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# A Prospective Study of Bode Index as a Predictor of Severity in Chronic Obstructive Pulmonary Disease

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**ABSTRACT**

In this study, we analyzed the BODE index as a predictor of hospitalization and severity in patients with COPD. A total of 100 patients who attended our outpatient were enrolled into the study. Of these, 60 patients of COPD were selected as cases. The patients with the following diagnostic criteria (according to the GOLD guidelines) were defined as having COPD. All the cases were males. Among patients with COPD, there were (35.56%) patients who had mild COPD with a BODE score between 0-2. Moderate (BODE score of 3-5) and severe COPD (BODE score >or equal to 6) groups had patients (32.22%) each. The average age of participants in the study was 55.71 years. Among the COPD patients, BODE index was found to increase with age with the mild group having a mean age of 53.47 years, moderate group 55.00 years and the severe group. The study revealed that the BODE score was significantly associated with the number of pack years of smoking., 7.42 pack yrs in mild cases, 15.07 in moderate and 26.90 in severe cases. On multiple comparison by LSD the difference between control group and mild group was not statistically significant but that of the other 2 groups were highly significant. The study results showed that a higher BODE score was associated with a higher incidence of hospital stay due to reasons related to COPD, over the past 2 years. The control group and the mild COPD group did not have any significant hospital admission during the past 2 years. The average duration of stay in the moderate study group was 3.17 days while it was 16 days in the group with severe COPD according to the BODE score. Both these values were found to be significant on multiple comparisons to other groups.

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**Key Words**

Chronic obstructive pulmonary disease, forced expiratory volume in one second body mass index (B), airflow obstruction (O), dyspnea (D) and exercise capacity (E), global initiative for obstructive lung disease

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## INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a major cause of morbidity and mortality throughout the world. The prevalence and burden of COPD are projected to increase in the coming decades due to continued exposure to COPD risk factors and the changing age structure of the world's population. It is projected to rank fifth in 2020 in burden of disease caused worldwide, according to a study published by the World Bank/World Health Organization[1]. The disease causes a heavy burden on the global health care resources. The costs involved in the treatment and evaluation is directly proportional to the pulmonary and the extra pulmonary components of the disease[2]. 'Chronic obstructive pulmonary disease (COPD, a common preventable and treatable disease, is characterized by persistent airflow limitation is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases. Exacerbations and comorbidities contribute to the overall severity in individual patients[3]. NEW GOLD defines Chronic Obstructive Pulmonary Disease (COPD) is a common, preventable and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities Usually caused by significant exposure to noxious particles or gases. BODE is a multi dimensional grading system that assessed the respiratory and systemic expressions of COPD was designed to predict outcome in these patients[4]. The four factors that predicted the severity most were the body-mass index (B), the degree of airflow obstruction (O) and dyspnea (D) and exercise capacity (E), measured by the six-minute-walk test. These variables were used to construct the BODE index, a multidimensional 10-point scale in which higher scores indicate a higher risk of death. The process of allocating limited medical resources to the most needed patients can be extremely difficult in diseases which affect a large number of patients. Decision makers need a rational and consistent scoring system that is designed to identify those who are maximally in need of a diagnostic or a therapeutic intervention under a healthcare budget constraint. BODE index has been proposed to serve this purpose in patients with chronic obstructive pulmonary disease (COPD)[5]. In this study, we analyzed the BODE index as a predictor of hospitalization and severity in patients with COPD.

**Aims and Objectives:**

- To determine whether higher BODE index in Chronic Obstructive Pulmonary Disease correlates with more years of cigarette smoking.
- To determine whether higher BODE index is associated with more days of hospitalization.

**Patients and Methods**:

**Period of Study:** 18months.

**Sample Size:** COPD cases 60.

**Inclusion Criteria:**

- Males.
- COPD patients according to GOLD guidelines.

**Exclusion Criteria:**

- Females were excluded.
- Who did not give consent for study.
- Spirometry proved bronchial asthma defined as an increase in the FEV1 of >15 percent above the baseline value or of 200ml after the administration of a bronchodilators.
- Recent myocardial infarction <4 months.
- Unstable angina.
- Congestive heart failure (NYHA class III or IV).
- Inability to perform spirometry or 6 minute walk test.
- Unrelated life threatening major illness.
- Liver disease.
- Patients with acute exacerbation.

## MATERIALS AND METHODS

A total of 100 patients who attended our outpatient were enrolled into the study. Of these, 60 patients of COPD were selected as cases. The patients with the following diagnostic criteria (according to the GOLD guidelines) were defined as having COPD:

- The presence of cough and sputum production for at least 3 months in each of the two consecutive years.
- Exertionaldyspnoea.

- **Physical Examination Showing:**
- Signs of airflow limitation like prolonged expiration and expiratory wheeze which is not fully reversible.
- Signs of hyperinflation and Spirometry showing post bronchodilator FEV1/FVC ratio <0.70.

The present analysis was restricted to male patients only, who met the acceptability and reliability criteria of the American Thoracic Society to improve the diagnostic accuracy as sex may be a confounding factor in many of the parameters assessed. For each enrolled subject, detailed history of smoking, personal and family medical histories were obtained. On the day of enrollment, height and weight were measured twice during the examination. Weight was measured to the nearest 100 grams with bare foot. Height was measured to the nearest mm with the stadometer. Body mass index (BMI) was calculated by the formula. BMI=Weight in Kgs / (Height in Ms)2.

Spirometry was performed with an equipment that met the American Thoracic society performance criteria, in each of the cases on enrollment into the study and 20 minutes following the administration of salbutamol nebulisation. To adjust for the height, sex, age and sex published prediction equations for forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC) were used. FEV1 and FVC were calculated. The procedure was repeated on 2 occasions and the average value was taken. A detailed history of the dyspnea experienced by the patient was taken. MMRC dyspnea scale was used to score the patients dyspnea. Six minute walk test was performed twice with a gap of 30 minutes rest in between and the average was taken. Patients were asked to walk on a level ground for maximum possible distance within duration of 6 minutes. Periods of rest taken, was also included in the 6 minutes test period. The BODE index was calculated for each patient using the body mass index, the threshold value of FEV1, the distance walked in 6 min and the score on the Modified Medical Research Council (MMRC) dyspnea scale. The patients received points ranging from 0 (lowest value) to 3 (maximal value). For body mass index the values were 0 (>21) or 1 (<21). The scores for FEV1 were 0 (more than or equal to 65%), 1 (50-64%), 2 (36-49%) and 3 (less than or equal to 35%). The 6 minute walk test scores were 0 (>350 ms), 1 (250-350 ms), 2 (150-249 ms) and 3 (<150 ms). The MMRC dyspnea class 0 and I were given 0 points, class II-1 point, class III-2 points and class IV-3 points. The points for each variable were added, so that the BODE index ranged from 0-10 points in each patient. The BODE score of 0-2 was taken as mild COPD. Scores between 3-5 was considered as moderate disease and those >or equal to 6 was considered as severe COPD.

**MMRC Dyspnea Scale**

- **Grade 0:** Only get breathless with strenuous exercise.
- **Grade 1:** Dyspnea on hurrying/walking up a hill.
- **Grade 2:** Walks slower than people of same age on the level because of breathlessness or/pause while walking on own pace on level ground.
- **Grade 3:** Stops for breath after walking 100 yards/few mins on level ground.
- **Grade 4:** Too breathless to leave the house/dyspnea on dressing.

A detailed history regarding number of days of hospital admission in the last two years was obtained from the patients response to the question “how many days have you been admitted in hospital in the past 2 years due to reasons related to COPD?” Patient’s discharge cards were also reviewed.

## RESULTS AND DISCUSSIONS

A total 60 patients with COPD including as cases were enrolled in the study. All the cases were males. Among patients with COPD, there were (35.56%) patients who had mild COPD with a BODE score between 0-2. Moderate (BODE score of 3-5) and severe COPD (BODE score >or equal to 6) groups had patients (32.22%) each. The average age of participants in the study was 55.71 years. Among the COPD patients, BODE index was found to increase with age with the mild group having a mean age of 53.47 years, moderate group 55.00 years and the severe group with 59.93 years as the mean age. The difference was statistically significant with a p value of 0.005. The study revealed that the BODE score was significantly associated with the number of pack years of smoking., 7.42 pack yrs in mild cases, 15.07 in moderate and 26.90 in severe cases. On multiple comparison by LSD the difference between control group and mild group was not statistically significant but that of the other 2 groups were highly significant (p=0.000). The average BMI of the patients in this study was 22.21 kg/m2. The BMI was found to be significantly lower in patients with COPD. It was 22.476 kg/m2 (standard deviation-2.455) in the mild group, 21.711 (std. deviation-2.552) in the moderate group and 20.260 (std. deviation-3.212) in the severe group. On Multiple comparisons the significance between mild and moderate groups was not found to be significant . All other comparisons showed significant difference. The study results showed that a higher BODE score was associated with a higher incidence of hospital stay due to reasons related to COPD, over the past 2 years. The control group and the mild COPD group did not have any significant hospital admission during the past 2 years. The average duration of stay in the moderate study group was 3.17 days while it was 16 days in the group with severe COPD according to the BODE score. Both these values were found to be significant on multiple comparisons to other groups.

COPD is predicted to be one among the most common killer diseases affecting a large number of individuals by the year 2020. In the recent past, more stress has been given to formulate a simple but effective index for assessing the severity of COPD[6]. Researchers have found that BODE index would fulfill this necessity. But most of there search has been limited to finding the usefulness of the index in predicting the mortality and hospitalization in patients with COPD. In this study I tried to evaluate its usefulness in predicating the severity of COPD in terms of hospitalization[7]. This study has brought out many results which would have a significant impact in the management of COPD in the future. The main finding of this study is that the BODE

**Bode Index**

| **BODE score** | **0** | **1** | **2** | **3** |
|---|---|---|---|---|
| FEV1 | ≥65% | 50-64% | 36 – 49% | ≤35% |
| 6 min walk test | >350ms | 250-349 ms | 150-249 ms | <149 ms |
| Dyspnea scale | 0-1 | 2 | 3 | 4 |
| BMI | >21kg/m2 | >21kg/m2 | | |

- Mild COPD (0-2)
- Moderate COPD (3-5)
- Severe COPD (≥6)

**Table 1: Duration of Hospital Stay Over Last 2 Year (Days)**

| **GROUP** | **N** | **MEAN(yrs)** | **Std. deviation** | **One way ANOVA F-Test** | **Multiple Comparison (LSD)** |
|---|---|---|---|---|---|
| Mild(0-2) | 21 | 0.13 | 0.49 | | 2Vs 3,4 |
| | | | | F=75.34 | |
| Moderate(3-5) | 21 | 3.17 | 2.92 | | 3vs 1,2,4 |
| | | | | p=0.001 | |
| | | | | Significant | |
| Severe(≥6) | 18 | 16.01 | 9.17 | | 4Vs 1,2,3 |
| Total | 60 | 4.68 | 8.04 | | p = 0.05 |

**Table 2: Classification of Patients According to GOLD with the Bode Index in Each Stage (n=60)., the Bode Index is Given as Median and 1st to 3rd Quartiles[8]**

| **Severity of COPD according to GOLD** | **Patients, N (%)** | **BODE index** |
|---|---|---|
| Stage I: FEV1 ≥80% predicted) | 6% | (0 to 0) |
| Stage II : (50% ≤FEV1 <80% predicted) | 39% | (1 to 4) |
| Stage III: (30% ≤FEV1 <50% predicted) | 31% | (3 to 6) |
| Stage IV: (FEV1 ≤30% predicted) | 7% | (5 to 8) |

staging system, which includes in addition to FEV1 other physiologic and clinical variables, helps to better predict hospitalization in patients with COPD. COPD is a complex multidimensional disease, 65 and classification schemes that incorporate more parameters than the degree of airflow obstruction are likely to predict outcomes more accurately. FEV1 is known to correlate poorly with symptoms, quality of life, exacerbation frequency and exercise intolerance. Hence, newer approaches to disease assessment are required and may even supersede the current FEV1-based system of classification of disease severity. The multistage scoring system used in this study incorporates variables that can be easily evaluated in any office setting and the BODE index has potential widespread applicability, just like the FEV1. The average duration of stay in the moderate study group was 3.17 days while it was 16 days in the group with severe COPD according to the BODE score. Both these values were found to be significant on multiple comparisons to other groups. The risk of death in patients with COPD increases with the severity of disease, which is often graded with the use of a single physiological variable, the forced expiratory volume in one second (FEV1). However, other risk factors, such as the presence of hypoxemia or hypercapnia, a short distance walked in a fixed time, a high degree of functional breathlessness and a low body-mass index (the weight in kilograms divided by the square of the height in meters), are also associated with an increased risk of death. A multi- dimensional grading system that assessed the respiratory, perspective and systemic aspects of COPD is expected to better categorize the illness and predict the outcome than does the FEV1 alone. Only male patients were included in this study, since COPD is more common among male patients. This was aimed at making the study group as uniform as possible. Such a selection would negate the differences in the BODE index among various patients studied, by removing the gender related differences in FEV1, BMI and patient perception of dyspnea. Studies by Celli *et al* and Kian Chung *et al.* has proven that grouping COPD patients into three groups with BODE scores 0-2 as first group, 3-5 as second and 6 or more as the third group correlates well with severity in terms of hospitalization andmortality. Hence, this study has accepted the same classification and grouped the above groups as mild, moderate and severe COPD. In this study individuals were almost equally distributed in the various groups. Moderate and severe cases of COPD have increased risk of exacerbations, which leads to increased chances for hospitalization and ICU admissions., hence they have high risk of morbidity and mortality. However, results from a few other studies do not significant progression with age. This difference is mainly due to the fact that duration of smoking was not proportional to age in those groups unlike in this study. Our findings of the usefulness of the BODE index in predicting hospitalization for COPD are also supported by the findings of a prospective study[5] of risk factors of hospital read missions for COPD exacerbation. In that study, a strong association between usual physical activity and reduced risk of COPD readmission was demonstrated. Patients with COPD who reported an activity equivalent to walking 60 min/d had a reduction in risk of readmission to hospital of almost 50%[5]. Moreover, the association did not change when adjusted for FEV1 or nutritional status. BODE index is a very good predictor of hospitalization. In this study there is a positive correlation between higher BODE index and longer period of hospitalization. Similarly studies done by

Kian-chung clearly demonstrates that BODE scoring is superior in assessing risk of hospitalization compared to FEV1 alone. B R Celli *et al* show that six-minute walk test is an independent predictor of mortality and morbidity in COPD patients., it reflects the systemic effects of COPD. It is a good predictor of the risk of death among patients with other chronic diseases, including congestive heart failure and pulmonary hypertension. Indeed, the distance walked in six minutes has been accepted as a good outcome measure after interventions such as pulmonary rehabilitation. This study also elaborates that the distance walked by patients with higher BODE scores is less when compared to other groups. In this study FEV1 levels of BODE score in severe COPD group correlates well. But there is not much of significant difference between mild and moderate groups. Vestbo *et al.* found a mean decline in FEV1 of 33±2 ml per year in patients with COPD. The FEV1 is essential for the diagnosis and quantification of the respiratory impairment resulting from COPD. In addition, the rate of decline in FEV1 is a good marker of disease progression and mortality. However, the FEV1 does not adequately reflect all the systemic manifestations of the disease. BODE index is useful because it encompasses one domain that quantifies the degree of pulmonary impairment (FEV1), one that captures the patient's perception of symptoms (The MMRC dyspnea scale) and two independent domains (The distance walked in six minutes and the BMI). A multiple component staging system combining FEV1, 6-min walking distance, dyspnea scored with the MMRC scale and PaO2 was reported to better describe health career sources utilization among COPD patients in different geographic areas when compared to international COPD classifications (ATS, British Thoracic Society and GOLD). 72. The BODE index was also reported to be a much better predictor of these verity in COPD acute exacerbations than FEV1. This study has found the usefulness of the BODE index in predicting hospitalization for COPD are also supported by the findings of a prospective study of risk factors of hospital read missions for COPD exacerbation. In the study, a strong association between the usual physical activity and reduced risk of COPD readmission was demonstrated. Moreover, the association did not change when adjusted for FEV1 or nutritional status.

These results are in agreement with the increased risk of COPD hospital admission associated with a limited 6-min walking test reported by another group of investigators. Therefore, it may be speculated that the superior value of the BODE index compared to FEV1 in predicting hospital admissions for COPD that this study has observed, is accounted for by the evaluation of physical performance status among the individual components of the BODE scoring system. Admission to the hospital and heavy use of health-care resources is a common feature of COPD. A clinical implication of the present study is that the BODE scoring system may prove to be helpful in health-care resource allocation and in guiding therapy for individual patients in the future. This multistage scoring system, which incorporates variables that can be evaluated easily in any office setting, should not be difficult or costly to implement routinely. As the BODE index can provide useful prognostic information of survival and hospitalization, the findings of the present study are in support of the utility of the BODE index as an assessment tool for COPD patients. While considering BMI as a criteria for BODE index scoring, significance is only given to whether it is more, or <21. This study has found that the BMI progressively declines with severity among the patients with COPD. BODE index can be used as a reliable index to assess the severity of chronic obstructive pulmonary disease.

- BODE index is directly correlated with the duration and intensity of smoking.
- BODE index predicts hospitalization due to causes related to COPD.
- Thus this study concludes that BODE index is reliable method to predict hospitalization and the severity of systemic involvement in patients with COPD.
- Since the assessment of BODE index requires only a spirometer, which is relatively inexpensive and can easily be made available, this index could be of great practical value in a primary health care setup to identify individuals who are at need for further evaluation in a higher center.

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