

Effect of Gender and Level of Physical Activity on Sit-To-Stand Test Performance in Patients with Restrictive Lung Disease: A Brief Review

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ABSTRACT

Restrictive lung disease (RLD) is characterized as chronic lung disease associated with interstitial inflammation and fibrosis. Restrictive lung diseases significantly impair physical functioning and quality of life. The Sit-to-Stand Test (STST) is a simple, reliable tool to assess functional capacity and exercise-induced oxygen desaturation in RLD patients. The objective of this review was to evaluate and summarize recent evidence related to the influence of gender and physical activity levels on STS test performance in RLD. A narrative review was performed utilizing literature obtained from the PubMed, Google Scholar, and Scopus databases. Search terms included "Restrictive Lung Disease," "Sit-to-Stand test," "Exercise Capacity," "Gender Differences," and "Physical Activity Levels." A total of ten relevant studies were included, examining various STS protocols and their correlations with pulmonary function, quality of life, and exercise tolerance. The findings indicate moderate to strong correlations between STS performance and other clinical markers. Gender and physical activity levels appear to influence test performance, although direct comparative data remain

limited. There is significant correlation between STS performance and other clinical cardiorespiratory parameters. Further research is required to establish standardized benchmarks and predictive validity across different patient subgroups.

Keywords: Sit-to-Stand test, Interstitial Lung Disease, Restrictive Lung Disease

INTRODUCTION

Restrictive Lung Disease (RLD) is characterized as a chronic lung disease associated with interstitial inflammation and fibrosis⁽¹⁻³⁾. Patients with restrictive lung diseases may suffer from interstitial lung disease (ILD), idiopathic pulmonary fibrosis (IPF), complications of connective tissue disease, occupational disease, and hypersensitivity or medication toxicity, defined by different radiological pictures^(4,5). Patients with restrictive lung disease may present with progressively worsening dyspnea, health related quality of life (HRQoL), fatigue and difficult-to-control cough^(6,7). Approximately, 30% of patients may also suffer from anxiety and depression⁽⁷⁾.

Patients with RLD frequently showed extra-pulmonary clinical features as well, such as muscle dysfunction, lower exercise

capacity, and reduced quality of life⁽⁸⁾. The reduced exercise capacity and physical activity, worsening HRQL, and high levels of fatigue may be due to contributions of abnormal breathing patterns, ventilator limitation, gas exchange abnormalities, pulmonary hypertension, and peripheral muscle dysfunction⁽⁴⁾.

The average life duration of patients with the most prevalent ILD, idiopathic pulmonary fibrosis (IPF), varies from 3 to 5 years following diagnosis in various studies; however, its clinical course is variable.

Patients suffering from ILD have shown a chronic progressive course; hence, the serial monitoring of the disease to assess treatment response is an important part of the routine of the disease management. The standard tests that are used routinely for monitoring include the lung function test and arterial blood gas analysis. However, these tests are done under resting conditions and are usually normal for an extended time during the early course of the disease, and resting hypoxemia only happens when the disease is advanced^(2,3). Also, in addition, the infrastructural cost of both the tests and the need for procedural training limit their universal applicability⁽²⁾.

The recent guidelines for the management of IPF include assessments of exercise-induced gas exchange impairment. In expert institutions, this is consistently assessed due to its correlation with the severity and prognosis of the disease, as well as the extent of ILD as determined by imaging and biopsy. However, such tests are not easily performed in primary care centers or office practices, and there is a need to identify a simple and inexpensive test that can estimate exercise-induced desaturation and can be performed in office practice⁽³⁾.

SIT-TO-STAND TEST IN INTERSTITIAL LUNG DISEASE PATIENTS

Exercise testing has become a recognized tool for assessing disorders and may be beneficial in the early stages of the disease. Various exercise tests, such as the 6-minute

walk test (6MWT), sit-to-stand tests (STST), and others, have been extensively evaluated and validated to assess exercise tolerance in many chronic respiratory diseases, including chronic obstructive pulmonary disease (COPD), interstitial lung disease, and cystic fibrosis⁽²⁾. The American Thoracic Society/European Respiratory Society recommendations suggest assessing exercise-induced desaturation as a prognostic indication in ILD patients⁽⁹⁾.

The sit-to-stand (STS) maneuver is one of the most critical activities for mobility, as per the International Classification of Functioning, Disability, and Health⁽⁹⁾. STS tests using more than one repetition of the STS maneuver examine people's fitness and functional ability. There are various versions of the STS test, including five repetitions (5xSTS), 10 seconds, 30 seconds, and 60 seconds STS (10sSTS, 30sSTS, and 60sSTS), which are the most commonly utilized in research and clinical practice^(9,10).

The Sit-to-stand test (1-STST) has been evaluated in various respiratory conditions. It is a field test that is less time-consuming and requires only a standard chair, on which the patient is supposed to perform stand-up and sit-down maneuvers for a specific amount of time or for a specific number of repetitions⁽²⁾. The available evidence demonstrated a good correlation between the STST and exercise capacity in patients with chronic obstructive pulmonary disease (COPD), pulmonary artery hypertension, and interstitial lung disease⁽⁵⁾.

Sit-to-Stand tests are easier to administer and do not require the space or time needed for the 6MWT, making them a more practical option in many clinical settings. The objective of this review was to evaluate and summarize recent evidence related to the influence of gender and physical activity levels on STS test performance in RLD.

MATERIALS & METHODS

A narrative review was performed utilizing literature obtained from the PubMed, Google Scholar, and Scopus databases.

Search terms included "Restrictive Lung Disease," "Interstitial Lung Disease," "Sit-to-Stand Test," "Exercise Capacity," "Gender Differences," and "Physical Activity Levels." Studies were selected based on their relevance to ILD populations and the use of STS as a primary or secondary outcome measure. Cohort, cross-sectional, and observational studies that were published in English were all considered. Data were extracted regarding study design, participant demographics, STS protocol used, and major findings.

IMPACT OF GENDER AND LEVEL OF PHYSICAL ACTIVITY ON SIT-TO-STAND TEST IN RESTRICTIVE LUNG DISEASE PATIENTS

Physical activity is defined as any bodily activities produced by the skeletal muscle and joints that result in energy expenditure, heart rate and respiratory frequency increment and fatigue in different levels. It can be classified as high, moderate and low. The physical activity level of the patients can be associated with the functional capacity of the person⁽⁹⁾.

Accelerometry is one of the methods of objectively measuring physical activity that involves the use of a device, which is worn on the patient's wrist, thigh, or midsection. Acceleration measurements can be converted into energy expenditure or step count to provide information on intensity of physical activity. Accelerometers are increasingly popular for their accuracy and relative ease of administration⁽¹³⁾.

Self-reported questionnaires are another commonly used and simple way of monitoring physical activity. The International Physical Activity Questionnaire (IPAQ) is a commonly used physical activity questionnaire that assesses the amount and intensity of physical activity in daily living⁽¹³⁾. In patients with ILD, a reliable measure of physical activity would help with prognostic estimate, disease progression assessment, and therapeutic intervention evaluation⁽¹³⁾.

Sit-to-Stand tests are influenced by strength, dynamic balance, and cardiorespiratory endurance and therefore represent overall physical performance rather than muscle strength alone. It has been shown to be reliable, valid, and responsive to intervention and has been used for multiple purposes, including as an indicator of lower limb strength, balance, and fall risk and a measure of disability. Also, there are only few studies which investigated its relationship with physical performance measures.

In several studies gender related differences in physical activity showed that male patients are more physically active than females⁽⁹⁾. But there are scare of studies which investigated the impact of gender on sit-to-stand test in patients with interstitial lung disease.

DISCUSSION

The Sit-to-Stand Test (STS) is increasingly acknowledged as an effective, accessible, and valid assessment of exercise tolerance and physical performance in individuals with Interstitial Lung Disease (ILD). Unlike the 6-minute walk test (6MWT), the STS test requires minimal space and equipment, making it more suitable for routine clinical assessments, particularly in outpatient or resource-limited settings⁽²⁾.

Numerous studies⁽⁹⁾ have identified differences between genders in STS performance, often favored male individuals. This trend is likely related to physiological differences in muscle mass, hormonal profiles, and habitual activity levels. However, it is important to note that the magnitude of difference varies across different STS protocols. The study by Gurses et al⁽⁹⁾ showed that all STS variants (5xSTS, 10sSTS, 30sSTS, 60sec STS) yielded significantly better performance in men. Despite these findings, few studies have focused specifically on dissecting how gender modifies the prognostic or diagnostic utility of the test in ILD.

S.NO.	AUTHOR	OBJECTIVES	DESIGN	SAMPLE SIZE	MATERIAL & METHODS	OUTCOME MEASURES	RESULTS
1	Singh et al. (2023) (2)	Correlate and compare the performance and effect of 1-STST with 6MWT on common cardiorespiratory variables in a cohort of ILD patients	Prospective Observational Study	30 Patients	Spirometry was performed on all patients, measuring forced expiratory volume in one second, forced vital capacity, and the FEV1/FVC ratio. Thereafter, the 6MWT and 1-STST be performed by the patients.	6MWD, 1 -minute STST	Repetitions after 1-STST showed significant correlation with 6MWT. Changes in the physiological variables were similar with good consistency between 6MWT and 1-STST. The 1-STST can be valid alternative to 6MWT in the assessment of ILD patients.
2	Briand et al. (2018) (3)	Compare the 1-min sit-to stand test (1STST) with the 6MWT for the ability to assess exercise induced oxygen desaturation in patients with Interstitial Lung Disease	Retrospective Observational Study	107 Patients	Participants were classified into three groups according to ILD etiology: (i) sarcoidosis, (ii) fibrotic idiopathic interstitial pneumonia, including IPF, fibrotic nonspecific idiopathic pneumonia, and chronic hypersensitivity pneumonitis; and (iii) other ILD. The 6MWT and 1STST were performed on the same day, and pulmonary function tests, pulse oxygen saturation, and dyspnea and fatigue were assessed.	1STST, 6MWT	The SpO ₂ nadir during the 1STST and 6MWT showed good consistency and correlated strongly. The 6MWT distance and the number of repetitions in the 1STST were associated, however the dyspnea ratings during the 1STST were greater than those during the 6MWT.
3	Tsai et al. (2025) (5)	Investigate the diagnostic value of the 1MSTS in predicting short-term mortality and its correlation with the 6MWT.	Prospective, Single-Center Study Design	150 Patients	The pulmonary function tests and 1-minute sit-to-stand test were done every 6 months along with high-resolution computed tomography and cardiopulmonary exercise testing at enrollment and annually	Modified Medical research council (mMRC) score, 36-item Short Form Survey, St. George's Respiratory Questionnaire and the gender-age-physiology index.	The 6MWT distance and the 1MSTS repetitions significantly predicted 18-month mortality. The repetitions of 1MSTS also showed significant correlation with the GAP score, mMRC scale, and 6MWT distance.
4	Labrecque et al. (2022) (6)	Compare exercise capacity, functional mobility, muscle function and composition, and HRQL of a group of ILD participants with a group of	Prospective Study Design	51 Patients	They all performed 6-min walk test, 1-min sit-to-stand test, a Short Physical Performance Battery test, a hand grip test and complete quadriceps function testing. Patient-related impacts were assessed via questionnaires. The frailty status of patients with	6MWT, 1STS test, 5TSTS test time (sec), SPPB score, Hand Grip, Quadriceps, CT scan, UCSD score, CES-D score, SGRQ score	Comparing with the control subjects, ILD participants showed significantly lower performance in every exercise and functional capacity test, higher dyspnea and depression scores and worse QoL. Physical frailty appears to be

		healthy subjects matched for comparable age and sex.			ILD was determined using the Fried frailty phenotype assessment		linked to reduced quality of life, exercise tolerance, muscular and functional deterioration, and worse clinical state.
5	Krinski et al. (2023) (7)	Compare people with ILD who have clinical indications for EOLC with those who do not in order to describe different clinical and functional features of the former.	Cross-Sectional Study Design	58 Patients	ILD individuals underwent various assessments, including lung function, exercise capacity, physical activity in daily life, peripheral muscle strength, maximal respiratory pressures, body composition, quality of life, symptoms of anxiety and depression, dyspnea and sleep quality	6MWT, PADL, Timed-up and-go test, 1STST, 4 m walking speed test, Maximum voluntary isometric contraction (MVIC), SGRQ Scale, mMRC scale, HADS, PSQI.	According to the study's findings, people with ILD who have a recommendation to start EOLC have lower levels of functional performance, peripheral muscle strength, quality of life, daily physical activity, and dyspnea. Anxiety and depression symptoms, body composition, respiratory muscle strength, daytime sleepiness, and sleep quality of life did not differ significantly.
6	Zamboti et al. (2021) (8)	Investigate impairment in functional performance tests in subjects with ILD in comparison to healthy control group & the reliability and validity of these tests in ILD patients	Cross-Sectional Study Design	76 Patients	Participants were asked to perform thrice in a random sequence, a battery of tests comprising seven functional tests: timed-up-and-go at two paces (fast and usual), 4-m gait speed test (4MGS), STS test using three protocols: 30 s STS, 1 min and five repetition STST and Short Physical Performance Balance.	TUGu, TUGf, 4MGS, 30sec-STS, 1min-STS, 5rep-STS, SPPB	Subjects with ILD presented worse lung function, exercise capacity, quadriceps muscle strength and handgrip force. Patients with ILD performed worse on all other functional tests, with the exception of the 30-second STS. Oxygen desaturation was only mild and did not differ between groups ($p > 0.05$ for all). Differences in oxygen saturation between before and after each test were of $\Delta 1 \pm 3\%$ in the 30sec-STS, $\Delta 3 \pm 4\%$ in the 1min-STS, and $\Delta 0 \pm 1\%$ in the 5rep-STS.
7	Gurses et al. (2019) (9)	Determine the Sit-to-Stand (STS) test performance and physical activity levels of young adults and investigate the	Prospective Observational Study	60 Patients	Participants were randomly performed the 5*STS, 10sSTS, 30sSTS and 60sSTSs. Fatigue was rating using the Borg category scale. The International Physical Activity Questionnaire was used to determine the	STST, Physical Activity levels	The 5*STS, 10sSTS, 30sSTS and 60sSTS test scores were statistically different between genders. There was no gender difference in fatigue levels following STS testing. With the exception of the 5*STS

		relationship of STS tests with gender and physical activity levels			subjects' weekly energy expenditure and degree of physical activity.		test, weekly energy expenditures showed a positive correlation with STS tests. Participants with moderate and high levels of physical activity showed significant differences on all STS tests.
8	Cilekar et al. (2023) (10)	Investigate the exercise tolerance in Sarcoidosis patients with sit-to-stand method	Cross-Sectional Study Design	49 Patients	Patients performed 5-repetitions STST, 1-minute STST and the 6-minute walking test along with pulmonary function test, body mass index, and quadriceps muscle strength.	5-STST, 1-minute STST, 6MWT distance	The average 6MWD result of all patients was 410 ± 153 meters. Significant correlations were found when we examined the relationships between 5RSTS and 1MSTS in 6MWT. A significant correlation was observed between 1MRSTS and 5RSTS with quadriceps muscle strength.
9	Oishi et al. (2022) (11)	Examine the 1STST's applicability in determining exertional desaturation in ILD patients whose resting blood oxygen levels are normal.	Retrospective Observational Study	116 Patients	All patients performed the 6MWT and 1STST followed by assessment of oxygen saturation	6MWT, 1STST	1STST was superior to diffusing capacity for carbon monoxide in detecting desaturation during the 6MWT. The 1STST is a substitute for the 6MWT and can be used to measure exertional desaturation in ILD patients with normal resting blood oxygen levels.
10	Trivedi et al. (2023) (12)	Establish the construct validity, responsiveness to pulmonary rehabilitation (PR), and minimal important difference (MID) of the 5STS in IPF	Cohort Study Design	149 Patients	In this, participants underwent an outpatient PR program which comprised two supervised sessions of exercise and education and one unsupervised home-based exercise session/week for 8 weeks. They compared the 5STS with measures of lung function, exercise capacity, quadriceps strength, breathlessness a health-related quality of life before and after PR.	Incremental shuttle walk test, isometric quadriceps maximum voluntary contraction, Medical Research Council Dyspnea scale score, Chronic respiratory Questionnaire total, and King's Brief Interstitial Lung Disease Questionnaire.	The 5STS correlated but very weakly significant with incremental shuttle walk test ($r = -0.55$), QMVC ($r = -0.45$), MRC dyspnea scale score ($r = 0.40$), CRQ-total ($r = -0.21$) but not forced vital capacity percentage predicted or quadriceps 1RM. 5STS time improved with PR.

Similarly, levels of physical activity exhibit a significant association with STS performance. Individuals with higher levels of habitual physical activity consistently perform better on the STS test. This may reflect greater baseline cardiorespiratory fitness, muscular strength, and coordination, all of which are relevant to STS execution. Some studies utilized self-reported questionnaires, such as the International Physical Activity Questionnaire (IPAQ), to quantify activity levels, while others used indirect markers like energy expenditure. Notably, the test appears responsive to interventions like pulmonary rehabilitation, highlighting its utility in tracking progress over time.

Additionally, there is significant correlation between the STS test and other clinical data. For instance, there is a significant correlation between 6MWT distance, quadriceps strength, oxygen desaturation, and HRQoL ratings and STS repetitions or time to completion⁽¹²⁾. The construct validity of the test as a proxy for general functional health in ILD is supported by these associations. Furthermore, the potential for risk stratification is shown by its capacity to forecast unfavorable outcomes, like mortality, as shown in the study by Tsai et al⁽⁵⁾.

However, differences in STS methods, outcome measures, and population variables limit the current literature. Various studies employ 30sSTS, 1MSTS, or 5xSTS, which makes cross-study comparisons difficult. Furthermore, there are no normative data that are specific to ILD severity levels and subtypes. Results can't be applied widely because most research are observational and have small sample sizes.

The goals of future studies should be to standardize testing procedures, examine long-term variations in STS performance, and look into the relationships between clinical outcomes in ILD, gender, and physical activity level. Larger sample sizes and multi-center prospective studies are ideal for establishing evidence-based

thresholds for clinical practice interpretation and application.

CONCLUSION

Research studies included in present review suggest that gender and physical activity level have a significant impact on test outcomes. To improve clinical decision-making and individualized patient management, future studies should standardize test protocols and investigate demographic and clinical moderators of performance. STS tests are a practical, reliable, and valid method for assessing functional impairment in RLD and other disease.

Declaration by Authors

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