPD is a highly prevalent and progressive disease that poses significant challenges in its diagnosis and management. Therefore, we aimed to investigate the relationship between various measures of COPD severity, including FEV1, BMI, MMRC grading, and the 6-minute walk test as predictors of morbidity among COPD patients.

METHODS

This study was conducted on 54 patients with chronic cough and shortness of breath who attended the Pulmonary Medicine OPD or were admitted to the Pulmonary Medicine ward at HIMS Varanasi during the period of September 2021 to November 2022. The study included subjects over 18 years of age who were diagnosed with COPD based on the GOLD guidelines and who provided consent. The exclusion criteria included subjects with active pulmonary Koch's or known lung cancer, those who cannot follow PFT instructions or have conditions that interfere with PFT procedures, and patients with active arthritis or any lower limb pathology affecting the walking speed and distance.

The study involved obtaining ethical clearance and conducting a clinical examination on subjects who met specific criteria. The subjects' BMI was noted, and plain chest X-ray PA view and Pulmonary Function (Spirometry) were assessed. The Spiro Excel was used to perform the PFT, and a reversibility test was done before and 15 minutes after administering a bronchodilator (400 micrograms salbutamol by meter dose inhaler) to assess FEV1. Additionally, a six-minute walk test was performed according to the ATS guidelines. The data was analyzed using SPSS version 23 for Windows. For means, either the student "t" test or ANOVA test was used depending on suitability. The level of significance was set at $p<0.05$.

RESULTS

Male patients (61.1%) were more common than females (38.9%). (Figure 1) The majority of patients were aged between 61-70 years (50%), and the mean age was 66.44±9.44 years. Hypertension was most common in 15 patients followed by 6 (23.1%) patients with Diabetes Mellitus, 4 (15.4%) patients had DM or HTN and 1 (3.8%) patient had hypothyroid or CAD.

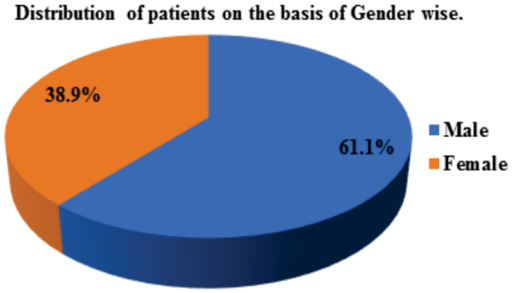

Figure 1: Distribution of studied patients based on gender-wise

The study observed a statistically significant association between Spirometric staging and the duration of symptoms. (Table 1)

Table 1: Distribution of studied patients based on Spirometric Staging and Duration of symptoms

Spirometric Stagin	Duration of Symptoms (years)					
	<1	1-5	6-10	11-15	16-20	>25
I	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	1 (25.0%)	0 (0.0%)
II	1 (50.0%)	8 (40.0%)	8 (53.3%)	2 (22.2%)	0 (0.0%)	1 (25.0%)
III	1 (50.0%)	8 (40.0%)	6 (40.0%)	4 (44.4%)	1 (25.0%)	1 (25.0%)
IV	0 (0.0%)	3 (15.0%)	1 (6.7%)	3 (33.3%)	2 (50.0%)	2 (50.0%)

Chi-Square test (p=0.100)

The mean value of FEV1/FVC, FEV1 in %, and 6MWD in meters decreased significantly as the grade of gold stage increased from stage II to stage III and stage IV. The underweight patients had a lower mean of FEV1/FVC, FEV1 in %, and 6MWD in meters than the normal-weight patients, but the difference was not statistically significant. (Table 2)

Table no. 2: Association of Gold stage and BMI with PFT tests and 6MWD test findings

Variables		FEV1/FVC	FEV1 IN %	6MWD in meters	Bode Index
Gold Stage	II	61.46±5.17	57.97±5.89	314.25±72.39	3.86±1.35
	III	41.32±10.32	37.53±6.10	281.85±64.35	5.87±1.33
	IV	26.56±5.91	24.57±4.11	236.62±59.90	7.75±1.34
p-value		<0.001	<0.001	0.007	<0.001
BMI (kg/m2)	Underweight (≤18.0)	46.91±12.06	36.41±13.28	259.00±67.46	6.61±1.61
	Normal weight (>18.0)	48.24±12.50	40.28±13.94	285.78±71.17	5.56±2.05
p-value		0.712	0.332	0.191	0.062

There was no significant correlation between MMRC grading and Spirometric staging of COPD. However, the table suggests that patients with higher MMRC grading (3 or 4) tended to be in more advanced stages of COPD (stage III or IV). (Table 3)

Table no. 3: Association between MMRC grading and Spirometric staging of COPD

		Gold Staging			P value
		II (n=14)	III (n=24)	IV (n=16)	
MMRC Grading	1	1 (7.1%)	1 (4.2%)	0 (0.0%)	0.203
	2	6 (42.9%)	10 (41.7%)	4 (25.0%)	
	3	6 (42.9%)	10 (41.7%)	5 (31.3%)	
	4	1 (7.1%)	3 (12.5%)	7 (43.8%)	

There were strong negative correlations between Gold Stage and FEV1/FVC, FEV1, MWD6, and BODE Index, indicating that as COPD severity increases, these measurements decrease. Additionally, there were moderate positive correlations between FEV1/FVC and FEV1, and a moderate negative correlation between FEV1/FVC and BODE Index. The study also found a strong positive correlation between Gold Stage and BODE Index, indicating that as COPD severity increases, the BODE Index also increases. (Table 4)

Table 4: Correlation between BMI, COPD staging and other COPD severity by measurements

		BMI	Gold Stage	FEV1/FVC	FEV1	MWD6	Bode Index
BMI	Pearson Correlation	1	-0.058	0.113	0.154	0.076	-0.284*
	Sig. (2-tailed)		0.678	0.416	0.267	0.585	0.038
Gold Stage	Pearson Correlation	-0.058	1	-0.760**	-0.908**	-0.416**	0.744**
	Sig. (2-tailed)	0.678		<0.001	<0.001	0.002	<0.001
FEV1/FVC	Pearson Correlation	0.113	-0.760**	1	0.816**	0.343*	-0.653**
	Sig. (2-tailed)	0.416	<0.001		<0.001	0.011	<0.001
FEV1	Pearson Correlation	0.154	-0.908**	0.816**	1	0.359**	-0.784**
	Sig. (2-tailed)	0.267	<0.001	<0.001		0.008	<0.001
MWD6	Pearson Correlation	0.076	-0.416**	0.343*	0.359**	1	-0.658**
	Sig. (2-tailed)	0.585	0.002	0.011	0.008		<0.001
BODE Index	Pearson Correlation	-0.284*	0.744**	-0.653**	-0.784**	-0.658**	1
	Sig. (2-tailed)	0.038	<0.001	<0.001	<0.001	<0.001	

DISCUSSION

In the present study, the majority of the studied cases were in the age group between 60 to 70 years (50.0%) accounting for half of the studied populations followed by over 70 years patients (27.8%) and between 42 to 60 years (22.2%) with mean age 66.44±9.44 (range: 42- 90 years). These findings were comparable to the studies done by Nojomi M et al, Nakken N et al, Parveen S et al which implies that the majority of patients suffer from Chronic obstructive pulmonary disease in 6th and 7th decade of their lives.

In the present study, the majority of patients were males (61.1%) followed by females (38.9%) and this result was comparable to several studies like Nojomi M et al[12] and Parveen S et al[14], who also found the prevalence of male was greater than females in COPD disease. Hypertension was the major comorbidity (57.7%) followed by diabetes mellitus (23.1%) in the present study; Agmy G et al reported that diabetes mellitus was in 38.0% of cases whereas hypertension was in 28.0% of cases.

In the present study, the mean FEV1/FVC, FEV1 IN % and 6MWD in meters were higher in the Gold Staging II category and it decreases significantly as the gold staging increased toward stage IV ($p<0.05$). Our findings were supported by Koo HJ et al who reported that FVC%, FEV1 and FEV1/FVC decrease significantly with increasing severity of COPD ($p<0.05$).

In the present study, we observed an insignificant association of underweight and normal-weight cases with gold staging or COPD severity ($p>0.05$). The mean of COPD Severity (FEV1/FVC, FEV1 IN % and 6MWD in meters) were higher in the Normal weight category than in the underweight but the difference was found statistically insignificant ($p>0.05$). COPD Severity of BODE Index was higher in Underweight category than normal category but the difference was insignificant ($p>0.05$). Kang HS et al reported that the bronchial subtype was associated with higher body mass index (BMI), better lung function and higher lung density.

Participants with trace emphysema showed a rapid increase in functional small airway disease. Sun Y et alreported that the estimated rate of FEV1 decline decreased with increasing BMI. In our study, the association between MMRC grading and spirometric staging of COPD was found to be statistically non-significant ($p>0.05$). According to Moya-Álvarez V et al taking as reference a score ≥10 in the CAT questionnaire, the variation of the degree of concordance was analyzed when modifying the cut-off point of Dyspnea according to the mMRC scale.

Our sample size was relatively small. In our opinion, more studies are needed to understand the difference between flow and volume responders in all phenotypes of COPD.

CONCLUSION

The study found an insignificant association between MMRC grading and spirometric staging of COPD. Overall, the study provides useful insights into the clinical features and underlying pathophysiological mechanism of COPD, which can help clinicians in the management of the disease

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