Original research

EVALUATION OF THE RESULTS OF THE 1 - MINUTE SIT - TO - STAND TEST AND RELATED FACTORS IN COPD PATIENTS

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ABSTRACT

Objectives: To evaluate exercise capacity using the 1-minute sit-to-stand test (1MSTST) and investigate factors related to the results of the 1MSTST in patients with chronic obstructive pulmonary disease (COPD).

Methods: A cross-sectional study was conducted on 61 stable COPD patients being hospitalized at Hue University of Medicine and Pharmacy Hospital. Clinical characteristics were collected, and the 1MSTST was performed. The data were analyzed to study factors related to the results of the 1MSTST.

Results: The average number of 1MSTST repetitions was 17.56 ± 6.76 times. The ≤ 60 - year - old group showed better performance in the 1MSTST compared to the > 60 - year - old group. The COPD group A and B showed better performance in the 1MSTST compared to the COPD group E. The number of 1MSTST repetition decreased progressively from mMRC = 0 to mMRC = 4. The CAT < 10 group showed better performance in the 1MSTST compared to the CAT ≥ 10 group. The CCQ total ≤ 3 group showed better performance in the 1MSTST compared to the CCQ total > 3 group. There was an inverse correlation between 1MSTST performance and the following factors: disease duration (r = -0.338), number of COPD exacerbations requiring hospitalization per year (r = -0.346), mMRC (r = -0.669), CAT (r = -0.588), CCQ total (r = -0.592), CCQ symptoms (r = -0.419), CCQ functional state (r = -0.612), and CCQ mental state (r = -0.532). The results were statistically significant with p < 0.05.

Conclusion: The number of 1MSTST repetitions was performed in patients > 60 years old, patients had more symptoms, a higher exacerbation risk, and a longer disease duration, is significantly lower compared to patients ≤ 60 years old, patients had few symptoms, a lower exacerbation risk, and a shorter disease duration.

Keywords: Chronic obstructive pulmonary disease (COPD), exercise capacity, functional status, 1-minute sit-to-stand test (1MSTST)

I. INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a common condition in the community, characterized by irreversible airway obstruction. The most common causes are exposure to tobacco smoke, air pollution, and, to a smaller extent, gene mutations. COPD is a condition that cannot be completely cured and is one of the leading causes of death worldwide as well as in Vietnam. COPD patients experience reduced respiratory function and limitations in performing daily activities, which negatively impact their quality of life [1].

Exercise capacity is an important aspect in the assessment of COPD patients. Currently, exercise capacity is used to predict the patient's condition and the effectiveness of therapeutic interventions [2]. Several tests have been developed that are simple to perform, do not require sophisticated or expensive equipment, and can be conducted in a comfortable setting, while still effectively assessing the patient's

exercise capacity. The most commonly used of these tests is the 6-minute walk test (6MWT). However, assessment can be challenging when a long enough hallway is not always available in hospitals or clinics to complete the test.

An alternative solution that patients can perform in a smaller space is the 1-minute sit-to-stand test (1MSTST). The 1MSTST was first described by Koufaki and colleagues in 2002 [3] and has recently been more frequently studied and applied in clinical settings due to its benefits [4], [5].

Therefore, we conducted this research with the following two objectives: (1) To evaluate the number of 1MSTST repetitions in COPD patients. (2) To investigate factors related to the number of 1MSTST repetitions in COPD patients.

II. MATERIALS AND METHODS

2.1. Study subjects

The study included 61 COPD patients who met the inclusion criteria and did not meet any of the exclusion criteria.

Inclusion criteria: Stable COPD patients from groups (A, B, E), diagnosed according to the guidelines of the Global Initiative for Chronic Obstructive Lung Disease (GOLD 2024), who were receiving treatment at Hue University of Medicine and Pharmacy Hospital.

Exclusion criteria: Participants were excluded if they met any of the following conditions: Acute exacerbation of COPD. Limitations in lower limb mobility due to neurological conditions, musculoskeletal disorders, peripheral vascular diseases, or unstable cardiovascular conditions (e.g., myocardial infarction within the past month, unstable coronary artery disease, acute exacerbation of chronic heart failure, etc.). Lower limb surgery within the past 3 months. Current use of stimulants. Presence of abnormal symptoms (e.g., vomiting, nausea, dizziness, etc.). Inability to understand the study procedures or refusal to participate due to language barriers or other reasons [6].

2.2. Methods

We carried out a cross - sectional study at the Department of General Internal Medicine - Endocrinology - Rheumatology, Hue University of Medicine and Pharmacy Hospital, from March 2024 to October 2024. A convenience sampling method was used, including all patients who met the inclusion criteria.

How to Perform 1MSTST: According to Bohannon RW and colleagues, the patient sits upright in a chair. Upon hearing the command "Start," the patient stands up and sits down, repeating the movement as many times as possible within 1 minute. The number of sit-to-stand repetitions within 1 minute is recorded and referred to as the variable "Number of 1MSTST repetitions" [7].

Place of Implementation: The 1MSTST is performed in a treatment room where all necessary equipment is available, and medical staff are present to intervene if any abnormalities arise.

Study Procedure: Before performing the 1MSTST, the following assessments were conducted: mMRC (Modified Medical Research Council) to evaluate breathlessness severity [8], CAT (COPD Assessment Test) to assess the severity of COPD symptoms [9], and CCQ (Clinical COPD Questionnaire) to evaluate the clinical status of COPD over the past week [10]. The 1MSTST was performed at a single time point when the COPD patient was stable, prior to discharge. The following variables were assessed before and immediately after the 1MSTST: pulse, systolic blood pressure (SBP), diastolic blood pressure (DBP), respiratory rate, SpO2, and the BORG-10 scale. The number of sit-to-stand repetitions (or cycles of 1MSTST) was recorded, along with any symptoms experienced by the patient, such as coughing, shortness of breath, or chest pain.

Data collection tools: Questionnaire, watch, blood pressure monitor, stethoscope, oximeter, chair without armrests (45 – 48 cm height), measuring tape, scale.

2.3. Data analysis

Data were analyzed using SPSS 26.0 software with descriptive statistical methods. Differences were assessed, and the level of correlation was evaluated using Pearson or Spearman correlation analysis. A linear regression model was used to determine the regression line. Excel 2021 and MedCalc software were used to calculate experimental parameters and generate charts.

2.4. Research ethics

The research project was approved by the Research Proposal Review Board of Hue University of Medicine and Pharmacy and was officially authorized under Decision No. 1179/QD-DHYD on March 22, 2024. Participants were fully informed about the study's objectives and voluntarily agreed to participate in accordance with the principles of the Declaration of Helsinki. Participant safety was ensured throughout the study.

III. RESULTS

3.1. Participant characteristics

The study included 61 patients, with a mean age of 67.87 ± 8.22. The majority were > 60 years old (80.3%) and were male (98.4%). Other characteristics of the study subjects are described in Table 1.

Table 1: Participant characteristics

Variables		N	%
Age	≤ 60	12	19.7
	> 60	49	80.3
	X ± SD	67.87 ± 8.22	
Gender	Male	60	98.4
	Female	1	1.6
BMI (kg/m²)	< 23	46	75.4
	≥ 23	15	24.6
	X ± SD	20.48 ± 3.52	
Smoking		59	96.7
Chronic heart failure		3	4.9
Treatment adherence		41	67.2
Number of COPD exacerbations hospitalized/year (Median (Quarterile))		1 (1 - 2)	
mMRC	0	8	13.1
	1	11	18.0
	2	20	32.8
	3	18	29.5
	4	4	6.6
	X ± SD	1.98 ± 1.13	
CAT	< 10	15	24.6
	≥ 10	46	75.4
	X ± SD	15.64 ± 7.48	
CCQ total	≤ 3	49	80.3
	> 3	12	19.7
	X ± SD	2.22 ± 0.94	

Variables		N	%
CCQ symptom	X ± SD	2.62 ± 0.90	
CCQ functional state	X ± SD	2.24 ± 1.18	
CCQ mental state	X ± SD	1.43 ± 1.23	
COPD group	A	11	18.0
	B	13	21.3
	E	37	60.7

3.2. The number of 1MSTST repetitions

The average number of times the study subjects performed 1MSTST was 17.56 ± 6.76, with the highest being 34 times and the lowest being 5 times. After performing 1MSTST, vital signs such as pulse, SBP, DBP, respiratory rate and BORG-10 score all increased, SpO2 decreased. The above differences were all statistically significant with $p < 0.001$ (Table 2). No warning symptoms appeared after performing 1MSTST in our study subjects.

Table 2: Vital signs of subjects before and after performing 1MSTST

Vital signs	Before	After	Variation	p
Pulse (rates/minute)	84.54 ± 13.11	96.08 ± 13.80	11 (8 - 14)	< 0.001
SBP (mmHg)	120.98 ± 11.79	135.25 ± 12.30	10 (10 - 20)	< 0.001
SpO2 (%)	97 (96 - 98)	95 (93 - 97)	2.25 ± 1.19	< 0.001
BORG-10	1.08 ± 1.35	3.48 ± 1.96	2.39 ± 1.13	< 0.001
Number of 1MSTST repetitions	17.56 ± 6.76 (min - max: 5 - 34) (repetitions)			

3.3. Correlation between participant characteristics and the number of 1MSTST repetitions

The group of patients aged ≤ 60 years had a higher average number of 1MSTST repetition compared to the group of patients aged > 60 years ($p < 0.05$). There was no significant difference in the number of 1MSTST repetition between the two groups of smokers: those smoking > 30 pack - years and those smoking ≤ 30 pack - years. The COPD patient group without comorbid chronic heart failure had a higher number of 1MSTST repetition compared to the group with comorbid chronic heart failure ($p < 0.05$) (Table 3).

Table 3: Correlation of characteristics with the number of 1MSTST repetitions

Variables	The number of 1MSTST repetitions (repetitions)		p
Age	≤ 60 years old	> 60 years old	0.007
	22.17 ± 5.94	16.43 ± 6.52	
Smoking	≤ 30 pack - years	> 30 pack - years	0.532
	18.26 ± 6.48	17.13 ± 6.98	
	Yes	**No**	
Chronic heart failure	8.67 ± 4.73	18.02 ± 6.56	0.018
Maintenance treatment compliance	17.46 ± 6.96	17.75 ± 6.53	0.878

Figure 1 compares the number of 1MSTST repetitions in subgroups according to each scale. The average number of 1MSTST repetitions tend to decrease from group A, group B to group E; decreasing from mMRC = 0 to mMRC = 4. The CAT < 10 group has a higher number of 1MSTST repetitions than the CAT ≥ 10 group. The CCQ total ≤ 3 group has a higher number of 1MSTST repetitions than the CCQ total > 3 group ($p < 0.05$).
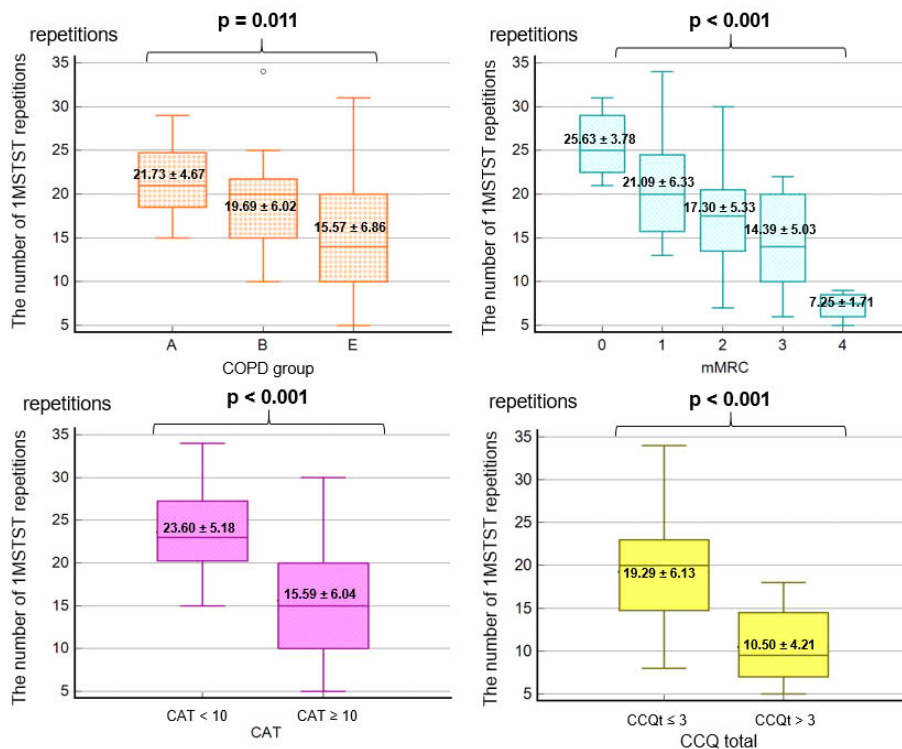

Figure 1: Correlation between COPD assessment scales and the number of 1MSTST repetitions

There was a negative correlation between 1MSTST and age ($r = -0.225$) and number of pack-years ($r = -0.074$). In contrast, there was a positive correlation between 1MSTST and BMI ($r = 0.112$). However, all of the above correlations were not statistically significant with $p > 0.05$. There was a positive correlation between 1MSTST and SpO2 ($r = 0.322$, $p < 0.05$). There was a negative correlation between 1MSTST and BORG-10 ($r = -0.578$, $p < 0.001$).

There was a negative correlation between 1MSTST and COPD duration ($r = -0.338$), number of COPD exacerbations/year ($r = -0.346$), mMRC ($r = -0.669$), CAT ($r = -0.588$), CCQ total ($r = -0.592$), CCQ symptom ($r = -0.419$), CCQ functional state ($r = -0.612$), CCQ mental state ($r = -0.532$) ($p < 0.01$), in which mMRC and CCQ functional state were the two indices with the strongest correlation with the number of 1MSTST repetitions (Table 4).

Table 4: Correlation of COPD assessment indicators and the number of 1MSTST repetitions

COPD assessment indicators	r	p
COPD duration	-0.338	0.008
Number of COPD exacerbations/year	-0.346	0.006
mMRC	-0.669	< 0.001
CAT	-0.588	< 0.001
CCQ total	-0.592	< 0.001
CCQ symptom	-0.419	< 0.001
CCQ functional state	-0.612	< 0.001
CCQ mental state	-0.532	< 0.001

IV. DISCUSSION

4.1. Characteristics of the study subjects

In our study, COPD patients undergoing inpatient treatment predominantly belonged to the age group > 60 years (80.3%), with an average age of 67.87 ± 8.22 years. Male patients were more prevalent. The average BMI was 20.48 ± 3.52 kg/m², with 75.4% having a BMI < 23 kg/m². These findings align with the epidemiology of COPD in Vietnam. For instance, a study by Nguyen Nhu Vinh reported an average age of 65.50 ± 8.25 years, with the 60-69 age group comprising 51.70% and those aged ≥70 accounting for 31.10%, summing to 82.8% of the population. Males made up 85.6%, with an average BMI of 21.50 ± 3.55 kg/m², and 32.50% had a BMI ≥ 23 kg/m² [11].

In terms of the CAT score, the average in our study was 15.64 ± 7.48, with 75.4% of patients scoring ≥ 10. The prevalence of severe respiratory symptoms was high, as indicated by both the CAT and mMRC scales, with 32.8% scoring mMRC = 2 and 29.5% scoring mMRC = 3. This is consistent with Nguyen Nhu Vinh's research on 209 outpatient COPD patients, where the average CAT score was 15.70 ± 7.09, with more than ¾ scoring ≥ 10. We observed a 68.9% prevalence of mMRC scores ≥ 2 in our study, compared to 55% in Nguyen Nhu Vinh's study [11], likely reflecting the greater severity of our hospitalized subjects, who had more comorbidities. Similarly, Wilson's study found that 82% of COPD patients had a CAT score ≥ 10 [12].

Our study also recorded an average CCQ total score of 2.22 ± 0.94, with CCQ symptom at 2.62 ± 0.90, CCQ functional state at 2.24 ± 1.18, and CCQ mental state at 1.43 ± 1.23. Another study reported similar averages at discharge: a CCQ total score of 2.2, CCQ symptom of 2.4, CCQ functional state of 2.6, and CCQ mental state of 1.3 [13].

The majority of our study subjects fell into group E (60.7%), with group A comprising only 18.0% and group B at 21.3%. This finding aligns with Ta Ba Thang's study, where 68.2% belonged to groups C and D, while group B made up 24.2% and group A comprised 7.6% [14]. This study used the GOLD 2011 ABCD classification system, the grouping of C and D into E emphasizes the clinical significance of COPD exacerbations.

4.2. The number of 1MSTST repetitions

The average number of 1MSTST repetitions in our study was 17.56 ± 6.76 per minute. Similarly, Ana L. Fernandes found an average of 18.13 ± 5.46 repetitions per minute [15], and Nguyen Thi Thu Hang recorded an average of 20 (18.8 - 22.0) repetitions per minute [4]; the slightly higher values in these studies may be due to their outpatient subjects, who generally have better exertional capacity compared to our inpatient population. Variations in repetitions may also depend on regional demographics.

In our study, we recorded changes in pulse rate, systolic blood pressure, and SpO_2 before and after the test, with average changes of 11 beats per minute, 10 mmHg, and 2.25%, respectively. These differences were statistically significant ($p < 0.001$). Nguyen Thi Thu Hang's study found a pulse change of 14 beats per minute and a SpO_2 change of 2% during the first test round [4]. This highlights the significant variations in vital signs, which can depend on the study subjects.

Regarding breathlessness symptoms, measured by the BORG-10 scale before and after the test, average scores were 1.08 and 3.48, respectively, with an average change of 2.39 points, which was also statistically significant ($p < 0.001$). Similarly, Ana L. Fernandes' study found pre- and post-test scores of 1.23 and 2.09, respectively ($p < 0.001$) [15].

4.3. Correlation of characteristics with the number of 1MSTST repetitions

Our findings indicated that patients over 60 years old had fewer 1MSTST repetitions compared to those ≤ 60 ($p = 0.007$), which is consistent with Ana L. Fernandes' findings that age negatively correlated with 1MSTST repetitions ($r = -0.53$, $p = 0.002$) [15]. This suggests that age-related muscle and skeletal strength loss may reduce exertional capacity. Patients with chronic heart failure performed fewer 1MSTST repetitions than those without (8.67 ± 4.726 vs. 18.02 ± 6.557 repetitions, $p < 0.05$). Christina's study on heart failure patients similarly noted limited 1MSTST performance [16]. Heart failure, along with COPD, is a major reason for hospitalization and breathlessness, reducing exertional capacity [17].

There was a negative correlation between 1MSTST repetitions and the duration since COPD diagnosis (r = -0.338, p = 0.008), implying that the longer the duration since diagnosis, the lower the exertional capacity due to the systemic effects of chronic COPD. Additionally, the number of hospitalizations per year correlated negatively with 1MSTST repetitions (r = -0.346, p = 0.006).

We found a strong inverse correlation between breathlessness severity, measured by mMRC scores, and 1MSTST repetitions (r = -0.669, p < 0.001), evident in the decreasing repetitions with increasing mMRC scores. Nguyen Thi Thu Hang reported a similar correlation (r = -0.577, p < 0.001) [5]. Limited evidence exists on the correlation between mMRC scores and 1MSTST repetitions, so our study provides additional data. CAT scores, reflecting symptom severity, also correlated strongly and negatively with 1MSTST repetitions (r = -0.588, p < 0.001). Specifically, in the CAT < 10 group, the average 1MSTST repetitions was 23.60 ± 5.18 per minute; and 15.59 ± 6.04 per minute in the CAT ≥10 group.

CCQ scores correlated negatively with 1MSTST repetitions (r = -0.592, p < 0.001). Patients with a CCQ ≤3 averaged 19.29 ± 6.13 repetitions per minute, while those with a CCQ >3 averaged 10.50 ± 4.21 repetitions. The correlation extended to the CCQ subscales (symptom, functional state, and mental state), with coefficients of -0.419, -0.612, and -0.532, respectively (p < 0.001). Le Khac Bao's study showed a similar correlation between CCQ scores and 6MWT results (r = -0.428, p < 0.01) [18]. Our use of 1MSTST instead of 6MWT adds further evidence of its validity for assessing COPD patients [19].

Group E COPD patients averaged 15.57 ± 6.86 repetitions, compared to 21.73 ± 4.67 repetitions in group A. This finding is consistent with Nguyen Thi Thu Hang's study, which found significantly higher 1MSTST repetitions in group A COPD patients compared to group D (21.9 ± 1.9 vs. 17.7 ± 1.5, p < 0.001) [5].

V. CONCLUSION

The average number of the 1-Minute Sit-to-Stand Test repetitions (1MSTST) among COPD patients was 17.56 ± 6.76 repetitions per minute.

Factors such as age, mMRC, CAT score, CCQ score, COPD duration, and the number of annual COPD exacerbation-related hospitalizations were found to be associated with the number of 1MSTST repetitions.

Competing interests

The authors declare that they have no competing interests.

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