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Modified Version for COPD BODE Index: A Mini Review

Marcelo Velloso* **and Isabella Diniz Faria**

Department of Physical Therapy, School of Physical Education, Physical Therapy and Occupational Therapy, Federal University of Minas Gerais, Belo Horizonte, Minas Gerais, Brazil

***Corresponding author:** Marcelo Velloso, Department of Physical Therapy, School of Physical Education, Physical Therapy and Occupational Therapy, Federal University of Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, E-mail: marcello.vel@gmail.com

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Abstract

Chronic Obstructive Pulmonary Disease (COPD) is one of the leading causes of morbidity and mortality around the world. The functional impairment status is directly related to the number of exacerbations and risk of death. Therefore, BODE index assessment is essential in pulmonary rehabilitation (PR) programs. The aim of this mini review was to describe the modified BODE indices which have been developed so far. The following modified BODE indices were found in the literature: the BODE-VO_2, the iBODE, the BODE-TGlittre, the BODE-PSFDQ-M and the BODE-HAP and all showed significant associations with the original BODE index.

Keywords: COPD; BODE; BODE-PSFDQ-M; BODE-TGlittre

Abbreviations: 6MWT: 6 Minute Walk Test; m: meters; VO_2 mL.min.kg: oxygen uptake in milliliters per minute per kilogram; % VO_2 predicted: oxygen uptake in percentage of predicted; ISWT: Incremental Shuttle Walking Test; TGlittre: Glittre Activities of Daly Living Test; s: seconds; PSFDQ-M: Pulmonary Functional Status and Dyspnea Questionnaire-Modified version and HAP: Human Activity Profile.

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is one of the leading causes of morbidity and mortality around the world. COPD patients are frequently limited in their activities of daily living (ADL) and this functional impairment status is directly related to the number of exacerbations and risk of death. Therefore, its assessment is essential in pulmonary rehabilitation (PR) programs [1,2].

Due to the importance to measure risk of death, Celli et al., developed the BODE index, which is a multidimensional evaluation composed by body mass index (weight/height^2), degree of airflow obstruction (FEV1-forced expiratory volume in the first second), dyspnea (MRC), and exercise capacity (6MWT-six-minute walk test). Each variable has a specific score, and the total BODE index varies from 0 to 10 points. High scores indicate high risk of death [1,3].

The distance covered during the 6MWT is used to evaluate functional capacity of COPD patients in the BODE index [1,4]. Although, the lower limbs movements are commonly involved in ADL, currently, it has been questioned that ADL also involve upper-limb activities and they should also be evaluated. In this way, alternative instruments to the 6MWT have been proposed to evaluate functional performance of COPD patients [4-9] (Table 1).

An important barrier of the original BODE index is which only the measures of BMI and dyspnea are easily to be obtained. In order to measure FEV1, a spirometer is necessary, and for the 6MWT a long physical space (30-meter corridor) is required, which is often not feasible within clinical contexts. In addition, elderly or weak individuals may have difficulty in performing the 6MWT [6,10]. Thus, it is necessary to seek other alternatives for the calculation of the BODE index [5].

Based upon the above information, the aim of the present review was to describe the modified BODE indices which have been developed so far.

Original BODE vs. BODE VO_2

It is well known that exercise capacity and oxygen consumption (VO_2) in COPD patients are low during cardiopulmonary exercise tests [3]. Cardoso et al., evaluated the association between the original BODE index and the modified BODE index, which replaced the 6MWT by the VO_2 obtained during a maximum incremental test on a treadmill. They included 50 mild to severe COPD patients, who performed spirometry (forced vital capacity-FVC and FEV1), dyspnea level (MRC), body mass index (BMI), 6MWT, and maximum incremental test on a treadmill with exhaled gas analysis [5]. For the calculation of the modified BODE index (BODE VO_2), it was assumed that there was a significant association between the distance covered during the 6MWT and the VO_2 reached during the maximum incremental test on a symptom-limited treadmill. The original BODE index showed an excellent correlation with the modified BODE index, in which the distance covered during the 6MWT was replaced by the VO_2 absolute value, in milliliters per minute per kilogram (VO_2 ml.min.kg) (r=0.92) and by the VO_2, in percentage (%VO_2) of the predicted value (r=0.95) [5]. The BODE VO_2 was calculated, as follows: Each variable was scored between 0 and 3 points, except for the BMI, which was scored as a dichotomous variable (0 or 1). In this way, the values corresponding to the 6MWT were replaced by the VO_2, in mL.min.kg or by the predicted %VO_2. For stratification purposes, as given in Table 1, Cardoso et al., presented the values to be considered, according to the American Medical Association. The modified BODE index final score corresponded to that of the original BODE index, between 1 and 10 points [5]. This study was the first to evaluate the association between the original and the modified BODE index during an incremental exercise treadmill test.

Original BODE vs. Incremental Shuttle Walking Test (i-BODE

The incremental shuttle walking test (ISWT), which is an alternative field test to the 6MWT [7], is widely used within clinical and research environments, and is highly correlated to the VO_2 [4]. The main differences between the 6MWT and ISWT are that the former is self-paced and time-limited, whereas the latter uses sound stimuli to impose walking rhythm and is limited by symptoms [11,12]. Willians et al., evaluated whether the BODE index calculated by the ISWT (i-BODE) results could be an alternative to the 6MWT, as a discriminatory independent predictor of mortality in COPD patients. They analyzed data from 633 COPD patients, who performed pulmonary rehabilitation (RP) for a period of 11 years. The distance covered during the ISWT (in meters) replaced the distance covered during the 6MWT, by creating the scores shown in Table 1. The authors concluded that the ISWT can successfully replace the 6MWT as an alternative measure of exercise capacity within the BODE index. The i-BODE index showed to be an independent predictor of death, and increases in one point in the i-BODE score being associated with a 1.27 increase in risk of death (hazard ratio 1.27 (CI 1.17 and 1.35), p<0.001).

Based upon the importance of the BODE index for the evaluation of COPD patients in both clinical outcomes and pulmonary rehabilitation programs, Moreira et al., studied twenty-eight patients with moderate to very severe COPD with the objective of analyzing three possibilities for the replacement of the 6MWT in the BODE index [4]. From their results, the BODE TGlittre, the BODE-PSFDQ-M, and the BODE-HAP emerged.

Original BODE vs. BODE TGlittre

The Glittre ADL test (TGlittre) was developed to assess functional performance in most limiting ADLs of COPD patients. It includes the following four tasks: sitting and standing, walking, going up and down stairs, and moving objects from one shelf to another [13]. Moreira et al., aiming at more accurately evaluating COPD patients during their ADLs by using a test that targeted both the upper and lower limbs, investigated the associations between the original BODE index and the modified BODE index [4]. For this, they replaced the distance covered during the 6MWT by the time to perform the TGlittre (BODE-TGlittre). Measures of BMI, spirometry, and degree of dyspnea were obtained. For the BODE-TGlittre analysis, the authors created four quartiles, by placing the TGlittre values in ascending order and dividing them into 4 equal-sized groups, representing the cut-off points for the quartiles, as shown in Table 1. The original BODE index showed a strong association with the BODE-TGlittre (R^2=0.824, $p \leq 0.0001$) and the regression model resulted in the following equation: original BODE=-0.641+0.731 (BODE TGlittre).

Original BODE vs. BODE-PSFDQ-M

The Pulmonary Functional Status and Dyspnea Questionnaire-Modified version (PFSDQ-M) is a questionnaire developed to assess ADL limitations in COPD patients. The PFSDQ-M is composed of three domains: the influence of dyspnea and fatigue on ADL (5 general and 10 specific items for each domain) and changes in ADL, compared with the pre-disease period (10 specific items). Partial scores are calculated for each of the three domains, ranging from 0 to 100, and a total score is composed by the sum of the partial scores, with values ranging from 0 to 300. Higher scores indicate higher limitations in ADLs [14]. Because the PSFDQ-M is a questionnaire that is easy to apply, requires little time to administer, and does not require physical space, such as the 6MWT and TGlittre, health professionals can evaluate patients' mortality within clinical settings, such as out-patient clinics and hospitals, where there is not a 30-meter track available for the performance of the 6MWT. Moreira et al., found a strong association between the original BODE and the BODE-PSFDQ-M (R^2=0.803, $p \leq 0.0001$), which resulted in the following regression equation: original BODE=-0.1999+0.664 (BODE PFSDQ-M) [4]. The BODE-PSFDQ-M index was also presented in 4 quartiles, by placing the scores on the questionnaire in ascending order and dividing them into 4 equal size groups that represented the cut-off points, as shown in Table 1.

Original BODE Index	**Celli et al.**			
	0	**1**	**2**	**3**
6MWT distance (m)	≥ 350	250-349	150-249	≤ 149
BODE-VO_2 index	**Cardoso et al.**			
VO_2 mL.min.kg	>25	20-25	15-20	<15
% VO_2 predicted	>70	60-69	40-59	<40
iBODE	**Williams et al.**			
ISWT (m)	≥ 250	150-249	80-149	<80
	Moreira et al.			
	Quartile 1	**Quartile 2**	**Quartile 3**	**Quartile 4**
BODE TGLITTRE				
TGlittre (s)	≥ 493	≥ 394.5 and <493	≥ 290 and <394	<290,0
BODE-PSFDQ-M				
PSFDQ-M (score)	≥ 47.5	≥ 29 and <47.5	≥ 12 and <29	<12
BODE-HAP				
HAP (score)	≥ 70.8	≥ 61 and <70	≥ 51.5 and <61	<51.5

Table 1: Values and quartiles for the calculation of the Original BODE and the Modified BODE Indices.

Original BODE vs. BODE-HAP

The Human Activity Profile (HAP) was developed and validated to assess COPD patients, specifically as a measure of general physical activity levels [15-17]. It is a self-administered questionnaire, composed of 94 activities arranged according to the requirements of energy consumption. Thus, the initial activities require less energy expenditure and as it progress, the energy expenditure requirement increases [4,16]. The HAP score is estimated by the maximum activity score (MAS), based upon the activity that requires the highest oxygen consumption that the person is still able to do and by the adjusted activity score (AAS), which is calculated by subtracting the number of activities the patient "stopped doing" from the MSA. Based upon the AAS scores, individuals are classified as inactive (AAS<53), moderately active (AAS=53-74) or active (AAS>74) [5,17]. To evaluate the BODE-

HAP index, four quartiles were created, by placing the values in ascending order and dividing them into 4 equal size groups, representing the quartile cut-off points, as shown in Table 1. The original BODE index showed significant association with the BODE-HAP (R2=0.500, $p \leq 0.0001$), resulting in the following regression equation: original BODE=-1.160+0.814 (BODE-HAP) [4].

The results of Moreira et al., showed that the BODE-TGlittre and the BODE-PSFDQ-M are interesting options, when there is not physical space and/or the patient's conditions do not allow the 6MWT to be performed.

Conclusion

The BODE index is an important tool to predict risk of death in COPD patients. Alternative forms of calculating this index have arisen in an attempt to make this measure more accurate and more accessible for clinical practice. The folowing modified BODE indices were found in the literature: the BODE-VO_2, the iBODE, the BODE-TGlittre, the BODE-PSFDQ-M and the BODE-HAP and all showed significant associations with the original BODE index. However, it is worth noting that some of them, such as the BODE-VO_2, the iBODE, and the BODE TGlittre indices require high-cost equipment or large physical space, which is not available in most rehabilitation settings. On the other hand, the BODE-PSFDQ-M and the BODE-HAP indices are based upon scores on questionnaires, which are low-cost and easy to apply, making them more clinical useful. However, the BODE-PSFDQ-M showed better association with the original BODE index and may be a good alternative in cases of space limitation.

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