DOI: https://doi.org/10.54393/pjhs.v7i6.3558

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 7, Issue 06 (June 2026)

Original Article

OPEN ACCESS

Comparison of the Six-Minute Walk Test and the One-Minute Sit-To-Stand Test for Assessing Exercise Tolerance in Patients with Chronic Obstructive Pulmonary Disease

Sheema Sajjad[1], Saadia Ashraf[1], Rukhsana Anwar[1*], Amjad Ullah[1], Muhammad Younas[1] and Karishma Rehman[1]

[1]Department of Pulmonology, Khyber Teaching Hospital, Peshawar, Pakistan

ARTICLE INFO

Keywords:
Six-Minute Walk Test, Chronic Obstructive Pulmonary Disease, One-Minute Sit-To-Stand Test, Dyspnea

How to Cite:
Sajjad, S., Ashraf, S., Anwar, R., Ullah, A., Younas, M., & Rehman, K. (2026). Comparison of the Six-Minute Walk Test and the One-Minute Sit-To-Stand Test for Assessing Exercise Tolerance in Patients with Chronic Obstructive Pulmonary Disease: Six-Minute Walk and the Sit-To-Stand Test for Exercise Tolerance in Patients with COPD. Pakistan Journal of Health Sciences, 7(6), 127-132. https://doi.org/10.54393/pjhs.v7i6.3558

***Corresponding Author:**
Rukhsana Anwar
Department of Pulmonology, Khyber Teaching Hospital, Peshawar, Pakistan
rukhsanafarooqi1995@gmail.com

Received Date: 16th October, 2025
1st Revision Received: 17th November, 2025
2nd Revision Received: 25th November, 2025
3rd Revision Received: 12th March, 2026
Acceptance Date: 31st March, 2026
Published Date: 30th June, 2026

ABSTRACT

Exercise tolerance assessment plays an important role in the management of chronic obstructive pulmonary disease (COPD). The Six-Minute Walk Test (6-MWT) and One-Minute Sit-to-Stand Test (1-MSTST) are commonly used, although few studies have compared their relative value in COPD. **Objective:** To compare 6-MWT and 1-MSTST in assessing exercise tolerance in patients with COPD. **Methods:** This analytical cross-sectional study was conducted in the Department of Pulmonology, Khyber Teaching Hospital, Peshawar, from March 29 to September 28, 2024. 98 participants were included in the study using a non-probability convenience sampling technique. Exercise tolerance was assessed in both tests, using heart rate (beats/min) and oxygen saturation (SpO_2%) measured with a pulse oximeter. Data were analyzed using SPSS version 23.0. **Results:** Out of the 98 patients with COPD (50 males, 48 females; mean age, 58.98 ± 7.75 years), the 6MWT, pulse rate rose from 88.92 ± 6.84 to 93.15 ± 7.73 bpm, and SpO_2 fell from 93.99 ± 1.97% to 91.24 ± 2.72%. In the 1MSTST, pulse rate increased from 88.38 ± 6.48 to 90.02 ± 6.37 bpm, and SpO_2 declined from 94.01 ± 2.07% to 92.94 ± 2.34%, with changes significant for SpO_2 (p-value<0.001) and modest for pulse rate (p=0.002). The 6MWT induced greater tachycardia and desaturation, reflecting higher cardiopulmonary demand. **Conclusions:** Both tests effectively assessed exercise tolerance in COPD, but the 6MWT demonstrated greater desaturation, making it more sensitive for evaluating functional limitation.

INTRODUCTION

Chronic Obstructive Pulmonary Disease, or COPD, is the third leading cause of death globally and is defined by phlegm, cough, and progressive airway obstruction [1, 2]. COPD is considered a public health problem by the Global Initiative for Chronic Obstructive Lung Disease GOLD, and its prevalence is increasing steadily because of the ageing of the population, tobacco exposure, and other environmental risk factors [3]. COPD has been said to affect more than 300 million individuals worldwide according to the World Health Organization, and it is expected to be the third leading cause of death worldwide by the year 2030 [4]. In South Asia, this creates a higher burden of COPD because tobacco use, indoor air pollution, and late diagnosis are all prevalent [5, 6]. The prevalence of COPD has been estimated to be between 3-6% in the general Pakistani population, increasing among those living in rural areas and those exposed to biomass fuel sources [7, 8]. Though the disease is a burden, knowledge

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and early diagnosis are lacking, resulting in late presentations and worse outcomes [9]. Evaluating functional capacity is fundamental to COPD diagnosis, staging, disease monitoring, and developing a treatment plan [10]. The most used and accepted submaximal exercise test, the 6-Minute Walk Test (6MWT), is not practical in all types of resource-limited situations as it requires physical space and a trained staff [11]. Alternatively, the 1-Minute Sit-to-Stand Test (1MSTST) is a simple and practical tool to assess exercise tolerance and has been proposed as a valid alternative [12, 13].

Although the two tests have been validated separately, little is known about the performance and applicability of the 6MWT and the 1MSTST in a local COPD population, especially in a low-tech environment. Also, the impact of demographic and clinical variables, including age, gender, and comorbidity, on test results is not well understood in Pakistani patients either. It is important to choose valid and reliable instruments that are feasible and cost-efficient for the assessment of COPD in clinical practice. Thus, the present study aimed to compare the performance of pre- and post-6MWT and 1MSTST in COPD patients and to analyze the influence of demographic and clinical variables on test performance.

METHODS

This was an analytical cross-sectional study conducted in the Department of Pulmonology, Khyber Teaching Hospital, Peshawar, from March 29 to September 28, 2024. The ethical approval was taken from the institutional review board with ref no: 277/DME/KMC issued on 5th October 2023. The sample size was calculated using the formula for comparing two means: $n=2(Z_{1-\alpha/2}+Z_{1-\beta})^2\sigma^2/(\mu1-\mu2)^2$. Using $Z_{1-\alpha/2}=1.96$, $Z_{1-\beta}=0.84Z$, $\mu1=110 \pm 20$bpm (6MWT), and $\mu2=98 \pm 22$bpm (1MSTST) in COPD patients, the pooled SD was 21 [11]. Substituting these values yielded n=49 per group, giving a total sample of 98 patients. Using a non-probability consecutive sample collection method, all eligible patients who presented during the study period and satisfied the eligibility criteria were included in the study until the desired sample size was reached. All patients of either gender, aged 40 to 75 years, with a confirmed diagnosis of chronic obstructive pulmonary disease (COPD) of mild to moderate severity according to the GOLD criteria, were included in the study. Patients were not included in the study if they had any orthopedic condition, previously diagnosed arrhythmia or heart failure, neurological deficit, arthritis of the knee, or end-stage renal failure. COPD patients with acute infections concomitant to the diagnosis were also excluded. After receiving permission from the ethical review board of the hospital, as well as the Department of Research in CPSP Karachi, the study was started. Those who fulfilled the study criteria were informed about the study objectives and potential benefits and risks, and written informed consent was obtained. The demographic and clinical characteristics recorded at baseline included age, gender, occupation, education, monthly income, and socioeconomic status, residence (rural/urban), duration of COPD, and associated comorbidities, including hypertension, diabetes, anemia, hyperthyroidism, and cor pulmonale. All patients underwent a thorough physical examination and a detailed medical history. The One-Minute Sit-to-Stand Test was performed first, and the Six-Minute Walk Test was performed after one hour of rest. Oxygen saturation (SpO_2%) and pulse rate (beats/min) were measured pre- and post each testing using a pulse-oximeter. A senior postgraduate resident working in the pulmonology ward led all evaluations and used a proforma to document the findings.

Data were analyzed using SPSS version 23.0. Normality of continuous variables (heart rate, oxygen saturation) was assessed using the Shapiro–Wilk test. All variables showed $p>0.050$, indicating normal distribution. Therefore, continuous variables are presented as mean ± SD, and parametric tests were applied. The paired sample t-test was used to compare pre- and post-test heart rate and oxygen saturation in both exercise tests. Categorical variables, such as gender, were expressed as frequencies and percentages. A $p\text{-value}<0.050$ was considered statistically significant.

RESULTS

Ninety-eight patients with COPD were enrolled in the study. Distribution by gender was approximately balanced: 50 were male (51.02%), and 48 were female (48.98%). Participants ranged in age from 40 to 85 years, with a mean age of 58.98 +/– 7.75 years. The majority of patients, 54.1%, were aged between 51 and 60 years, 18.4% were younger than 50 years, and 27.6% older than 60 years. As for residence, 53 patients (54.1%) were from an urban area and 45 (45.9%) from a rural area. Housewives comprised the majority of the population, at 46.9%, followed by Labourers at 24.5%, farmers at 14.3%, and "other" professions like driving, teaching, and shopkeeping at 11.2%. Three patients (3.1%) were electricians. About education status, there were more uneducated participants with 89.8%, as compared to 10(10.2%) educated population. Regarding socioeconomic status, 69.4% were lower-class, 29.6% were middle-class, and only 1 patient (1.0%) belonged to the upper-class. Regarding disease duration, 54 patients (55.1%) had COPD for 5 years or less, while 44 patients (44.9%) had it for more than 6 years (Table 3).

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Table 1: Demographic and Clinical Characteristics of COPD Patients(n=98)

Variables	Category	n (%)
Gender	Male	50 (51.02%)
	Female	48 (48.98%)
Age Group (Years)	≤ 50	18 (18.4%)
	51–60	53 (54.1%)
	≥ 61	27 (27.6%)
Mean Age ± SD	—	58.98 ± 7.75
Residence	Urban	53 (54.1%)
	Rural	45 (45.9%)
Profession	Labour	24 (24.5%)
	Housewife	46 (46.9%)
	Electrician	3 (3.1%)
	Farmer	14 (14.3%)
	Driver/Teacher/Shopkeeper	11 (11.2%)
Education	Educated	10 (10.2%)
	Uneducated	88 (89.8%)
Socioeconomic Status	Lower	68 (69.4%)
	Middle	29 (29.6%)
	Upper	1 (1.0%)
Duration of COPD (years)	≤ 5	54 (55.1%)
	≥ 6	44 (44.9%)

The study displays the difference between pre- and post-test results of the Six-Minute Walk Test (6MWT) and the One-Minute Sit-to-Stand Test (1MSTST) in 98 COPD patients. The average pre-test pulse rate was the same in both groups (88.93 ± 6.84 bpm for 6MWT vs. 88.39 ± 6.48 bpm for 1MSTST, p=0.571), with no statistically significant difference. Similarly, pre-test SpO_2 levels were not statistically different (93.99 ± 1.98% for 6MWT vs. 94.02 ± 2.07% for 1MSTST, p=0.916). However, the 6MWT group had higher post-test measurements compared to the 1MSTST group. The post-test pulse rate was greater in the 6MWT group (93.15 ± 7.74 vs. 90.02 ± 6.37 bpm, p=0.002). Likewise, desaturation of oxygen was more evident following the 6MWT, where mean SpO_2 decreased to 91.24 ± 2.72% from 92.93 ± 2.34% in the 1MSTST (p<0.001). In general, these results suggest that although the baseline parameters were similar, the 6MWT elicited more elevated rises in heart rate and larger falls in oxygen saturation than the 1MSTST (Table 2).

Table 2: Comparison of Pre- and Post-Findings in Both the Test (n=98)

Groups		n	Mean ± SD	p-value
Pre Pulse Rate	6MWT	98	88.9286 ± 6.84	0.571
	1MSTST	98	88.3878 ± 6.48	
Pre SPO2%	6MWT	98	93.9898 ± 1.97	0.916
	1MSTST	98	94.0204 ± 2.06	
Post Pulse Rate	6MWT	98	93.1531 ± 7.73	0.002*
	1MSTST	98	90.0204 ± 6.36	
Post SPO2	6MWT	98	91.2449 ± 2.73	<0.001*
	1MSTST	98	92.9286 ± 2.33	

asterisk(*)denotes statistical significance at p≤0.050

Normality of continuous variables (heart rate, oxygen saturation) was assessed using the Shapiro–Wilk test. All variables showed p>0.050, indicating normal distribution (Table 3).

Table 3: Normality Test Results for Continuous Variables (Shapiro–Wilk test, n=98)

Variables	Shapiro–Wilk Statistic (W)	p-value	Distribution
Pre-test Pulse Rate (6MWT)	0.983	0.214	Normal
Pre-test Pulse Rate (1MSTST)	0.981	0.198	Normal
Pre-test SpO_2 (6MWT)	0.987	0.266	Normal
Pre-test SpO_2 (1MSTST)	0.985	0.241	Normal
Post-test Pulse Rate (6MWT)	0.979	0.187	Normal
Post-test Pulse Rate (1MSTST)	0.982	0.205	Normal
Post-test SpO_2 (6MWT)	0.988	0.272	Normal
Post-test SpO_2 (1MSTST)	0.986	0.258	Normal

The study shows a comparison between the tests, with the independent-samples t-test showing no difference between the tests in terms of pre-test pulse rate (p=0.571) and pre-test SpO_2 (p=0.916), while pulse rate post-test (p=0.002) and SpO_2 post-test (p<0.001) were different between the 6MWT and 1MSTST.

Table 4: Independent Samples t-Test Comparing Physiological Parameters Between 6MWT and 1MSTST (n=98)

Variables		n	Mean ± SD	p-value
Pre-test Pulse Rate	6MWT	98	88.93 ± 6.84	0.571
	1MSTST	98	88.39 ± 6.48	
Pre-test SpO_2 (%)	6MWT	98	93.99 ± 1.97	0.916
	1MSTST	98	94.02 ± 2.06	
Post-test Pulse Rate	6MWT	98	93.15 ± 7.73	0.002*
	1MSTST	98	90.02 ± 6.36	
Post-test SpO_2 (%)	6MWT	98	91.24 ± 2.73	<0.001*
	1MSTST	98	92.93 ± 2.33	

All variables showed p > 0.05, confirming normal distribution and validating the use of parametric tests (paired t-test). asterisk (*) denotes statistical significance at p≤0.050

As shown in the bar chart, in the study's 98 patients with COPD, there was a high rate of concomitant illnesses. Ten patients (10.2%) were hypertensive, while 88 patients (89.8%) did not have hypertension. Six patients (6.1%) were diabetic, and 92 patients (93.9%) were not diabetic. Anemia, hyperthyroidism, and Cor pulmonale were excluded in all patients, leaving no case of any of the three conditions out of 98 (100%). Hypertension was more prevalent overall, and both conditions were the only meaningful comorbidities present among the study population (Figure 1).

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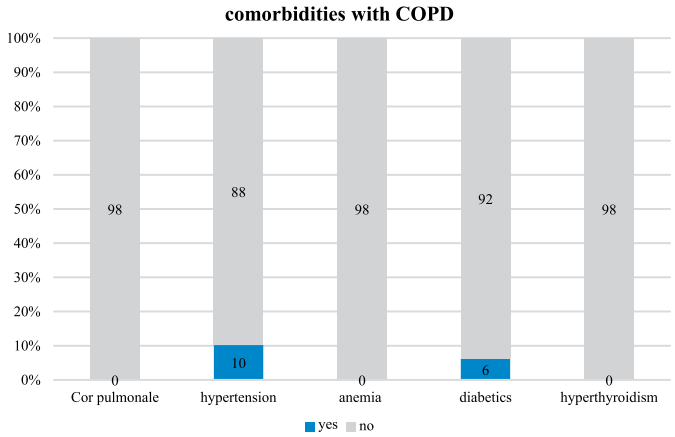

Figure 1: Distribution of Comorbid Conditions among Patients with COPD(n=98)

DISCUSSION

In the present study, both the Six-Minute Walk Test (6MWT) and One-Minute Sit-to-Stand Test (1MSTST) effectively assessed exercise tolerance in COPD patients; however, the 6MWT produced a significantly greater increase in heart rate (from 88.92 ± 6.84 to 93.15 ± 7.73 bpm) and a larger decrease in oxygen saturation (from 93.99 ± 1.97% to 91.24 ± 2.72%) compared to the 1MSTST, where heart rate rose modestly (from 88.38 ± 6.48 to 90.02 ± 6.37 bpm) and SpO_2 declined slightly (from 94.01 ± 2.07% to 92.94 ± 2.34%). Similarly, the study found that the 6MWT induced greater physiological stress, with a mean SpO_2 drop of 3.1 ± 1.6% compared to 1.5 ± 0.8% in the 1MSTST group ($p<0.050$). Both previous studies, therefore, support the present study's conclusion that the 6MWT elicits higher cardiopulmonary demand and provides a more sensitive measure for detecting exertional desaturation in COPD patients [14]. But the practicality and feasibility of 1MSTST, particularly in low-resource clinical settings, make it a useful option. On top of that, it has been previously established that 1MSTST is well correlated with 6MWT as functional capacity predictors and, therefore, is especially useful when space and time are limited [15]. Hypertension and diabetes were the most common among all other documented comorbidities, but the overall prevalence was lower compared to other cohorts [16]. This difference may be due to underdiagnosis or our sample being biased against patients with more severe disease. But even small comorbidity prevalence is of clinical significance as it may also contribute to a faster progression of COPD and increased complexity of its management [17]. The need for and advantage of a systematic screening process for the identification of comorbidities among patients with COPD was recently highlighted by other authors [18] and is in line with our findings. An additional relevant finding was that more than half of the patients were diagnosed within the last five years. On top of that, early intervention is key as benefits to treatment such as smoking cessation, medication therapy, and pulmonary rehabilitation have been shown to improve outcomes when initiated early [19]. Nonetheless, ignorance and difficult access to healthcare represent all of them, and remain as barriers to being diagnosed also in other areas, mainly rural ones [20]. These study results further highlight the complementary purposes of 6MWT and 1MSTST for the assessment of people with COPD. While the 6MWT continues to be considered the gold standard for assessment of exercise capacity and prognosis, the 1MSTST might be a better alternative in outpatient and primary care settings where the necessary infrastructure for the 6MWT is not available [21]. The sensitivity vs. convenience trade-off is one example of how the way functional assessment is done must conform to the healthcare world.

There are some limitations to this study. First, it was conducted at a tertiary care hospital, and the sample may not reflect the general population, particularly in rural areas, in which access to health and exposure risk might be different. Second, the sample was relatively small, which limits the power to identify weak correlations among demographic variables, comorbidities, and functional outcomes. Third, patients with multiple or severe comorbidities were not included, which may have reduced the overall effect of COPD-related comorbidities. Longitudinal outcomes such as frequency of exacerbation and rate of hospitalization, both important indicators of disease progression, were also not assessed. Lastly, functional assessment was limited to 6MWT and 1MSTST; other measures, such as spirometry or cardiopulmonary exercise testing, could have provided a more detailed breath assessment. Given the study findings, the One-Minute Sit-to-Stand Test (1MSTST) and the Six-Minute Walk Test (6MWT) should be incorporated as part of the usual assessment of patients with COPD, since in outpatient clinics or in developing countries where 6MWT requires space and/or several materials are not available, the 1MSTST represents a practical alternative. Similarly, it is going to be important to pursue awareness also for low-literacy and socioeconomic groups to promote early diagnosis and risk management of COPD. Periodic screening for such comorbidities as hypertension and diabetes would be necessary to improve patient outcomes. Also, formal exercise programs and rehabilitation should be promoted as a means to achieve optimal functional capacity, while policy interventions aimed at reducing exposure to environmental risk factors, such as biomass fuel use or urban air pollution exposure, remain essential in preventing overall disease progression.

DOI: https://doi.org/10.54393/pjhs.v7i6.3558

CONCLUSIONS

The 1MSTST is more convenient, space-saving, and a valid alternative to be used for functional assessment, especially in resource-limited settings or outpatient use. These findings support the clinical use of both tests as complementary, considering the 6MWT as the gold standard and the 1MSTST as a feasible alternative when the 6MWT is not feasible.

Authors' Contribution

Conceptualization: RA
Methodology: SA, MY, KR
Formal analysis: SS
Writing and Drafting: AU
Review and Editing: SS, SA, RA, AU, MY, KR

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The authors received no financial support for the research, authorship and/or publication of this article.

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