

# Correlation of Six Minute Walking Test, Sit to Stand Test and Pulmonary Function Test in Patients with Chronic Obstructive Pulmonary Disease

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## ABSTRACT

**Introduction:** Assessment of functional capacity in Chronic Obstructive Pulmonary Disease (COPD) patients helps in determining the severity of the disease. While spirometry is the gold standard, six Minute Walk Test (6MWT) and one minute Sit To Stand Test (STST) are simple and practical tests to assess exercise capacity and physical condition.

**Aim:** To find the diagnostic accuracy of these of 6MWT and one minute STST in comparison with spirometry.

**Materials and Methods:** This cross-sectional study was conducted in the Department of General Medicine at Sri Devaraj Urs Academy of Higher Education and Research, Kolar, Karnataka, India, from January 2019 to December 2019. All cases of COPD diagnosed using GOLD 2018 criteria were included in the study. Patients performed 6MWT and one minute STST. Heart rate, blood pressure, oxygen saturation, SpO<sub>2</sub>, dyspnoea, and fatigue (Borg scale) were noted pretest and post-test. The sensitivity, specificity, predictive values and diagnostic accuracy of the screening test with the decided cut-off values along with

their 95% CI were presented. A p-value <0.05 was considered statistically significant.

**Results:** The mean age of the patients was 64.09±8.31, while there were 112 (94.9%) males and 6 (5.1%) female. Overall, 81.54% of the participants had severe/very severe COPD group, walked <332.49 meters, and only 18.46% could walk more than 332.50 m. The SpO<sub>2</sub> decreased from 93.98±0.82 to 91.75±1.39. During the one minute STST, SpO<sub>2</sub> decreased from 93.98±0.82 to 91.75±1.39. A positive correlation was observed between the one minute STST, and it had good predictive validity in predicting COPD, as compared with spirometry {Area Under the Curve (AUC) of 0.915 (95% CI 0.866 to 0.963, p-value <0.001)}. 6MWT has a sensitivity of 81.54%, the specificity of 79.25%, and one minute STST had a sensitivity of 89.23%, specificity of 67.92% in predicting COPD.

**Conclusion:** In a remote clinical setting, where spirometry is not available, 6MWT and one minute STST are the best methods for assessing COPD severity.

**Keywords:** Exercise capacity, Functional capacity, Sensitivity, Smokers, Specificity

## INTRODUCTION

India has an increasing burden of chronic respiratory diseases. Chronic Obstructive Pulmonary Disease (COPD) and asthma occur more commonly [1]. Chronic obstructive pulmonary disease is a progressive inflammatory disease of the lung characterised by chronic bronchitis, airway thickening, and emphysema. Chronic obstructive pulmonary disease is a major cause of morbidity and mortality and is predicted to become the 3<sup>rd</sup> leading cause of death worldwide in 2030 [2]. Globally, it accounts for around 5% of the mortality. Around 90% of COPD deaths are from low-income and middle-income countries. In India, approximately 30 million people were diagnosed with COPD. Worldwide, the mortality rate caused by COPD was identified highest in India [3].

Pulmonary Function Tests (PFT) are considered to be the “gold standard” for the diagnosis of COPD. Spirometry, lung volumes and diffusion capacity of the lung for carbon monoxide are the three basic components of pulmonary function testing. COPD can affect each of these components. Spirometry airflow measures or PFT results are used to measure the severity of COPD. The exercise capacity in patients with COPD can be assessed using the six Minutes Walk Test (6MWT). The primary outcome measure in 6MWT is the distance walked in six minute. It can be used to evaluate the benefit of pulmonary rehabilitation [4-6]. It is associated with poor health-related quality of life. Hence, it is considered as a potentially useful biomarker in COPD [7]. A 6MWT <350 m indicates a significant increase in the rate of mortality in patients

with COPD [8]. The Sit To Stand Test (STST) is considered as a simple and practical test to identify assess the functional capacity in COPD patients. The inability to perform the movements of standing up and sitting down is associated with mortality and with impairment of function and mobility [9]. The STST can be used to indirectly determine exercise tolerance, as well as, the lower extremity skeletal muscle function [6].

Shah H and Bhatt F found that at the end of 6MWT and STST, there was a significant difference in heart rate, systolic and diastolic blood pressure [10]. Thus, concluded that the STST and 6MWT can be used to assess cardiovascular endurance in COPD. Gurses HN et al., conducted a cross-sectional study in COPD patients in which a moderate correlation was identified between 30 and 60 seconds STS tests and 6MWT [11]. Reychler G et al., concluded that STST can be used to assess functional exercise capacity in COPD patients, and also that STST had good repeatability [12].

One of the major goals in COPD management should be the improvement in functional status as per the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines. Several tests are now available to measure functional exercise capacity. The 6MWT and STST are the most commonly used clinical exercise tests. The relationship between the 6MWT and pulmonary function test in stable COPD remains limited in data. The aim of the present study was, to evaluate the functional capacity among COPD patients by the STST and 6MWT and also, to compare results of both tests to parameters of pulmonary function test.

## MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of General Medicine at Sri Devaraj Urs Academy of Higher Education and Research, Kolar, Karnataka, India, from January 2019 to December 2019. All cases of COPD diagnosed using GOLD 2018 criteria [13] were recruited into the study consecutively, by convenient sampling till the sample size was reached. The study was approved by the Institutional Human Ethics Committee (IEC:130) and informed written consent was obtained from all participants.

**Inclusion criteria:** Clinically stable patients, above 40 years of age, with COPD as defined by GOLD 2018 criteria (FEV1/FVC <0.7), and free of acute exacerbations were included in the study.

**Exclusion criteria:** Patients with ischaemic heart disease/left heart failure, those with resting heart rate >120 bpm and systolic blood pressure >180 mmHg and diastolic blood pressure >120 mmHg, patients with neurological, musculoskeletal and peripheral vascular disease in lower extremities, anaemia, asthma, pneumonia, lung cancer, tuberculosis, asthma COPD overlap syndrome and other respiratory illness limiting patient's movements were excluded from the study.

**Sample size calculation:** Sample correlation coefficient=0.6, population correlation coefficient=0.5, Power (%)=80,  $\alpha$  Error (%)=5, sided=2. The estimated sample size was 72. However, 118 patients were finally included.

### Study Procedure

The COPD patients who satisfied the inclusion criteria underwent spirometry, one minute Sit To Stand Test (STST) and six Minute Walk Test (6MWT). Age, gender, weight and height of patients were noted.

## STATISTICAL ANALYSIS

Chronic obstructive pulmonary disease severity by spirometry, 6MWT distance and STST are primary outcome variables. Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency and proportion for categorical variables. The predictability of 6MWT and STST was assessed by Receiver Operating Curve (ROC) analysis. The area under the ROC curve along with its 95% CI and p-value are presented. Based on the ROC analysis, it was decided to consider 332.49,332.50 and 15.49,15.50 as the cut-off values. The sensitivity, specificity, predictive values and diagnostic accuracy of the screening test with the decided cut-off values along with their 95% CI were presented. The p-value <0.05 was considered statistically significant. The IBM Statistical Package for Social Sciences (SPSS) version 22.0 was used for statistical analysis [14].

## RESULTS

A total of 118 subjects were included in the final analysis. The mean age of the population was 64.09±8.31 with 112 (94.9%) males and 6 (5.1%) females. Based on spirometry findings, a majority (54) of the patients had severe COPD [Table/Fig-1].

Parameters	n (%)
Age (years) (Mean±SD) (Min-Max)	64.09±8.31 (40.00, 75.00)
<b>Gender</b>	
Male	112 (94.9%)
Female	6 (5.1%)
<b>Risk factors</b>	
Hypertension	25 (21.2%)
Type 2 diabetes mellitus	21 (17.8%)
Smoker (yes)	109 (92.4%)
<b>Pulmonary function test</b>	
Post Fev1 (Mean±SD) (Min-Max)	47.48±16.14 (10.0, 94.0)
Post Fev1/Fvc (Mean±SD) (Min-Max)	57.91±12.88 (0.5, 86.3)

Pulmonary function tests stage [13]	
Mild	6 (5.08%)
Moderate	47 (39.83%)
Severe	54 (45.76%)
Very severe	11 (9.32%)

**[Table/Fig-1]:** Descriptive analysis of baseline parameters (N=118).  
FEV1: Forced expiratory volume in 1 second; FVC: Forced vital capacity

The mean 6MWT of the study population was 332.54±67.03, and the SpO<sub>2</sub> decreased from 93.98±0.82 to 91.75±1.39. The mean STST was 15.03±2.41, after which the SpO<sub>2</sub> decreased from 93.98±0.82 to 91.75±1.39 [Table/Fig-2].

Parameters	Mean±SD (Min-Max)
<b>Severity of COPD</b>	
Mild/Moderate, n (%)	53 (44.91%)
Severe/Very severe, n (%)	65 (55.08%)
<b>Six minute walk test</b>	
Mean six minute walk distance	332.54±67.03 (170.0, 450.0)
Heart rate (Beats/min) pretest	72.6±6.36 (60.0, 90.0)
Heart rate (Beats/min) post-test	77.95±7.59 (64.0, 100.0)
Blood pressure pretest	130.73±7.61 (110.0, 150.0)
Blood pressure post-test	136.19±8.27 (110.0, 160.0)
SpO <sub>2</sub> pretest	93.98±0.82 (93.0, 96.0)
SpO <sub>2</sub> post-test	91.75±1.39 (90.0, 94.0)
Bode's index pretest	1.47±0.68 (0, 3.0)
Bode's index post-test	2.47±0.67 (1.0, 4.0)
<b>One minute sit to stand test</b>	
One minute sit to stand test	15.03±2.41 (10.0, 22.0)
Heart rate (Beats/min) pretest	72.6±6.36 (60.0, 90.0)
Heart rate (Beats/min) post-test	77.95±7.59 (64.0, 100.0)
Blood pressure pretest	130.73±7.61 (110.0, 150.0)
Blood pressure post-test	136.19±8.27 (110.0, 160.0)
SpO <sub>2</sub> pretest	93.98±0.82 (93.0, 96.0)
SpO <sub>2</sub> post-test	91.75±1.39 (90.0, 94.0)
Bode's index pretest	1.47±0.68 (0, 3.0)
Bode's index post-test	2.47±0.67 (1.0, 4.0)

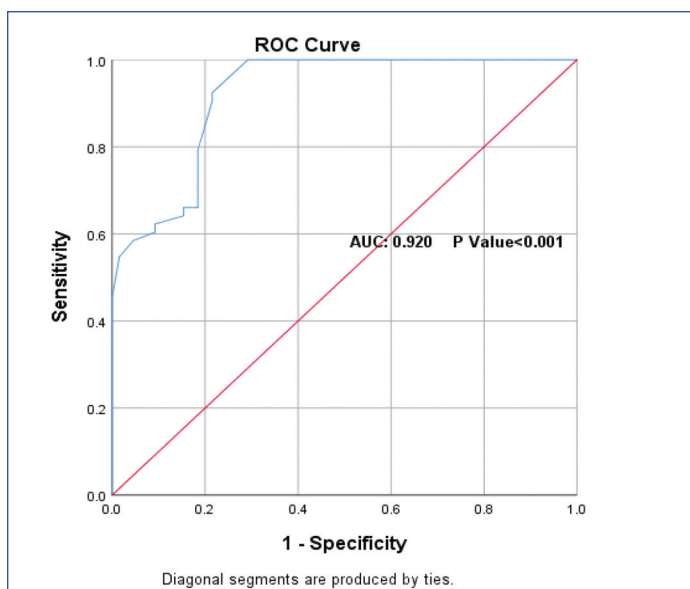
**[Table/Fig-2]:** Descriptive analysis of outcome parameters (N=118).  
BODE: Body mass index, airflow obstruction, dyspnoea, exercise performance

The 6MWT had sensitivity of 81.54% (95% CI 69.97% to 90.08%), the specificity of 79.25% (95% CI 65.89% to 89.16%) in predicting severe COPD spirometry. Diagnostic accuracy of 6MWT was 80.51% (95% CI 72.20% to 87.2%) [Table/Fig-3,4].

The STST had sensitivity of 89.23% (95% CI: 79.06% to 95.56%) and specificity was 67.92% (95% CI: 53.68 to 80.08%) in predicting severe COPD spirometry. Diagnostic accuracy was 79.66% (95% CI: 71.27% to 86.51%) [Table/Fig-5,6]. The 6MWT has good predictive validity in predicting severe COPD as indicated by AUC of 0.92 (95% CI 0.874 to 0.966, p-value <0.001). STST has good predictive validity in predicting severe COPD as indicated by Area under curve (AUC) of 0.915 (95% CI 0.866 to 0.963, p-value <0.001).

## DISCUSSION

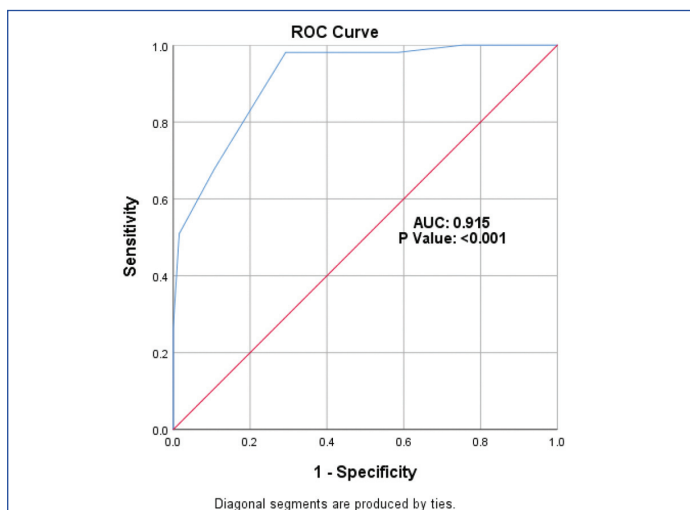
Chronic obstructive pulmonary disease (COPD) has been defined as a preventable and treatable disease [15] and proper diagnosis and management of this disease consequently include evaluation of exercise tolerance aimed at improved orientation towards pulmonary rehabilitation [16,17]. Spirometry though is the gold standard test in assessing COPDs; requires high cost, considerable skill and is not easily available at the peripheral center [18]. The 6MWT is a simple tool widely used for assessing functional capacity in COPDs. It is easy to



**[Table/Fig-3]:** Predictive validity of six minute walk distance in predicting severe COPD spirometry (ROC analysis).

Parameters	Value	95% CI	
		Lower	Upper
Sensitivity	81.54%	69.97%	90.08%
Specificity	79.25%	65.89%	89.16%
False positive rate	20.75%	10.84%	34.11%
False negative rate	18.46%	9.92%	30.03%
Positive predictive value	82.81%	71.32%	91.10%
Negative predictive value	77.78%	64.40%	87.96%
Diagnostic accuracy	80.51%	72.20%	87.22%

**[Table/Fig-4]:** Predictive validity of six minute walk distance in predicting severe COPD spirometry (N=118).



**[Table/Fig-5]:** Predictive validity of sit to stand test in predicting severe COPD spirometry (ROC analysis).

Parameters	Value	95% CI	
		Lower	Upper
Sensitivity	89.23%	79.06%	95.56%
Specificity	67.92%	53.68%	80.08%
False positive rate	32.08%	19.92%	46.32%
False negative rate	10.77%	4.44%	20.94%
Positive predictive value	77.33%	66.21%	86.21%
Negative predictive value	83.72%	69.30%	93.19%
Diagnostic accuracy	79.66%	71.27%	86.51%

**[Table/Fig-6]:** Predictive validity of sit to stand test in predicting severe COPD spirometry (N=118).

perform, reproducible, and inexpensive [19]. The STST is a simple and practical test, widely adopted to evaluate functionality in community-dwelling elderly [9]. The present study was conducted to evaluate the functional status by the STST and 6MWT in patients with COPD and to compare results of both tests to parameters of pulmonary function tests so that they can be considered as an alternative to spirometry at places, where it is not available.

A positive correlation was observed between the 6MWT and spirometry and 6MWT showed good predictive validity in predicting COPD as indicated by the AUC of 0.920 (95% CI 0.874 to 0.966, p-value <math><0.001</math>). The study demonstrated a relationship between the 6MWT and desaturation and heart rate. There was a decrease in  $\text{SpO}_2$  during the 6MWT, from  $93.98 \pm 0.82$  to  $91.75 \pm 1.39$ , similar to that seen in a study by van Gestel AJ et al., [20], but they had a decrease of 7.2%. Meena M et al., [21], reported that 6MWT correlated positively to all spirometer parameters post FVC% predicted (p-value <math><0.0001</math>).

The 6MWT showed a sensitivity of 81.54% in predicting COPD and the specificity of 79.25%. Van Gestel AJ et al., reported the number of steps taken per day related to the number of repetitions in the one minute STST among COPD patients [20]. Although the one minute STST and 6MWT involve different movements, they both elicited similar physiological responses. During the one minute STST, there was a decrease in  $\text{SpO}_2$  from  $93.98 \pm 0.82$  to  $91.75 \pm 1.39$  almost similar to that noted in the 6MWT. This is similar with previous studies that found a decrease in  $\text{SpO}_2$  of 1-2% in the one minute STST [22,23].

In the present study, a positive correlation was observed between the one minute STST with a good predictive validity in predicting COPD as indicated by the area under the curve of 0.915 (p-value <math><0.001</math>). The one minute STST had a sensitivity of 89.23% in predicting COPD, specificity was 67.92%. Vaidya T et al., also demonstrated the utility of the one minute STST in the assessment of COPD patients and reported that its ability to detect a change in exercise tolerance is similar to 6MWT [24].

### Limitation(s)

There were only few women included in the study. Spirometric parameters, such as Diffusing capacity of the lungs for Carbon monoxide (DLCO) and airway resistance, were not assessed in the present study. Obesity is associated with decreased lung function measures, and the study population did not include obese patients. It is recommended to include a larger cohort with a significant number of women exclusively designed to evaluate the effect of gender on the clinical manifestations of COPD.

### CONCLUSION(S)

The gold standard for the diagnosis of COPD is considered to be the pulmonary function tests. Several tests are now available to measure functional exercise capacity. Most commonly used clinical exercise tests are 6MWT and STST. Spirometry, which is the gold standard for grading severity of COPD, will not be available in remote clinical settings and hence, 6MWT and one minute STST are the best methods for assessing the severity.

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