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Evaluation of Different Dyspnea Scales in Smokers with Preserved FEV1/FVC Ratio

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Abstract

Background: This study evaluated the relationships between two dyspnea scales (Modified Borg Scale [MBS] and modified Medical Research Council dyspnea scale [mMRCds]) and clinical characteristics of smokers with preserved FEV_1/FVC ratio. It also assessed their ability to differentiate symptomatic (CAT score ≥10) from asymptomatic smokers (CAT score <10).

Methods and Results: Sixty-one smokers (FEV1: 98.69±15.83% of predicted, age: 29–77 years) were included in this study. Dyspnea intensity was assessed using MBS and mMRCds, and correlations were examined between these scales and pulmonary function tests, quality of life (QoL) indices, and physical parameters. ROC analysis determined cutoff values for dyspnea scales.

MBS (1.29±1.16) and mMRCds (0.61±0.92) scores were higher in symptomatic smokers. Both scales significantly correlated with 6-minute walk distance (MBS: r_s=-0.519; mMRCds: r_s=-0.699; P<0.001 in both cases) and QoL measures (CAT, SGRQ). Spirometry parameters showed significant correlations with both scales. ROC analysis demonstrated strong discriminatory ability for both mMRCds and MBS between symptomatic and asymptomatic groups.

Conclusion: mMRCds and MBS effectively assess dyspnea in smokers with preserved FEV1/FVC ratio, correlating with clinical and functional outcomes and distinguishing between symptomatic and asymptomatic individuals.(**International Journal of Biomedicine. 2025;15(1):72-77.**)

Keywords: smoking • spirometry • dyspnea • exercise test • quality of life

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Abbreviations

6MWD, 6-minute walk distance; **6MWT**, 6-minute walk test; **BDI**, Baseline Dyspnea Index; **BMI**, body mass index; **COPD**, chronic obstructive pulmonary disease; **CAT**, COPD assessment test; **FEV1**, the forced expiratory volume in 1 second; **FEF**, forced expiratory flow; **FVC**, forced vital capacity; **MBS**, Modified Borg Scale; **PEF**, peak expiratory flow; **mMRCds,** modified Medical Research Council dyspnea scale; **QoL**, quality of life; **SGRQ**, St. George's Respiratory Questionnaire; **VAS**, Visual Analogue Scale.

Introduction

Dyspnea is a common symptom experienced by individuals with a range of respiratory conditions, including chronic obstructive pulmonary disease (COPD), asthma, and lung fibrosis, which can significantly impact a person's daily activities and quality of life (QoL).[1]

The mechanism underlying dyspnea is complex and multidimensional. Dyspnea originates from a mismatch between the perceived respiratory effort and the actual work of breathing, which can be influenced by various physiological, psychological, and behavioral factors. These factors include airflow limitation, respiratory muscle function, central nervous system processing of respiratory sensations, and emotional and cognitive factors that can modulate the perception of breathlessness.[2,3]

The clinical measurement and assessment of dyspnea are important for several reasons. First, it allows us to quantify the severity and impact of dyspnea on a patient's daily activity and QoL. This information can then be used to guide treatment

strategies, monitor disease progression, and evaluate the effectiveness of interventions and the management of the disease. Additionally, accurately measuring dyspnea via validated scales and questionnaires provides clinicians with valuable insights that may not be fully captured by traditional lung function tests alone, as the perception of breathlessness can vary significantly among patients with similar degrees of airflow obstruction. Therefore, a comprehensive assessment of this important respiratory symptom is essential for effectively managing various lung conditions.[4,5]

Dyspnea assessment is also essential in individuals with preserved FEV1/FVC ratio, as these individuals may experience significant respiratory symptoms despite having relatively normal spirometry values.[6,7]

Various scales and questionnaires have been developed to quantify the severity and impact of dyspnea on a person's daily life, including the Modified Borg Scale (MBS), Visual Analogue Scale (VAS), Baseline Dyspnea Index (BDI), and modified Medical Research Council dyspnea scale (mMRCds). However, the performance and applicability of these different dyspnea assessment tools may vary depending on the specific target population and disease setting.[6,8]

This study had the following objectives: (i) to investigate whether these scores of dyspnea are related to pulmonary and physical function measures in both symptomatic and asymptomatic smokers with preserved FEV1/FVC ratio, and to identify the most suitable instrument for this set of patients; and (ii) to determine whether the measures of dyspnea can distinguish between symptomatic (CAT score of ≥10) and asymptomatic individuals (CAT score of <10).

Materials and Methods

Participants

Sixty-one participants (34 males and 27 females; mean age of 49.7±10.3 years with a range of 29–77 years) with a preserved FEV1/FVC ratio as defined by the Global Initiative for Obstructive Lung Disease Guidelines (2024 GOLD Report) were recruited. All participants had a history of significant smoking (mean number of pack-years: 37.55±16.46, range 20–90 pack-years).[9] The inclusion criteria for this study were as follows: (i) prebronchodilator FEV1/FVC equal to or greater than 0.7; (ii) no respiratory medical treatment; (iii) no cardiac, renal, musculoskeletal, or neurological disease; (iv) no history suggestive of asthma; (v) being a current or former smoker with a history of significant smoking (≥20 pack-years); and (vi) being cooperative and willing.

Study Design

All cases were clinically stable and evaluated in the Clinic of Pulmonology and Institute of Pathophysiology, University Clinical Center, Prishtina, Kosova. The participants' anthropometric data (age, height, weight and body mass index [BMI]) were recorded, and then spirometry for measures of FVC, FEV1, FEV1/FVC, PEF, FEF25-75, FEF25, FEF50, and FEF75, 6MWD and QoL questionnaires were completed on the same day that dyspnea was graded. The enrolled participants were studied in a successive order between September 2022 and February 2023. The detailed study protocol was approved by the Faculty of Medicine ethics committee (REF. NR. 12923). Written informed consent was obtained from all subjects.

Dyspnea Assessment

The severity of dyspnea was assessed via two validated scales: the MBS and the mMRCds. The participants were informed about using and interpreting both scales before the assessment. MBS is a self-reported measure that quantifies the perceived severity of respiratory symptoms, such as dyspnea, during daily activities. This scale consists of a 0–10 numeric rating scale, with 0 representing "no breathlessness at all" and 10 representing "maximal breathlessness." mMRCds is a 5-point scale that describes the level of dyspnea based on activity limitations, ranging from grade 0 (no dyspnea except with strenuous exercise) to grade 4, with 4 indicating the most severe dyspnea.[10-12] The participants were asked to read the descriptive statements of the mMRCds and then select the number that best represented their level of shortness of breath during daily activities.

Pulmonary Function Test

Prebronchodilator spirometry was performed according to American Thoracic Society/European Respiratory Society standards. FEV1, FVC, and other spirometry parameters were recorded. The examination was performed by a trained specialist using an MIR Spirolab III Spirometer (Medical International Research (MIR), Italy); three consecutive measurements were obtained, and the best flow-volume measurement was registered. Calculations were performed automatically by the instrument. Twenty-four parameters, including FVC, FEV1, and FEV1/FVC, were recorded and analyzed.

6-Minute Walk Test (6MWT)

The 6MWT was performed according to a standard protocol. The participants were instructed to walk as long as possible in 6 minutes. The total distance walked during the test was documented.[13,14] Additionally, arterial blood pressure (Professional Sphygmomanometer, GIMA S.p.A., Italy), heart rate, and oximetry (OXY-3, GIMA S.p.A., Italy) were performed before and after the test.

Quality of Life

The participants' QoL was assessed via the COPD assessment test (CAT) and St. George's Respiratory Questionnaire (SGRQ). CAT is a simple, self-administered questionnaire that measures the impact of COPD on a person's daily life and well-being. The CAT comprises 8 items that assess various aspects of a patient's health, including cough, sputum, chest tightness, and activity limitations, among others. Each item is scored from 0 to 5, with higher scores indicating greater impairment. CAT scores were also used to categorize the subjects into two groups: symptomatic (score ≥10) and asymptomatic (score <10).[15,16] SGRQ is a widely used, disease-specific, health-related QoL instrument for patients with respiratory diseases, including COPD, asthma,

and bronchiectasis. It consists of 50 items with 76 weighted responses across 3 domains (symptoms, activity, and impacts). It measures impairment to overall health, daily life, and perceived well-being in patients with respiratory disease. [17,18]

Statistical analysis

Statistical analysis was performed using the statistical software package SPSS version 27.0 (SPSS Inc, Armonk, NY: IBM Corp). Figures were created using GraphPad Prism v10 (GraphPad Software, Boston, USA). Descriptive statistics were used to summarize the data. For the descriptive analysis, results are presented as mean (M) ± standard deviation (SD) and minimum-maximum. Associations between dyspnea scale scores, pulmonary function test results, the 6MWD, and quality of life scores were evaluated using Spearman's Rank correlation analysis. The Mann-Whitney U test was used to compare continuous variables between symptomatic and asymptomatic groups. A receiver operating characteristic (ROC) analysis was undertaken for MBS and mMRCds to investigate their ability to discriminate between symptomatic and asymptomatic dyspneic individuals. Area under the curve (AUC) data is calculated and presented. Significance was set at $P<0.05$.

Results

Clinical characteristics of patients, lung function, 6MWD, and QOL values are shown in Table 1.

Table 1.
Baseline patient characteristics (n=61).

Caracteristics	All (n=61)	Asymptomatic group	Symptomatic gtoup	*P*-value
Age, years	50±10 (29-77)	46±9 (29-64)	53±11 (36-77)	0.006
Height, cm	173.0±8.3 (153-191)	176.0±7.8 (156-191)	170±7.9 (153-182)	0.471
Weight, kg	81.5±16.8 (57-144)	82.9±17.2 (62-144)	80±16.5 (57-118)	0.006
BMI, kg/m^2	27.3±5.0 (19.1-41.6)	26.8±5.1 (20.2-41.6)	27.7±5.1 (19.1-38.1)	0.356
FVC, %	100.0±14.9 (74-141)	102.3±14.5 (81-132)	97.6±15.2 (74-141)	0.179
FEV1, %	98.7±15.8 (70-161)	101.9±11.8 (80-124)	95.3±18.8 (70-161)	0.036
FEV1/FVC, %	79.7±7.2 (70-99)	81.4±7.3 (71.4-99.0)	78.1±6.9 (70-94.9)	0.040
PEF, %	88.6±17.0 (51-123)	92.8±17.6 (58-123)	84.2±15.4 (51-107)	0.062
FEF25-75, %	92.8±30.7 (46-238)	97.9±23.7 (56-171)	87.4±36.2 (46-238)	0.016
FEF25, %	81.6±17.2 (47-115)	86.2±15.7 (57-115)	76.8±17.6 (47-113)	0.038
FEF50, %	79.9±28.1 (1.3-200)	88.2±21.4 (61-141)	71.4±31.9 (1.3-200)	0.003
FEF75, %	83.5±40.9 (25-254)	91.5±35.6 (25-202)	75.1±44.9 (28-254)	0.007
6MWD, m	394.0±79.9 (165-535)	436.3±58.3 (339-527)	350.2±76.1 (165-535)	<0.001

BMI, body mass index; FVC, forced vital capacity; FEV1, forced expiratory volume in one second; PEF, peak expiratory volume; FEF, forced expiratory flow; 6MWD, 6-minute walk distance. Values shown as mean ± SD (minimum-maximum). Significance level at P<0.05.

The results revealed that the severity of dyspnea in the participants was 1.29±1.16 for the MBS and 0.61±0.92 for the mMRCds.

Association between Dyspnea scales, Patient Characteristics and Clinical Tests

Among the spirometry measurements, FEF75 showed significant correlations with MBS (r_s=-0.306, P=0.017) and mMRCds (r_s=-0.407, P=0.001), while FEF50 also correlated with MBS (r_s=-0.357, P=0.005) and mMRCds (r_s=-0.266, P=0.038). Additionally, FEV1 demonstrated a significant negative correlation with MBS (r_s=-0.267, P=0.038) and mMRCds (r_s=-0.294, P=0.021), reflecting their relationships with airflow limitation. Both dyspnea scales showed strong correlations with the 6MWD, indicating a significant association between dyspnea severity and exercise capacity (MBS: r_s=-0.519, P<0.001; mMRCds: r_s=-0.699, P<0.001). Also, robust positive correlations were observed between the dyspnea scales and QoL measures. MBS and mMRCds were strongly correlated with the CAT score (MBS: r_s=0.776, P<0.001; mMRCds: r_s=0.703, P<0.001) and SGRQ total score (MBS: r_s=0.604, P<0.001; mMRCds: r_s=0.610, P<0.001) (Table 2).

Table 2.
Correlation between dyspnea scales and different parameters.

Caracteristics	MBS	*P*-value	mMRCds	*P*-value
Age, years	0.296	0.021	0.454	< 0.001
Smoking status	0.056	0.667	0.214	0.097
BMI, kg/m^2	0.197	0.127	0.228	0.077
FVC, % pred	- 0.232	0.072	- 0.201	0.120
FEV1, % pred	- 0.267	0.038	- 0.226	0.021
FEV1/FVC, %	- 0.129	0.322	- 0.226	0.080
PEF, % pred	- 0.139	0.284	- 0.114	0.380
FEF25-75, %	- 0.245	0.057	- 0.313	0.014
FEF25, % pred	- 0.143	0.270	- 0.113	0.388
FEF50, % pred	- 0.357	0.005	- 0.266	0.038
FEF75, % pred	- 0.306	0.017	- 0.699	0.001
6MWD, m	- 0.519	< 0.001	- 0.699	< 0.001
CAT	0.776	< 0.001	0.703	< 0.001
SGRQ total score	0.604	< 0.001	0.610	< 0.001

MBS, Modified Borg Scale; mMRCds, modified Medical Research Council dyspnea scale; BMI, body mass index; FVC-forced vital capacity; FEV1, forced expiratory volume in one second; PEF, peak expiratory volume; FEF, forced expiratory flow; 6MWD, 6-minute walk distance; CAT, COPD Assessment Test; SGRQ, St. Georg's Respiratory Questionnaire. The values presented are Spearman's Rank correlation coefficient (r_s). Significance level at P<0.05.

Difference in Dyspnea Scale Outcomes by Symptomatic Status

For both the mMRCds and MBS, the Mann-Whitney test showed statistically significant differences between the symptomatic and asymptomatic groups (P<0.05 in both cases). The mean differences are 1.037 for mMRCds and 1.617 for MBS (Figure 1).

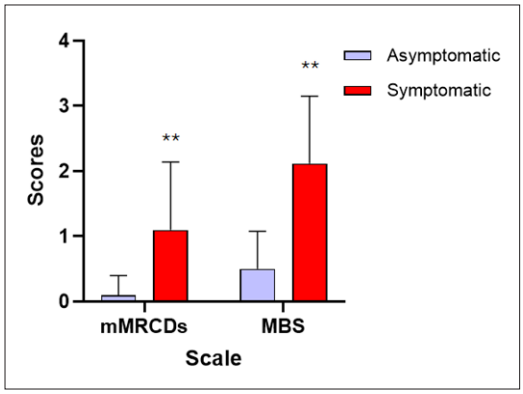

Fig. 1. *Comparison of mMRCds and MBS between CAT-derived asymptomatic (n=30) and symptomatic group (n=31). Values shown are mean±SD. **P<0.001 vs asymptomatic group.*

Sensitivity and Specificity of Dyspnea Scales

The ROC analysis demonstrated that the mMRCds (AUC=0.816±0.057, 95% confidence intervals [CI]=0.704 - 0.928, P<0.001) and MBS (AUC=0.912±0.038, 95% confidence intervals [CI] = 0.839 - 0.986, P<0.001) demonstrate significant discriminatory ability of these scales to distinguish between symptomatic and asymptomatic dyspneic individuals (Figure 2). An mMRCds score of ≥1 was identified as the best predictor of symptomatic dyspnea in the ROC analysis, with a sensitivity of 70.0% and specificity of 90.3%. An MBS score of ≥1.5 was identified as the best predictor of symptomatic dyspnea in the ROC analysis, with a sensitivity of 76.7% and specificity of 93.6%.

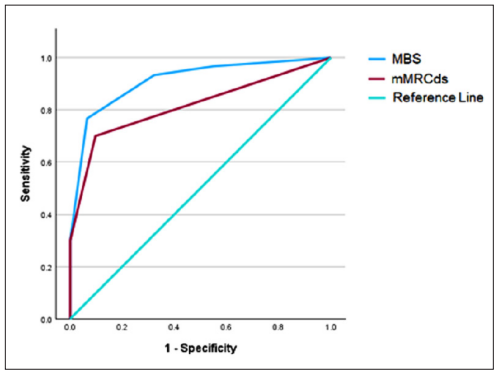

Fig. 2. *Comparison ROC analysis of mMRCds and MBS for detecting symptomatic dyspnea individuals.*

Discussion

Evaluating dyspnea is essential for understanding the burden of respiratory conditions, particularly in ever smokers with preserved FEV1/FVC ratio, where conventional spirometry often fails to detect functional limitations. The mMRCds and MBS are two widely used tools, each with distinct advantages. The mMRCds has consistently been shown to categorize dyspnea severity by its impact on daily activities reliably. Studies by Bestall et al.[12] and Ozalevli and Ucan[19] demonstrate a strong correlation of mMRCds with QoL measures, daily activity limitations, and health-related outcomes despite weak associations with FEV1. Similarly, Hajiro et al.[20] found that health-related quality of life in COPD patients was more closely linked to dyspnea levels than to disease severity based on FEV1, underscoring the mMRCds relevance.

MBS, on the other hand, is particularly effective for real-time assessments of dyspnea intensity during exercise or dynamic conditions, as noted by Mahler et al.[21] and Johnson et al.[10] However, its complexity and limited applicability to everyday activities make it less practical for routine clinical use. Both scales, however, are complementary. Guleria et al.[22] reported strong correlations between the mMRCds, the MBS, and other dyspnea measures, and highlighted that the mMRCds and the 12-minute walking test correlated well with pulmonary function tests. These findings align with our results and reinforce the multidimensional nature of dyspnea, as discussed by O'Donnell et al.,[23] who emphasized the ability of MBSs to capture sensory intensity and the focus of mMRCds on functional impacts.

In ever smokers with preserved lung function, where dyspnea often reflects subtle changes not detectable by spirometry, the mMRCds offers insights into activity-related disability. At the same time, the MBS provides detailed intensity ratings during physical exertion. Together, these tools offer a comprehensive approach to evaluating dyspnea and enhancing clinical decision-making. While extensive research has examined the relationship between dyspnea scales and lung function in COPD populations, including correlations with FEV1 and FVC as observed by Mahler et al.,[21] there remains a gap in studies focusing specifically on ever smokers with preserved FEV1/FVC ratio. This highlights the need for further investigation to better understand and address dyspnea in this subgroup.

This study demonstrated that the mMRCds and MBS are effective in assessing dyspnea in ever smokers with preserved FEV1/FVC ratio and are correlated with various physical and clinical parameters. The severity of dyspnea, as measured by both the mMRCds and MBS, significantly differed between the symptomatic and asymptomatic groups. The strong correlation between the two dyspnea scales suggests that they are both suitable for evaluating breathlessness in this population. While the current findings indicate that these scales can differentiate symptomatic individuals from asymptomatic individuals, further research is needed to determine the minimal clinically important differences in the mMRCds and MBS in this specific patient

population. The negative correlation between both dyspnea measures (mMRCds and MBS) and the 6MWT indicates that as dyspnea severity increases, patients' functional capacity (by the 6MWD) decreases. This implies that patients who experience more severe breathlessness are likely to have more limitations in physical activity, which is clinically significant for patient management. Both mMRCds and MBS show strong positive correlations with QoL instruments (CAT score and SGRQ). Higher dyspnea scores are associated with worse QoL, emphasizing the profound impact of respiratory symptoms on daily living and overall well-being in patients. This underscores the importance of managing dyspnea to improve patients' QoL.

To conclude, while the MBS and mMRCds are commonly employed to evaluate dyspnea severity in COPD patients, our observations indicate that these instruments also demonstrate a strong correlation with physical and clinical indicators in current or former smokers with preserved FEV1/FVC ratio. Given these results, we suggest implementing and regularly using the mMRCds and MBS in evaluating dyspnea in significant ever smokers with preserved FEV1/FVC ratio.

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Disclosure and Conflicts of Interest

The authors declare no financial, professional, or personal relationships that could be construed as a conflict of interest in conducting or reporting this study. No external funding was received, and there were no affiliations with organizations, government agencies, nonprofit entities, or commercial sources, including pharmaceutical companies, that could influence the results or interpretation of the findings.

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