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ORIGINAL RESEARCH

An evaluation of FEV1, 6 Minute Walk Test and BMI as predictors of morbidity among cases of COPD Admitted in F.H. Medical College & Hospital Agra

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ABSTRACT

Introduction: Body mass index has an interesting relationship with COPD prevalence and severity. It also influences the lung function and exercise ability independently. Both COPD as well as Body mass index are independent predictors of morbidity.

Objectives: To evaluate the usefulness of FEV1, 6-minute walk test and BMI as predictors of morbidity among cases of COPD

Methods: A total of 100 COPD patients were enrolled (mean age 56.47 years; 74% males; mean BMI 20.86±5 kg/m²) and underwent BMI assessment, pulmonary function tests and 6minute walk tests. Assessment of severity of COPD was done using GOLD criteria. Number of exacerbations and hospitalizations during last one year were enquired. Correlation of 6minute walk test, BMI, FEV1, severity of COPD and its morbidity (in terms of exacerbation and hospitalization events) was done.

Results: As per BMI, Maximum (40%) patients had normal weight followed by underweight (39%), overweight (18%) and obese (3%). Mean post- bronchodilator FEV1(% of predicted values) was 46.44±19.24% respectively. Maximum (n=36) cases were GOLD Grade D followed by Grade B (28%), Grade C (24%) and Grade A (12%). Mean actual distance covered was 286.34±85.69 meters (57.56±16.18% of the predicted value). With increasing severity grades of COPD there was a significant decline in mean BMI, post- bronchodilator FEV1 (% of predicted values) and distance covered on 6minute walk test. Underweight and obese patients as compared to normal and overweight BMI patients had significantly lower post-FEV1 values, shorter distance coverage on 6minute walk test and higher number of exacerbations and hospitalizations. 6minute walk test, FEV1 and BMI showed a significant mutual correlation as well as a correlation with COPD GOLD grade, number of exacerbations and number of hospitalizations

Conclusion: BMI in normal and overweight range had a protective effect against COPD severity, better pulmonary functions (FEV1), exercise capacity and fewer exacerbation and hospitalization events.

Keywords: COPD, Body mass index, FEV1, 6m walk test, Exacerbations, Hospitalization.

Introduction

Chronic obstructive pulmonary disease (COPD) is a common chronic respiratory condition which results in gradual deterioration and worsening of symptoms.[1] It is characterized by progressive airflow limitation and tissue destruction and is associated with structural lung changes due to chronic inflammation from exposure to harmful substances (noxious particles, gases or cigarette smoke)[1]. COPD is a preventable as well as treatable chronic lung disease.[2,3] As per 2023 GOLD guidelines, COPD is defined as "a heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, cough, sputum production, exacerbations) due to abnormalities of the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema) that cause persistent, often progressive, airway obstruction. In contemporary studies, smoking is considered to be major contributor to COPD, numerous studies suggested other important factors to be strongly associated with COPD.[4]

Spirometry is a procedure that requires skilled manpower as well as infrastructural facilities. It is an

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expensive procedure and is not available in low resource primary care settings, especially in rural India, owing to which a lot of COPD patients remain undiagnosed. Six-minutes' walk test (6mWT) is a simple and economical cardiopulmonary functional testing modality and has got a high utility in assessing the outcome of pulmonary rehabilitation programmes in COPD patients.[5,6] Hence, the present study was proposed to evaluate the usefulness of FEV1, 6-minute walk test and BMI as predictors of morbidity among cases of COPD at a tertiary care teaching hospital in Western Uttar Pradesh.

Materials & Methods

The study was carried out at Department of Pulmonary Medicine, F.H. Medical College and Hospital (FHMCH), Etmadpur, Agra. It comprised of Chronic Obstructive Pulmonary Disease (COPD) patients admitted to inpatient or visiting outpatient Department of Pulmonary Medicine, FHMCH, Agra. All gave their written consent to participate in the study.

Data such as name, age, gender etc. was recorded. Details regarding risk exposure (smoking, occupational exposure, biomass fuel exposure) were also noted. The patients were also enquired regarding number of exacerbations during the last one year and number of hospitalizations. Subsequently, weight of the patients was taken and height was measured. Body mass index was calculated using the formula: BMI = weight (in kg)/height (in m²). Spirometry was performed in these patients before and after giving a short-acting bronchodilator (200–400 µg of salbutamol) and spirometry parameters such as pre-FVC, pre-FEV1, pre-FEV1/FVC ratio, post-FVC, post- FEV1, post-FEV1/FVC ratio were noted. COPD Assessment Test (CAT) questionnaire Hindi version was administered to all the patients. Following spirometry and CAT questionnaire administration, the patients were asked to participate in a 6m walk test. Oxygen saturation and vital parameters (blood pressure – SBP/DBP and heart rate) were measured both before and after the test. Physical exertion before and after the test was also measured using Borg Scale. Before the test, the patients were asked to take 10 minutes rest during which monitoring of oxygen saturation, blood pressure and dyspnea (Borg scale) was done. Data was analysed using Statistical Package for Social Sciences (IBM Inc., Version 25.0). Results thus obtained were subjected to statistical analysis. P value < 0.05 was considered significant.

Results

Table: I Demographic Profile of the patients enrolled in the study

Characteristics	Number of patients	Percentage%
Age	56.99±10.00 (35-75)	
Sex		
Male	74	74
Female	26	26
Place of residence		
Rural	85	85
Urban	15	15
Occupation		
Farmer	60	60
Housewife	22	22
Bangle factory worker	7	7
Construction worker	6	6
Driver	2	2
Private service/shopkeeper	3	3

Age of patients ranged from 35 to 75 years. Mean age of patients was 56.99±10.00 years. Most of the cases (85%) were rural residents. There were only 15% urban residents. Farmers (60%) comprised the most common occupational group followed by housewives (22%), bangle factory workers (7%), construction workers (6%), private service/ shopkeepers (3%) and drivers (2%) respectively.

Table II Distribution of cases according to Body Mass Index

SN	Body Mass Index Category	BMI Range (kg/m^2)	Number of patients	Percentage
1.	Underweight	<18.5	39	39
2.	Normal weight	18.5-24.9	40	40
3.	Overweight	25.0-29.9	18	18
4.	Obese	≥30	3	3
Mean BMI±SD (Range) kg/m²			20.86±5.00 (13.3-37.5)	

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Body mass index ranged from 13.3 to 37.5 kg/m^2. Maximum (40%) patients were in normal weight category followed by underweight (39%), overweight (18%) and obese (3%). Mean BMI of cases was 20.86±5.00 kg/m.^{2}

Table : III Distribution of Cases according to GOLD severity grades

Grade	No. of cases	Percentage%
A (mild)	12	12.0
B (moderate)	28	28.0
C (severe)	24	24.0
D (very severe)	36	36.0

Maximum (n=36) cases were GOLD Grade D followed by Grade B (28%), Grade C (24%) and Grade A (12%) respectively.

Table: IV 6 minutes walk test and related outcomes

Outcome	Mean	±SD
Distance covered		
Predicted (m)	496.53	39.49
Actual (m)	286.34	85.69
% of Predicted value	57.56	16.18
Borg's Score		
Before test	3.76	1.65
After test	5.81	1.92
Change	2.05	0.88
Pulse rate (bpm)		
Before test	85.48	6.55
After test	104.01	8.25
Change	18.53	7.77
Systolic Blood Pressure (mmHg)		
Before test	110.13	10.36
After test	120.75	9.09
Change	10.62	4.41
Diastolic Blood Pressure (mmHg)		
Before test	72.98	8.78
After test	85.48	6.55
Change	8.14	4.41
% Oxygen saturation (SpO2)		
Before test	95.93	1.79
After test	92.36	2.05
Change	-3.57	1.77

Mean predicted distance was 496.53±39.49 meters whereas mean actual distance covered was 286.34±85.69 meters which was only 57.56±16.18% of the predicted value. Mean Borg's score before test was 3.76±1.65 which became 5.81±1.92 after the test, thus showing an increase of 2.05±0.88. Mean pulse rate, systolic blood pressure, diastolic blood pressure and oxygen saturation values were 85.48±6.55 bpm, 110.13±10.36 mmHg, 72.98±8.78 mmHg and 95.93±1.79% respectively at rest whereas after 6m walk test these values were 104.01±8.25 bpm, 120.75±9.09 mmHg, 85.48±6.55 mmHg and 92.36±2.05% respectively, thus showing a change of 18.53±7.77 bpm, 10.62±4.41 mmHg, 8.14±4.14 mmHg and -3.57±1.77% respectively.

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Table: V Association of GOLD Grade with FEV1, BMI and 6m walk test

SN	Parameter	GOLD A (n=12) (Mild)		GOLD B (n=28) (Moderate)		GOLD C (n=24) (Severe)		GOLD D (n=38) (V. Severe)		Statistical significance (ANOVA)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	'F'	'p'
1.	BMI (kg/m²)	23.26	5.04	23.20	4.50	19.71	5.16	18.99	4.35	5.790	<0.001
2.	Post FEV1 (L)	2.23	0.21	1.41	0.37	1.17	0.31	0.83	0.30	62.14	<0.001
3.	% Predicted Post FEV1	81.21	4.11	56.24	12.24	42.58	8.19	29.79	9.80	96.44	<0.001
4.	Distance covered (m)	394.8	26.8	368.0	62.8	251.8	28.6	209.7	27.1	114.51	<0.001
5.	% of predicted distance	80.59	7.65	72.54	9.33	51.38	4.66	42.36	3.88	174.13	<0.001
6.	At rest Borg's score	2.00	0.95	2.71	1.41	3.79	1.41	5.14	0.83	32.55	<0.001
7.	Post-test Borg's score	4.25	1.22	4.75	1.58	5.58	1.95	7.31	1.19	20.624	<0.001
8.	Change in Borg's score	2.25	0.87	2.04	0.92	1.79	0.88	2.17	0.85	1.112	0.348
9.	At rest PR (bpm)	84.00	6.41	86.00	6.34	87.29	5.90	84.36	7.08	1.232	0.302
10.	Post test PR (bpm)	101.3	8.8	103.2	7.1	106.8	7.9	103.7	9.0	1.520	0.214
11.	Change in Pulse rate (bpm)	17.25	7.84	17.18	7.27	19.54	6.85	19.33	8.75	0.647	0.587
12.	At rest SBP (mmHg)	109.08	8.10	110.86	10.32	108.04	10.80	111.31	10.90	0.559	0.643
13.	Post test SBP(mmHg)	119.42	5.65	120.86	9.55	118.92	8.69	122.33	9.90	0.772	0.512
14.	Change in SBP(mmHg)	10.33	4.64	10.00	4.75	10.88	3.67	11.03	4.63	0.324	0.808
15.	At rest DBP(mmHg)	71.50	9.75	71.21	7.49	70.92	8.12	76.22	9.20	2.702	0.050
16.	Post-test DBP(mmHg)	83.00	7.83	80.64	6.17	80.04	6.58	81.58	10.10	0.431	0.731
17.	Change in DBP(mmHg)	11.50	5.42	9.43	6.05	9.13	7.04	5.36	8.26	3.195	0.027
18.	At-rest SpO2 (%)	96.00	2.34	96.54	1.53	96.21	1.82	95.25	1.61	3.196	0.027
19.	Post-test SpO2 (%)	92.92	2.61	93.14	1.92	92.17	2.12	91.69	1.69	3.199	0.027
20.	Change in SpO2 (%)	-3.08	1.93	-3.39	1.50	-4.04	1.90	-3.56	1.83	0.963	0.413

With increasing severity of COPD grade A-D, there was a significant decline in mean BMI, post FEV1 (L), % predicted Post FEV1, 6 m walk test distance covered and % of predicted distance covered ($p<0.001$). At-rest as well as post-test Borg's scores showed an incremental trend with increasing severity of COPD ($p<0.001$), however, change in Borg's score after the test did not show any significant association with severity of COPD ($p=0.348$). No significant difference in pulse rate and systolic blood pressure at rest, after the

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test and change in pulse rate and systolic blood pressure after the test was seen among different severity of COPD (p>0.05). Mean diastolic blood pressure at rest and change in DBP showed a significant difference among different severity of COPD, however, post-test values did not show a significant difference among groups (p>0.05). Mean at rest and post-test SpO2 values showed a significant declining trend with increasing severity of COPD (p=0.027), however, no significant difference in mean change in SpO2 was seen among different severity of COPD (p=0.413).

Discussion

Chronic Obstructive Pulmonary Disease (COPD) represents a significant and escalating public health challenge globally, marked by persistent respiratory symptoms and airflow limitation. COPD primarily encompasses emphysema and chronic bronchitis, conditions that culminate in a progressive decline in pulmonary function. This deterioration is typically evaluated through spirometric measurements, with Forced Expiratory Volume in one second (FEV1) being paramount. FEV1, defined as the volume of air exhaled in the first second of a forceful breath out after full inhalation, serves as a critical indicator of lung function in COPD.[7] It quantifies the extent of obstruction within the airways, and its reduction correlates with disease severity. Clinical guidelines categorize COPD into stages based on FEV1 percentages of predicted values: mild (FEV1 ≥ 80%), moderate (50% ≤ FEV1 < 80%), severe (30% ≤ FEV1 < 50%), and very severe (FEV1 < 30%)[2]. Importantly, FEV1 is a robust predictor of morbidity and mortality in COPD patients, where lower FEV1 values are associated with increased risk of exacerbations, hospitalizations, and mortality.[8] The present study evaluated the usefulness of FEV1, 6-minute walk test and BMI as predictors of morbidity among cases of COPD at a tertiary care teaching hospital in Western Uttar Pradesh.

We found that age of patients ranged from 35 to 75 years. Mean age of patients was 56.99±10.00 years. Most of the cases (85%) were rural residents. There were only 15% urban residents. Farmers (60%) comprised the most common occupational group followed by housewives (22%), bangle factory workers (7%), construction workers (6%), private service/ shopkeepers (3%) and drivers (2%) respectively. We observed that body mass index ranged from 13.3 to 37.5 kg/m^2. Maximum (40%) patients were in normal weight category followed by underweight (39%), overweight (18%) and obese (3%). Mean BMI of cases was 20.86±5.00 kg/m.^{2} Maximum (n=36) cases were GOLD Grade D followed by Grade B (28%), Grade C (24%) and Grade A (12%) respectively. Tomohara- Ichishima et al[9] in their study analysed the data of 3471 hospitalized COPD patients to assess the relationship between BMI and activities of daily life (ADL). They used Barthel index to assess the ADL. The authors found a significant decline in Barthel index score in patients having BMI <18.5 kg/m2, however, they did not find a significant association of Barthel indices in higher BMI (obese) group. The authors also reported that lower-BMI was associated with a significantly longer duration of hospital stay and greater frequency of readmissions within 30 days. The findings of the study were suggestive of a positive impact of higher BMI on the ability to perform activities of daily life and reduction of hospital stay.

Mean predicted distance was 496.53±39.49 meters whereas mean actual distance covered was 286.34±85.69 meters which was only 57.56±16.18% of the predicted value. Mean Borg's score before test was 3.76±1.65 which became 5.81±1.92 after the test, thus showing an increase of 2.05±0.88. Mean pulse rate, systolic blood pressure, diastolic blood pressure and oxygen saturation values were 85.48±6.55 bpm, 110.13±10.36 mmHg, 72.98±8.78 mmHg and 95.93±1.79% respectively at rest whereas after 6m walk test these values were 104.01±8.25 bpm, 120.75±9.09 mmHg, 85.48±6.55 mmHg and 92.36±2.05% respectively, thus showing a change of 18.53±7.77 bpm, 10.62±4.41 mmHg, 8.14±4.14 mmHg and -3.57±1.77% respectively. Sangroula et al[10] registered a total of 145 COPD patients in their study (mean age 62.74±8.04 years; 55.9% males). Mean BMI of study population was 20.42±3.50 kg/m2. According to GOLD criteria, maximum (n=47; 32.4%) were grade 3 followed by grade 2 (n=44; 30.4%), grade 4 (n=34; 23.5%) and grade 1 (n=20; 13.8%) respectively. Mean BMI of patients in Grades 1, 2, 3, and 4 was 24.50±3.82, 21.69±2.84, 19.33±2.76 and 17.90±1.86 kg/m2 respectively, thus showing a significant declining trend with increasing severity grade of disease. The authors also found that mean oxygen saturation levels in Grades 1, 2, 3, and 4 were 95.85±1.18, 92.32±1.84, 88.17±1.48 and 84.50±1.66% respectively, which also showed a significant declining trend with increasing grade of disease. These findings in turn showed that declining BMI is associated with increasing severity of COPD and correspondingly a declining oxygen saturation level.

We found that with increasing severity of COPD grade A-D, there was a significant decline in mean BMI, post FEV1 (L), % predicted Post FEV1, 6 m walk test distance covered and % of predicted distance covered (p<0.001). At-rest as well as post-test Borg's scores showed an incremental trend with increasing severity of COPD (p<0.001), however, change in Borg's score after the test did not show any significant association with severity of COPD (p=0.348). No significant difference in pulse rate and systolic blood pressure at rest, after the test and change in pulse rate and systolic blood pressure after the test was seen among different severity of COPD (p>0.05). Mean

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diastolic blood pressure at rest and change in DBP showed a significant difference among different severity of COPD, however, post-test values did not show a significant difference among groups ($p>0.05$). Mean at rest and post-test SpO_2 values showed a significant declining trend with increasing severity of COPD ($p=0.027$), however, no significant difference in mean change in SpO_2 was seen among different severity of COPD ($p=0.413$). Song *et al*[11] in their study included "a total of 910 COPD patients were included with 144 (15.8%) patients in low-BMI, 475 (52.2%) in normal- BMI, and 291 (32.0%) in high-BMI groups. Patients with low BMI had worse pulmonary function, higher symptom scores, and exacerbations in the past year compared with normal- and high-BMI groups ($p < 0.05$). Logistic regression analysis revealed that age, Global Initiative for Chronic Obstructive Lung Disease grades 3 and 4, and hospitalizations in the past year were independent risk factors for patients with low BMI ($p < 0.05$). After 1 year of follow-up, patients with low BMI had higher mortality and number of hospitalizations. Patients with low BMI were more likely to attain clinically important deterioration and less likely to attain minimum clinically important difference compared with patients with high BMI.

Conclusion

BMI in normal and overweight range had a protective effect against COPD severity, better pulmonary functions (FEV1), exercise capacity and fewer exacerbation and hospitalization events.

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