International Journal of Innovative Research in Medical Science (IJIRMS)
Volume 10, Issue 09, September 2025,
*https://doi.org/10.23958/ijirms/vol10-i09/2100*

**Original Article**

# Power of Bode Index in Predicting Future Exacerbations of COPD - A Prospective Observational Study

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Received: 27 June 2025; Accepted: 13 August 2025; Published: 01 September 2025

## Abstract

***Background and Objective:*** The prevalence and the burden of COPD are projected to increase in the upcoming decades due to the continued exposure to COPD risk factors and changing age structure of world's population. BODE index is a multidimensional grading system for COPD assessment which combines 4 variables and is a simple and excellent predictor of survival and mortality in COPD patients. ***Objectives of the study are:*** 1. To predict prognosis and future risk of exacerbations in COPD patients on first visit on the basis of BODE index. 2. To assess the accuracy of prediction using BODE index during the follow up visits. ***Materials and methods:*** A prospective clinical study was conducted among 40 stable COPD patients who attended or got admitted at Mandya Institute of Medical Sciences during a time period of 12 months. Spirometry is done at the time of admission. Further, the patients were observed for future exacerbations of COPD by following up of cases once in 30 days for a period of 6 months. ***Results:*** In the study, the mean age of the participants was 60 years with the standard deviation of around ±3.737 years. Majority were males and more than one third of the study participants i.e., around 35.0% had given history of presence of co-morbidities. The mean value of BODE Index obtained was 3.50 with the standard deviations of around ±21.95. Majority of the participants i.e., about 80.0% of them belonged to the Stage 2 based on GOLD Staging. The next common stage was Stage 3 followed by Stage 1. The study found statistical and positive correlation of exacerbations in COPD with both BODE Index and GOLD Staging, after 6 months. Also the exacerbations of COPD was observed each month among the participants, accordingly, only 4-6 cases had experienced exacerbations in each month, while majority of participants were feeling better. At the end of 6 months, on estimating the total number of exacerbations of COPD, majority i.e., around 47.5% of the participants had no exacerbations overall. ***Conclusion:*** The study found that BODE Index on first visit was successful in foreseeing the prognosis of the condition of the patient. Also it accurately predicted the future risk of exacerbations as it was positively correlated with the number of exacerbations in the follow up period. Even the correlation of the severity of the condition with the GOLD staging was established.

**Keywords:** ***Chronic Obstructive Pulmonary Disease, Exacerbation, Prognosis, BODE Index***

## Introduction

Chronic obstructive pulmonary disease (COPD) is a major cause of mortality and morbidity throughout the world. The prevalence and the burden of COPD are projected to increase in the upcoming decades due to the continued exposure to COPD risk factors and changing age structure of world's population [1]. It is projected to be the 3rd leading cause of death in the coming decade. COPD represents an important public health challenge that is both preventable and treatable.

COPD 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. COPD is a progressive and distressing condition which is a leading cause of disability globally [2]. Major presenting symptoms are Chronic cough, breathlessness and sputum production[3].

The pathogenesis and clinical manifestations of COPD are not restricted to pulmonary inflammation and structural remodeling. Rather, this disorder is associated with clinically significant systemic alterations in biochemistry and organ function. The systemic aspects of COPD include oxidative stress and altered circulating levels of inflammatory mediators and acute-phase proteins. As in other chronic inflammatory conditions, weight loss, muscle wasting, hypo proteinemia and tissue depletion are commonly seen in COPD patients [4]. Selective wasting of fat-free mass coupled with impaired respiratory and peripheral muscle function and a reduced capacity for exercise occur in COPD patients. Indeed, weight loss may directly impact poor prognosis in COPD patients.

## Materials and Methods

**Study population:** All cases of COPD with age more than 40 years and less than 70 years, presented/attending the General medicine (OPD/inpatients) department of south indian tertiary care.

**Study design:** Prospective observational study

**Study period:** 1 Year

**Sample size:** 40 Cases (Retrospective assessment from department records the number of cases admitted to general medicine department of south indian tertiary care centre the inclusion criteria on an average is 6-7 cases per month. So over a period of 6 months the sample size will be 40 cases considering the inclusion and exclusion criteria are included in the study)

**Sampling method:** Purposive sampling

**Inclusion criteria**

- Stable COPD patients (no exacerbations in last 3 months) (FEVI/FVC<0.7)
- Age more than 40 years and less than 70 years.

**Exclusion criteria**

- Inability to perform Spirometry or Six-minute walk test or both.
- Unstable angina/CCF
- MI within 4 months
- Medical history or clinical signs of asthma
- Increase in Post bronchodilator FEV1% >12%

**Methods of collection of data**

Information was collected through prepared structured proforma from each patient. All patients / their relatives was interviewed as per the prepared proforma. A detailed systemic examination was done. Patients with history of unstable angina or congestive cardiac failure or history of myocardial infarction in the past four months are not taken for the study. Spirometry is done at the time of admission. The patients were observed for future exacerbations of COPD by following up of cases once in 30 days for a period of 6 months. Cases are selected taking into consideration inclusion and exclusion criteria.

Patients included in the study were followed up till the end of 6 months from the baseline. At the end of 6 months, we have recorded the number of exacerbations the patient has experienced.

**Investigations:** ECG &Spirometry

## Results and Discussion

**Table 1: Age profile of study participants**

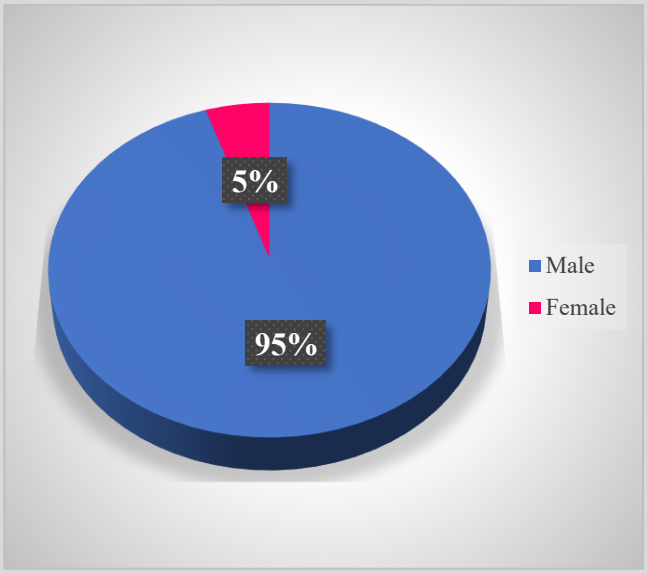
| Measures | Age (in years) |
|---|---|
| Mean | 60.07 |
| Standard Deviation | 3.737 |
| Minimum | 54 |
| Maximum | 67 |

The study comprised of the participants with the age range between 54 years and 67 years. The mean age of the study participants was 60 years.

**Table 2: Distribution of study participants based on gender**

| Gender | Frequency (N) | Percentage (%) |
|---|---|---|
| Male | 38 | 95.0 |
| Female | 2 | 5.0 |
| **Total** | **40** | **100.0%** |

In the study, majority of the participants were males i.e., about 95.0%. Remaining 5.0% of them were females.

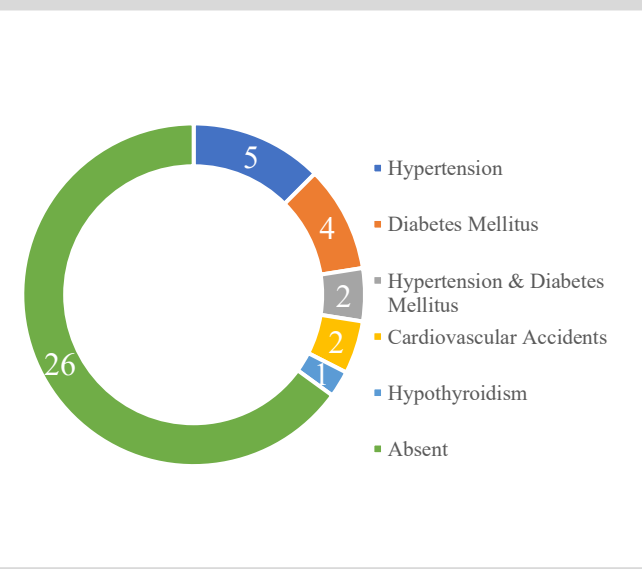



**Graph 1: Distribution of study participants based on gender**

**Table 3: Distribution of study participants based on the presence of co-morbidities**

| Co-morbidities | | Frequency (N) | Percentage (%) |
|---|---|---|---|
| Present | Hypertension | 5 | 12.5 |
| | Diabetes Mellitus | 4 | 10.0 |
| | Hypertension & Diabetes Mellitus | 2 | 5.0 |
| | Cardiovascular Accidents | 2 | 5.0 |
| | Hypothyroidism | 1 | 2.5 |
| Absent | | 26 | 65.0 |
| **Total** | | **40** | **100.0%** |

More than one third of the study participants i.e., around 35.0% had given history of presence of co-morbidities, among which hypertension & diabetes mellitus were seen in majority cases. However, majority of them were not having any co-morbidities i.e., about 65.0%.

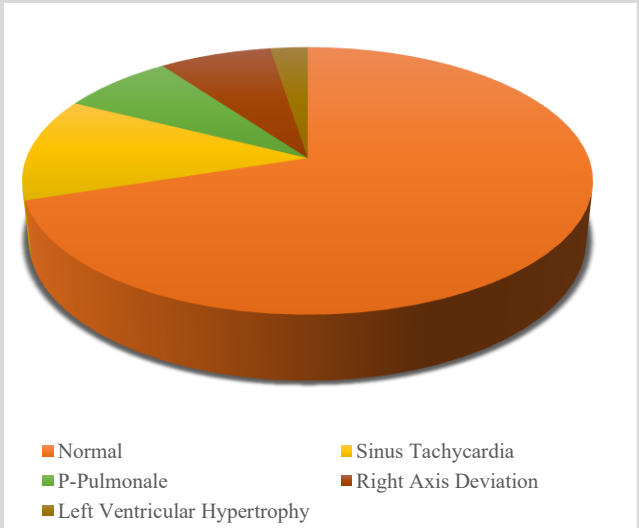



**Graph 2: Distribution of study participants based on the presence of co-morbidities**

**Table 4: Distribution of study participants based on ECG findings**

| ECG Findings | Frequency (N) | Percentage (%) |
|---|---|---|
| Normal | 28 | 70.0 |
| Sinus Tachycardia | 5 | 12.5 |
| P-Pulmonale | 3 | 7.5 |
| Right Axis Deviation | 3 | 7.5 |
| Left Ventricular Hypertrophy | 1 | 2.5 |
| **Total** | **40** | **100.0%** |

On performing electrocardiogram (ECG) among the study participants, majority of them i.e., about 70.0% showed normal findings. About 12.5% of them presented with sinus tachycardia in the ECG. The next common finding was p-pulmonale and right axis deviation. Left ventricular hypertrophy was observed in only 1 patient.




**Graph 3: Distribution of study participants based on ECG findings**

**Table 5: Variables of BODE Index**

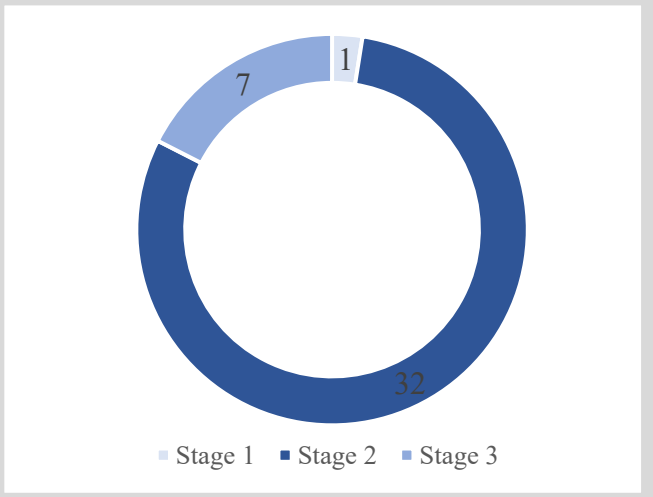
| Variable | Mean | Standard Deviation | Range |
|---|---|---|---|
| BMI (kg/m$^2$) | 19.67 | 2.057 | 16.08 - 24.21 |
| $FEV_1$ (%) | 57.78 | 8.232 | 43.00 - 82.00 |
| mMRC | 1.77 | 0.659 | 1.0 - 3.0 |
| 6MWD (m) | 298.00 | 80.230 | 130 - 410 |
| **BODE Index** | **3.50** | **21.950** | **0 – 8** |

In order to predict the severity of chronic obstructive pulmonary disease (COPD) among the study participants, the variables of BODE Index i.e., Body Mass Index (BMI), Forced Expiratory Volume in 1 second (FEV1), Modified Medical Research Council (mMRC), and 6 Minute Walk Distance (6MWD) were estimated at the time of first visit. The mean value with the standard deviations of BODE Index and its variables have been recorded.

**Table 6: Distribution of study participants based on GOLD Staging**

| GOLD Staging | Frequency (N) | Percentage (%) |
|---|---|---|
| Stage 1 | 1 | 2.5 |
| Stage 2 | 32 | 80.0 |
| Stage 3 | 7 | 17.5 |
| **Total** | **40** | **100.0%** |

Majority of the participants in the study i.e., about 80.0% of them belonged to the Stage 2 based on GOLD Staging. The nest common stage was Stage 3 followed by Stage 1.

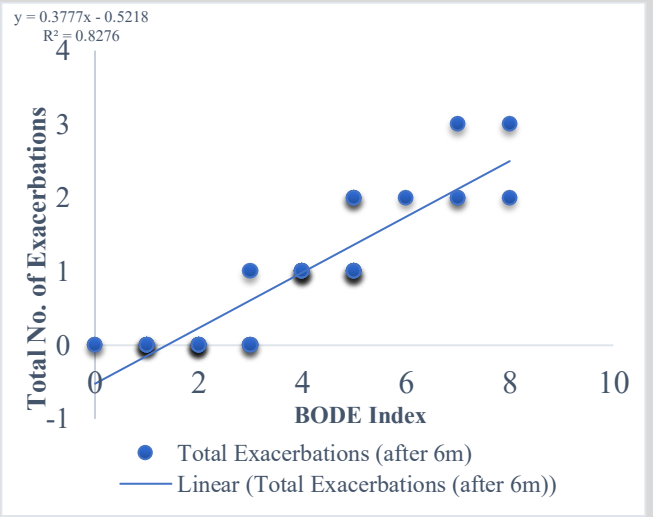



**Graph 4: Distribution of study participants based on GOLD Staging**

**Table 7: Correlation between BODE Index and Exacerbations in COPD**

| | | Total Exacerbations after 6 months |
|---|---|---|
| **BODE Index** | Pearson Correlation | 0.910 |
| | p-value | <0.0001 |

The study showed statistical and positive correlation between BODE Index and Exacerbations in COPD after 6 months with correlation co-efficient of 0.910 and p-value <0.0001 which is extremely significant. Thereby suggesting that exacerbations in COPD increased with the increase in BODE Index.

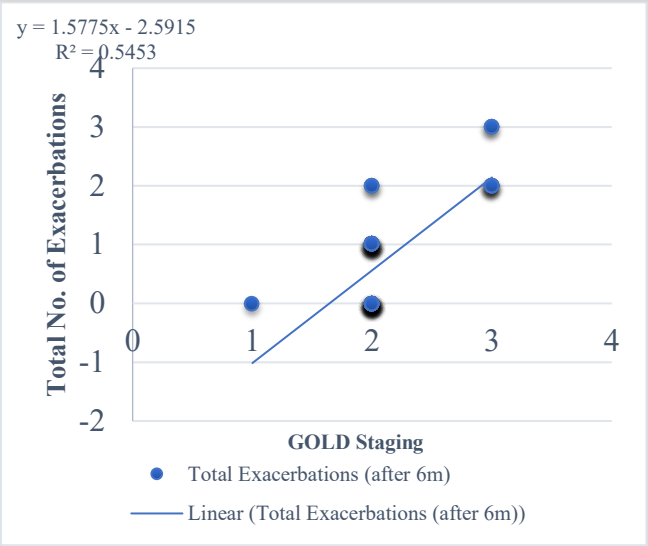



**Graph 5: Correlation between BODE Index and Exacerbations in COPD after 6 months**

**Table 8: Correlation between GOLD Staging and Exacerbations in COPD**

| | | Total Exacerbations after 6 months |
|---|---|---|
| **GOLD Staging** | Pearson Correlation | 0.738 |
| | p-value | <0.0001 |

The study showed statistical and positive correlation between GOLD Staging and Exacerbations in COPD after 6 months with correlation co-efficient of 0.738 and p-value <0.0001 which is extremely significant. Thereby suggesting that exacerbations in COPD increased with the increase in the GOLD Staging.

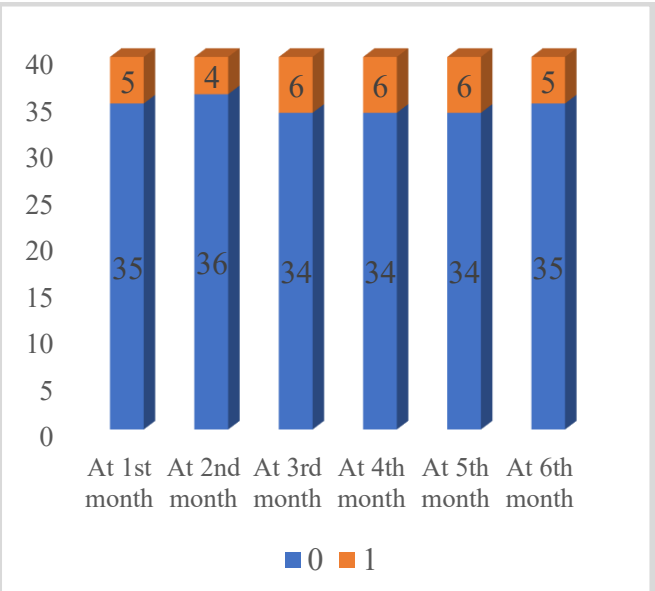



**Graph 6: Correlation between GOLD Staging and Exacerbations in COPD after 6 months**

**Table 9: Exacerbations of COPD among the study participants in each month**

| Monthly Exacerbations | 0 | 1 |
|---|---|---|
| At 1st month | 35 (87.5%) | 5 (12.5%) |
| At 2nd month | 36 (90.0%) | 4 (10.0%) |
| At 3rd month | 34 (85.0%) | 6 (15.0%) |
| At 4th month | 34 (85.0%) | 6 (15.0%) |
| At 5th month | 34 (85.0%) | 6 (15.0%) |
| At 6th month | 35 (87.5%) | 5 (12.5%) |

The exacerbations of COPD was observed each month among the participants in the study. Accordingly, only 4-6 cases had experienced exacerbations in each month, while majority of participants were feeling better.




**Graph 7: Exacerbations of COPD among the study participants in each month**

**Table 10: Total exacerbations of COPD among the study participants**

| Total Exacerbations | Frequency (N) | Percentage (%) |
|---|---|---|
| 0 | 19 | 47.5 |
| 1 | 12 | 30.0 |
| 2 | 7 | 17.5 |
| 3 | 2 | 5.0 |
| **Total** | **40** | **100.0%** |

At the end of 6 months, the total number of exacerbations of COPD was estimated among the participants in the study. Accordingly, majority i.e., around 47.5% of the participants had no exacerbations overall. About 30.0% participants had experienced exacerbation just once, while 17.5% developed it twice in 6 months. Remaining 2 cases in the study had three episodes of exacerbations during the follow-up.

## Discussion

The present prospective observational study was conducted for a period of 12 months on around 40 stable patients with chronic obstructive pulmonary disease who visited or admitted under the department of General Medicine at Mandya Institute of Medical Sciences, to predict prognosis and future risk of exacerbations on first visit on the basis of BODE index, and also to assess the accuracy of prediction on basis of BODE index on follow up visits.

The study comprised of the participants with the age range between 54 years and 67 years. The mean age of the study participants was 60 years. This resembles the study by Sarkar *et al.*[6], where the mean age of the participants was about 61.65 years.

Majority of the participants in the study were males i.e., about 95.0%. Remaining 5.0% of them were females. This is similar to the findings from the study by Ong KC *et al.*[5] and Sarkar *et al.*[6], where males were predominant with the proportion of around 91.3% and 92.9% respectively.

In the study, more than one third of the study participants i.e., around 35.0% had given history of presence of co-morbidities which include Hypertension, Diabetes Mellitus, Hypothyroidism, and Cerebrovascular Accidents. However, majority of them were not having any co-morbidities i.e., about 65.0%. Whereas in the study by Kamath S *et al.*[7], less than one fifth of the participants were suffering from either hypertension or diabetes mellitus.

On performing electrocardiogram (ECG) among the study participants, majority of them i.e., about 70.0% showed normal findings. In order to predict the severity of chronic obstructive pulmonary disease (COPD) among the study participants, the variables of BODE Index i.e., Body Mass Index (BMI), Forced Expiratory Volume in 1 second (FEV1), Modified Medical Research Council (mMRC), and 6 Minute Walk Distance (6MWD) were estimated at the time of first visit. Accordingly, the mean value of BODE Index obtained was 3.50 with the standard deviations of around ±21.95. This was closer to the mean value of 3.71 obtained in the study by Sarkar *et al.*[6]. Whereas in the studies by Ong KC *et al.*5 and Cote CG *et al.*[7], the mean values were quite higher comparatively.

In the study, majority of the participants i.e., about 80.0% of them belonged to the Stage 2 based on GOLD Staging. The next common stage was Stage 3 followed by Stage 1. This mimics the studies by Marin JM *et al.*9 and Sarkar *et al.*[6], where majority of the participants belonged to the Stage 2.

There exists a statistical and positive correlation between BODE Index and Exacerbations in COPD after 6 months in the study with correlation co-efficient of 0.910 and p-value <0.0001 which is

extremely significant. Thereby suggesting that exacerbations in COPD increased with the increase in BODE Index. This association has been well proven by multiple studies which include Cote CG *et al.*[7], Ong KC *et al.*[5], Marin JM *et al.*[9], and Praveen CK *et al.*[8].

The study found statistical and positive correlation between GOLD Staging and Exacerbations in COPD after 6 months with correlation co-efficient of 0.738 and p-value <0.0001 which is extremely significant. Thereby suggesting that exacerbations in COPD increased with the increase in the GOLD Staging. Even the studies by Ong KC *et al.*[5], Sarkar *et al.*[6], and Kamath S *et al.*[7] found similar correlation confirming the association.

The exacerbations of COPD was observed each month among the participants in the study. Accordingly, only 4-6 cases had experienced exacerbations in each month, while majority of participants were feeling better. At the end of 6 months, on estimating the total number of exacerbations of COPD, majority i.e., around 47.5% of the participants had no exacerbations overall. About 30.0% participants had experienced exacerbation just once, while 17.5% developed it twice in 6 months. Remaining 2 cases in the study had three episodes of exacerbations during the follow-up.

## Conclusion

On examining the stable patients with chronic obstructive pulmonary disease in the study, following observations were made;

- BODE Index on first visit was successful in foreseeing the prognosis of the condition of the patient.
- BODE Index accurately predicted the future risk of exacerbations as it was positively correlated with the number of exacerbations in the follow up period.
- Even the correlation of the severity of the condition with the GOLD staging was established.

## List of abbreviations

COPD: Chronic Obstructive Pulmonary Disease

BODE: BMI, Obstructions, Dyspnea, Exercise tolerance

FEV1: Forced Expiratory Volume in 1st second

FVC: Functional Vital Capacity

GOLD: Global Initiative for Chronic Obstructive Lung Disease

BMI: Body Mass Index

ECG: Electrocardiogram

## Declarations

## Ethics approval and consent to participate

Ethical committee approval was obtained from institute

## Informed written Consent

Obtained from participants

## Conflicts of Interest

There is no conflict of interest regarding the publication of this paper."

## Funding Statement

Nil

## Authors' contributions

All the authors are equally contributed for concept, study design, data collection, Analysis.

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