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# Comparison between Spirometry and BODE Index for Clinical Assessment in Chronic Obstructive Pulmonary Disease Patients

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## ABSTRACT

Classification of severity of airflow limitation in Chronic Obstructive Pulmonary Disease (COPD) does not represent the clinical consequences of COPD. Hence, combined COPD assessment should be preferred. The BODE index has recently been proposed to provide useful prognostic information. The present study aimed to identify the best component in the assessment of severity in terms of BODE index and spirometry. A prospective comparative study was carried out with 70 COPD patients recruited over 10 months at the Pulmonary Medicine outpatient department of a tertiary care hospital in Tamilnadu, India. Patients were classified according to the GOLD classification of severity of airflow limitation after performing spirometry. The BMI, dyspnea, 6 min walking distance, $FEV_1$ and BODE index was calculated for each patient. Patients were started on inhalation therapy and pulmonary rehabilitation and followed-up every fortnightly, after 2 months of the treatment, to repeat the BODE index and spirometry. Comparison was done between the $FEV_1$ and BODE index before and after treatment. The mean $FEV_1$ before the treatment was 51.00 (15.21) and after the treatment, it was 48.75 (14.92). There is no statistical difference found between pre and post treatment. However, the mean BODE index score before treatment was 5.47 (1.95) and after the treatment was 4.70 (2.35). With 95% confidence interval, the level of significance was 0.001. The present study concluded that, for the assessment of severity in COPD patients, BODE index helps in a better manner than $FEV_1$ in response to medical intervention. Calculating BODE index is simple and needs no special equipment. This makes it a potential tool of potentially widespread applicability.

**Key words:** Body mass index, BODE index, dyspnea, $FEV_1$

## INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a major and increasing global health problem which is currently the fourth leading cause of death and it is going to be the third leading cause of death by 2020. It is also predicted that COPD is becoming the fifth commonest cause of disability in the world by 2020 (Shankar, 2006). Although, $FEV_1$ remains the most important physiologic indicator of the severity of airflow obstruction in COPD, its predictive value is weak above 50% of its predicted value and once patients reach very low values of $FEV_1$, other markers of mortality in COPD become more accurate. Chief among these predictors are degree of dyspnea, exercise capacity and Body Mass Index (BMI).

Exercise produces an increase in oxygen consumption and carbon dioxide from skeletal muscle. Patients with COPD have the same oxygen consumption for a given workload as normal subjects, however, their dead space ventilation is higher and so a larger minute ventilation is needed to maintain carbon dioxide constant. Since in many patients expiratory airflow is limited within the tidal volume range, the only way to increase minute ventilation is to increase the inspiratory flow and/or shift the end expiratory position (Donaldson *et al*., 2002).

Fifty percent of patients with severe COPD show protein energy malnutrition. Reasons for this include resting metabolic demands, inadequate calorie intake due to dyspnea and anorexia and elaboration of cachexia associated inflammatory cytokines such as TNF-α, IL-1 and IL-6 (Rennard and Vestbo, 2006).

The BODE index encompasses the predictive validity of the best of these potential surrogates into a single measure of disease severity and survival. The BODE index, that captures the multi-systemic manifestations of COPD may prove to be valuable, not only in assessing the severity and progression of the disease but also in evaluating the response to medical intervention, compared to spirometry. However, there is a lack of evidence to say which is better in clinical assessment between spirometry and BODE index in COPD patients.

## MATERIALS AND METHODS

The study was conducted in the Pulmonary Medicine Out-Patient Department (OPD), SRM Medical College Hospital and Research Centre. The study was designed as a prospective, comparative study. Institutional Ethics Committee approval was obtained prior to the commencement of the study (Ethical Clearance Number: 444/IEC/2013). Written informed consent was obtained from all the study participants.

**Study criteria:** The COPD was defined by a ratio of $FEV_1$ to FVC of less than 0.7 measured 20 min after the administration of salbutamol. Patients fulfilling the spirometric criteria for COPD, patients attending OPD with clinic-radiological evidence of COPD were included in the study. Patients with reversible airway obstruction in spirometry (>12% change in $FEV_1$), COPD patients unable to do spirometry, patients with contraindication for spirometry, patients with history of asthma, allergic rhinitis, or atopy or elevated blood eosinophil count and patients with cardiovascular or osteo-articular impairment were excluded from the study.

**Study procedure:** All the patients' baseline demographic details and a detailed case history with special reference to risk factors like exposure to domestic smoke, smoking history viz., number of beedies or cigarettes smoked, age of starting and age of quitting if they were not current smokers. This was followed by a systematic clinical examination. All routine investigations and other advanced investigations like echocardiography were performed to rule out corpulmonale. Testing was performed in a location where a rapid, appropriate emergency service was available. Oxygen, sublingual nitroglycerine, aspirin and salbutamol nebulization were available on site.

Parameters such as height, weight, BMI, $FEV_1$, dyspnea, 6-Minute Walking Distance (6MWD) and BODE index were measured. The BMI was calculated as:

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

Degree of dyspnea was assessed by Modified Medical Research Council (MMRC) grading. Post bronchodilator $FEV_1$ was measured to assess the degree of obstruction using spirometry. EASY

ONE Pro (Mini Wright flow meter, Clement Clarke International, London) spirometer was used. The spirometry was performed by well-trained pulmonary technicians. At least three spirometry maneuvers were performed and the largest $FEV_1$ was considered for documentation.

Six minutes walking distance (6MWD) was measured in a 50 m corridor. Patients were instructed to walk from end to end at their own pace, attempting to cover as much distance as possible. The total distance walked in 6 min was recorded. Reasons for immediately stopping were noted. Patients were allowed to rest but were encouraged to proceed with the walk when they recovered.

The BODE index was calculated by assuming points for the above mentioned variables. Patients were treated with MDI containing, long acting β agonist and long acting anti-cholinergics±inhaled corticosteroids and pulmonary rehabilitation. Rescue medications were given in the form of short acting β agonist. Patients were counseled on the benefits of quitting smoking and regular use of MDIs. After 8 weeks of treatment, all the patients were reviewed. All the above mentioned parameters were assessed once again. The $FEV_1$ and BODE index after treatment was compared with that measured before treatment.

**Statistical analysis:** Statistical analysis was done by using software SPSS version 14 windows 8. The paired 't' test was used to analyze the results. Pearson correlation was performed to compare between variables. Quantitative data was expressed as mean (SD). The $p<0.05$ was considered to be statistically significant. Per Protocol Analysis (PPA) was performed.

## RESULTS

Eighty four patients were included in this study after fulfilling the inclusion criteria, out of which 70 patients were followed up. Being a PPA study method, statistical analyses were carried out in 70 patients. The study comprised of 64 males and 6 females. The average age of the subjects in the study was 60.8.

Twenty eight patients were diabetics, they were on regular treatment while another 22 had hypertension which was under control with medication. The rest of them were free from any co-morbidity. Fourty two patients had stopped smoking at the time of commencement of the study while 22 patients continued to smoke. The risk factor in the female patients was chronic exposure to domestic chula/biomass smoke.

BODE index was calculated by considering the points for variables such as BMI, airflow obstruction, dyspnea and exercise capacity (Table 1). Spirometry was done before and after the treatment, the values were statistically not significant ($p = 0.66$). Mean $FEV_1$ before treatment was 51 (±15.2) and after the treatment was 48.75 (±14.92). Difference in the dyspnea before and after treatment was found to be statistically significant ($p = 0.0001$). Mean 6MWD before was 236.78 (±87.1) and after the treatment was 269.57 (±103.08) and the values were statistically significant($p = 0.018$). The mean BODE index score before treatment was 5.47 (±1.95) and after the treatment mean BODE index score was 4.70 (±2.35). With 95% CI, the level of significance was

Table 1: The BODE index and variables

| | BODE index | | | |
|---|---|---|---|---|
| Variable | 0 | 1 | 2 | 3 |
| $FEV_1$ (Predicted%) | ≥80 | 50-79 | 30-49 | <30 |
| Dyspnea (MMRC) | 0-1 | 2 | 3 | 4 |
| 6MWD (m) | ≥350 | 250-349 | 150-249 | <150 |
| BMI | >21 | <21 | - | - |

found to be 0.001 (Table 2). Changes in BODE index and % predicted $FEV_1$ is shown in Table 3. The correlation between initial and final, BODE index and $FEV_1$ is shown in Fig. 1a and b, respectively.

Table 2: Comparison of baseline and end visit BODE index values

| | Baseline | | End visit | |
|---|---|---|---|---|
| Variables | No. | (%) | No. | (%) |
| **$FEV_1$ (Predicted%)** | | | | |
| ≥80 | 5 | 7.1 | 4 | 5.7 |
| 50-79 | 33 | 47.1 | 27 | 38.6 |
| 30-49 | 25 | 35.7 | 32 | 45.7 |
| <30 | 7 | 10.0 | 7 | 10.0 |
| **Dyspnea** | | | | |
| 0 | 0 | 0.0 | 2 | 2.9 |
| 1 | 2 | 2.9 | 16 | 22.9 |
| 2 | 24 | 34.3 | 28 | 40.0 |
| 3 | 43 | 61.4 | 22 | 31.0 |
| 4 | 1 | 1.4 | 2 | 2.9 |
| **6MWD (m)** | | | | |
| >350 | 7 | 10.0 | 19 | 27.1 |
| 250-349 | 20 | 28.6 | 18 | 25.7 |
| 150-249 | 22 | 31.4 | 23 | 32.9 |
| <150 | 21 | 30.0 | 10 | 14.3 |
| **BODE index** | | | | |
| 0-2 | 5 | | 13 | |
| 3-4 | 19 | | 22 | |
| 5-6 | 22 | | 18 | |
| 7-10 | 24 | | 17 | |

Table 3: Change in BODE index/$FEV_1$

| Change in BODE index/$FEV_1$ | No. of patients |
|---|---|
| $FEV_1$ increases, BODE index decreases | 24 |
| $FEV_1$ decreases, BODE index increases | 13 |
| $FEV_1$ decreases, BODE index decreases | 25 |
| $FEV_1$ decreases, BODE index no change | 6 |
| $FEV_1$ no change, BODE index decreases | 2 |

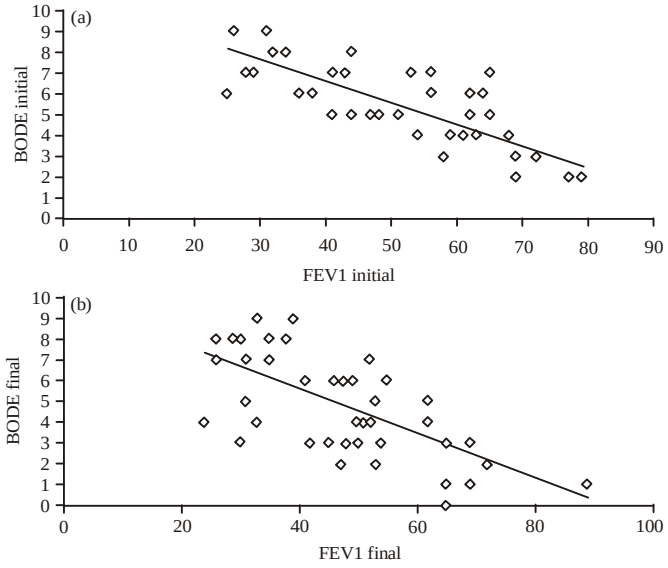


Fig. 1(a-b): Scattered diagram between (a) Initial and (b) Final $FEV_1$ and BODE index

## DISCUSSION

The COPD is increasingly considered as a disease not only of the lungs. It has been suggested as a part of the 'chronic systemic inflammatory syndrome' together with the metabolic syndrome, coronary artery disease and others (Lokke *et al*., 2006). The complexity of COPD and its frequent co-morbidities requires assessment and staging of the disease beyond the degree of airflow limitation. The most important cause of disability in COPD patients is dyspnea which is due to daily activities such as walking, nutritional abnormalities, weight loss, skeletal muscle dysfunction and CVS effects such as pulmonary arterial hypertension, right ventricular hypertrophy and failure (Mannino *et al*., 2006).

The GOLD spirometric staging showed that most of the studied patients were in the 2nd GOLD stage (39.3%) while in using combined assessment GOLD groups most of the studied patients were in the D group (43%). This indicates that GOLD spirometric staging underestimates the severity of COPD ignoring other physiological, psychological and exacerbation risk indicators. This was in line with the studies done by Johannessen *et al*. (2006) and Lopez *et al*. (2006) comparing between 2011 and 2007 GOLD for predicting mortality and hospitalization, found that the majority of the studied patients were in the more severe groups using GOLD 2011. A majority of the population were in old GOLD 2007 stage 2 and 10% of these patients were classified as severe COPD (groups C and D) when using the new GOLD criteria taking into account exacerbation history and dyspnea. It means that GOLD 2007 underestimates the severity of COPD (Murray and Lopez, 1997).

The stratification of severity should not only rely on objective assessment but also on subjective assessment as perceived by the patient. The GOLD guideline 2011 has taken in consideration and thereby dyspnea was added to the combined assessment. However, both the old and the new GOLD guidelines did not take into account the fundamental defect in COPD patients such as exercise capacity and oxygen consumption. Also, there are suggested refinements that appeared discussing some conflicts in the new GOLD combined assessment groups (Birring *et al*., 2002).

Burrows (1991) reported that a rapid decline in lung function was independently associated with a modest increased risk of hospital admissions and deaths from COPD. The present study observed that even after the medical treatment, 25 patients showed decrease in $FEV_1$ and BODE index and this showed the natural process of the disease. Ong *et al*. (2005) studied BODE scoring systems corresponded to important differences in health status of patients with COPD. This grading system was correlated to the health status indexes of the SGRQ than the GOLD staging criteria.

Anxious and depressive symptoms were common in patients with advanced COPD. The BODE index is superior to the GOLD classification for explaining anxious and depressive symptoms in COPD patients (Shah *et al*., 2001). Combined upper limb and lower limb training resulted in a significant improvement in the exercise performance and health related quality of life. According to ATS guidelines, comprehensive pulmonary rehabilitation is an improvement over standard medical management. The benefits achieved are decrease in dyspnea, increase in exercise ability and improvement in health status.

$FEV_1$ and MMRC scale assessed the pulmonary manifestations of COPD whereas BMI and 6MWD assessed the systemic manifestations of COPD. The BODE index is simple to calculate and requires no special equipment. Celli *et al*. (2004) have reported that BODE index is a better predictor of risk of death than $FEV_1$ alone. Ong *et al*. (2005) showed that the BODE index predicted hospitalization of patients better than $FEV_1$. On their study, the patients who had a BODE index score of 7-10, after treatment and poor functional status were termed as 'end stage'.

The present study showed that change in the BODE index after treatment was statistically significant than the change in $FEV_1$ alone. Although, the $FEV_1$ had shown a decline, the BODE index has improved, depicted the improvement in symptoms and quality of life. Imfeld *et al*. (2006) used the BODE index, 3 months after Lung Volume Reduction Surgery (LVRS) in COPD and showed it to be a better predictor of mortality than $FEV_1$, of the dyspnea score and of the 6MWD. The same was true for pulmonary rehabilitation where the improvement in the BODE index after intervention correlated with the survival in COPD. Funk *et al*. (2009) also stated that BODE index was superior to $FEV_1$ for explaining anxious and depressive symptoms in COPD patients. However, the present study had the limitations such as limited sample size and change in BODE index in response to individual drugs were not assessed. The reasons for the decline in $FEV_1$ in some patients were also not studied.

## CONCLUSION

The finding of this study concludes that the BODE index which includes, addition to $FEV_1$ other physiologic and clinical variables, helps to better assess severity and response to treatment in patients with COPD. The BODE index is simple to calculate and requires no special equipment. This makes it a practical tool of potentially widespread applicability. Further studies with more number of patients with variable parameters should be done to authenticate the finding.

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