



CORRELATION BETWEEN 1-MIN-SIT-TO-STAND TEST AND 6-MIN WALK TEST FOR EVALUATION OF CARDIORESPIRATORY PARAMETERS IN PATIENTS WITH INTERSTITIAL LUNG DISEASE.

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Abstract

Background: -

Six-minute Walk Test (6MWT) is frequently used in patients with Interstitial Lung Disease (ILD's) but requires infrastructural requirements and 1 minute sit to stand test (1STST) has emerged as recent exercise testing modality. But evidence for use of 1STST in ILD patients as a substitute for 6MWT is limited. The study was conducted to evaluate the performance of serial repetition of 1STST by correlating it with 6MWT in ILD patients as well as to compare the effects of these tests on cardiorespiratory parameters in ILD patients.

The Six-minute Walk Test (6MWT) is commonly used in Interstitial Lung Disease (ILD) patients but requires specific infrastructure. The one-minute sit-to-stand test (1STST) has emerged as an alternative, though evidence in ILD is limited. This study evaluated serial 1STST performance by correlating it with 6MWT and comparing their effects on cardiorespiratory parameters in ILD patients.

Material and methods: -

Prospective cross-over study conducted on eighty stable ILD patients (male±female) with mean age 54.8 ± 9.23 who after initial spirometry underwent two repetitions each of 6MWT and 1STST on same day with washout interval of 30 minutes with intervention order generated through computer generated list. Functional capacity and cardiorespiratory parameters including heart rate, pulse oxygen saturation, blood pressure, dyspnea including peripheral oxygen saturation (Nadir SpO₂) were correlated after the tests using Pearson correlation and Intraclass correlation coefficient (ICC).

Results: -

Repetitions after 1STST showed significant correlation with 6MWT distance [1st test:- $r=0.88$; p value:- 0.013^{**}]; [2nd test:- $r=0.28$; p value:- 0.013^{**}]. Both lowest SpO₂ and difference in SpO₂ also showed good agreement. Lowest SpO₂ (ICC=0.62; 95% confidence interval [CI]=0.47–0.74 and ICC=0.81; 95% CI=0.71–0.87 respectively) and significant correlation ($r = 0.29$ and $r = 0.34$, respectively)

Conclusion: -

The findings concluded that there is strong correlation between the performance of 1STST and 6MWT and effect of these exercise tests on common respiratory variables including HR, SBP, DBP, SpO₂, dyspnea and NADIR SpO₂ in cohort of ILD's patients in age range 45-70 years and with moderate degree of ILD. 1STST can be a valid alternative to 6MWT in evaluation of ILD patients.

Keyword:- Interstitial Lung Disease, 6-minute walk test, 1 minute sit-to-stand test, Exercise Capacity, NADIR SpO₂

Introduction

Interstitial lung diseases (ILD) are a heterogenic group of more than 200 diseases characterized by inflammation and progressive fibrosis of the pulmonary interstitium, that leads to reduction in elastic properties of lung, a progressive reduction of lung volumes, and impaired gas exchange¹. These alterations contribute to frequency of symptoms such as chronic cough², dyspnea³, decrease in total lung capacity, diminished exercise tolerance and reduced quality of life in these diseases. ILD patients may represent early pulmonary fibrosis^{2,3}.

Interstitial lung disease shows a prevalence of 4% - 9% in cigarette smokers and a prevalence of 2% - 7% in non-smokers³. Immunosuppressive anti-inflammatory agents are used to treat various forms of ILD⁴.

The American Thoracic Society (ATS) and European Respiratory Society (ERS) guidelines recommend that exercise capacity and exercise-induced desaturation should be assessed in most patients with ILD as an important prognostic indicator and to propose specific interventions, such as cardiopulmonary rehabilitation¹. Hence, serial monitoring of disease to assess treatment response is a vital part of disease management².

Exercise testing has emerged as a promising method of disease evaluation that can also be useful in early phase of the disease². The symptoms limited cardiopulmonary exercise test (CPET) with expiratory gas analysis is gold standard for assessing exercise capacity and determining the cause of exercise limitation. However, widespread adoption of CPET in clinical practice is restricted by the scarcity of pricey equipment and skilled medical personnel to give the test¹.

In patients with ILD, the 6 minute walk test (6MWT) is commonly used to evaluate exercise tolerance and alterations in gas exchange¹. The 6MWT is sensitive, reproducible and does not use any specialized equipment but it is time-consuming and requires 30-meter corridor. 1 minute sit-to-stand test (1STST) requires only a chair and is easy to perform, making it feasible for use in the physician's office⁴. Studies have shown that 1STST is a valuable alternative to 6MWT in COPD patients as 1STST is well tolerated and reliable and is strongly correlated with distance walked during 6MWT¹. However, studies on the use of 1STST in ILD are less with few showing positive correlation between 1STST and 6MWT in terms of lowest/nadir peripheral O₂ saturation^{5,6,7}.

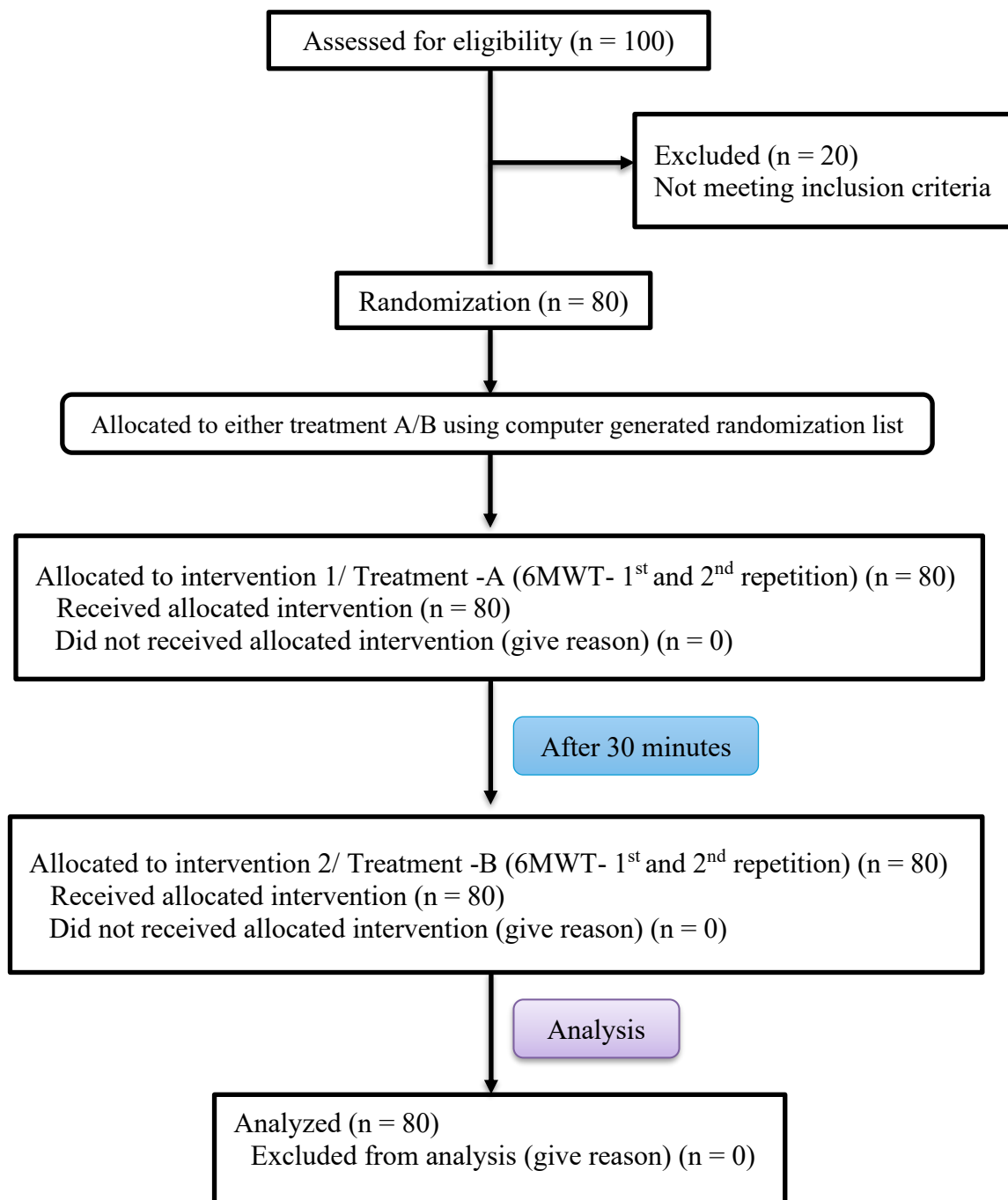
There is dearth of studies conducted on Indian population for correlation between 6MWT and 1STST in ILD patients. A recent study done on Indian population has compared the performance of 1STST and 6MWT and effect of these exercise tests on common respiratory variables in cohort of ILD's patients and has concluded that performance of 1STST was consistent with 6MWT in terms of exercise capacity and change in physiological parameters, but this study had limitations including small sample size and results of serial repetition of both tests were not evaluated.

Thereby, the present study tested the hypothesis that whether there is any correlation between the performance of 1STST and 6MWT and effect of these exercise tests on common respiratory variables including HR, SBP, DBP, SpO₂, dyspnea and NADIR SpO₂ in cohort of ILD's patients 1-min-sit-to-stand and 6-min walk test for evaluation of cardiorespiratory parameters in patients with Interstitial Lung Disease. Also, serial measurements of 1STST and 6MWT were done in order to determine the prognostic value of these tests.

Materials and methods

Study design

This study was cross over study undertaken from July 2024 to June 2025 in a tertiary care teaching hospital Pandit Bhagwat Dayal Sharma University of Health Sciences, Haryana, India. A convenient sampling method was used to gather the data. The ethical clearance was taken from the institutional biomedical research ethical committee of Pandit Bhagwat Dayal Sharma University of Health Sciences, Rohtak with reference to letter No. BREC/24/714. The study was registered in clinical trial registry – India (CTRI) with reference to the registration no. CTRI/2024/07/071435.



Flow chart of the study

Sample size

Clinically diagnosed patients with Interstitial Lung Disease (ILD) were recruited from Department of Pulmonary & Critical Care Medicine (PCCM), PGIMS Rohtak, Haryana. Sample size was determined based on the previous study by Singh et. al. 2023², on the correlation between 6-min walk distance (6MWD) and 1STST repetitions in ILD patients, a minimum sample size of 68 patients was required to achieve pearson correlation coefficient (r) of 0.48 with 95% power and 1% level of significance.

Sample size formula⁸ = $N = [(Z_{\alpha} + Z_{\beta})/C]^2 + 3$

Participants

The study included eighty clinically diagnosed patients with interstitial lung disease (ILD) with mean age of 54.8 ± 9.23 years. Of the total 80 subjects, 73.8% (n = 59) were female and 26.3% (n = 21) were male. Patients were excluded if they had respiratory comorbidities such as chronic obstructive pulmonary disease (COPD) or lung cancer, a history of acute exacerbation or recent respiratory infection, unstable cardiac disease, or any significant joint, musculoskeletal, or neurological disorder. Additionally, individuals who were receiving long-term oxygen therapy were also excluded from the study.

Randomization

Each participant received both interventions – 6MWT (Intervention 1) and 1STST (Intervention 2) were conducted on the same day with a 30-minute washout between tests, and a 15-minute interval between repeated trials of each test. The order of treatment (A/B) to be given to each participant was decided on the basis of a computer-generated randomization list with a 1:1 allocation ratio.

Outcome measures

Cardiorespiratory variables - Heart rate and SpO₂ were measured using a digital pulse oximeter. Both parameters were recorded at baseline and measured immediately post-test to assess recovery and exercise response. Blood pressure was recorded with an automated oscillometric blood pressure measuring device named OMRON UPPER ARM BLOOD PRESSURE MONITOR. MODEL HEM-7121J and the degree of dyspnea was assessed using the Modified Borg Scale. NADIR SpO₂ was measured using a pulse oximeter by recording the lowest oxygen saturation as the average value over three consecutive breaths immediately after the exercise tests.

Procedure

Patients who met inclusion criteria were given information about mode of performance and the risks involved in study using patient information sheet by the therapist before enrollment in the study. Informed consent was taken from all the participants/patients who met the inclusion criteria using patient consent form. Patient assessment was done using patient proforma. Eighty participants were randomly allocated in either of the two treatment groups, Group-A(6MWT) and Group-B (1STST), using sequence generated by computer-generated randomization list, generated using Randomizer.org. All participants randomly allocated in both treatment groups underwent both interventions with serial repetitions. Both the tests 6MWT and 1STST were performed on same day with a washout interval of 30 minutes between 1STST and 6MWT. Also, a washout interval of 15 minutes was given to all participants between serial repetition of either of two tests, i.e. between 1st and 2nd repetition of 1STST and also between 1st and 2nd repetition of 6MWT. Outcome measures including repetitions performed with 1STST, distance walked with 6MWT and cardiorespiratory parameters namely heart rate (HR), blood pressure (BP), SpO₂, dyspnea (Modified Borg's Scale) and NADIR SPO₂ were recorded before (PRE) and after (POST) the performance of corresponding repetition of either of two exercise tests and labelled as:- PRE-A1 and POST-A1 (1st repetition of 6MWT), PRE-A2 and POST-A2 (2nd repetition of 6MWT), PRE-B1 and POST B1 (1st repetition of 1STST) and PRE-B2 and POST-B2 (2nd repetition of 1STST) measurement. Initially participants

were allowed to rest for few minutes till their cardiorespiratory parameters HR, BP, SpO₂ and dyspnea became stable. Following which PRE-A1/PRE-B1 readings were recorded as per the sequence if test generated POST-A1 and POST-B1. Similarly, after 15 minutes and 30 minutes POST-A2 and POST-B2 readings.

Statistical analysis

Data was collected and tabulated in master chart. Statistical analysis was performed with the software package SPSS statistical software (SPSS IBM Version 26) for windows version.

Mean and standard deviation of demographic variables was calculated for all participants and significance of differences in mean values of quantitative data was inferred by paired “t” test ($p < 0.05$).

Comparison for the differences between the effect of serial repetition of 6MWT intervention (group-A) and serial repetition of 1STST intervention (Group-B) on outcome measures including HR, SBP, DBP, SpO₂, dyspnea and NADIR SpO₂ recorded before and after performance of either of two tests i.e. PRE-A1 vs PRE-A2, POST-A1 vs POST-A2, PRE-B1 vs PRE B2 and POST-B1 vs POST-B2 was done using paired sample “t” test.

Comparison for the difference between the effect of 6MWT (group-A) and 1STST (group-B) on outcome measures including HR, SBP, DBP, SpO₂, dyspnea and NADIR SpO₂ with first repetition (PRE-A1 vs PRE-B1, POST-A1 vs POST-B1) and second repetition (PRE-A2 vs PRE-B2, POST-A2 vs POST-B2) was done using paired sample “t” test. Bland-Altman plots were used to interpret between group mean differences.

Also, statistical agreement between all five cardiorespiratory parameters measured before and after performance of consecutive repetitions (1st and 2nd repetition) of 6MWT and 1STST was measured using correlation coefficient (r) :- PRE-A1 vs PRE-B1, POST-A1 vs POST-B1, PRE-A2 vs PRE-B1 and POST-A2 vs POST-B2 and intra class correlation coefficient (ICC):- POST-A1 vs POST-B1 and POST-A2 vs POST-B2.

Correlation between the performance of 6MWT and 1STST (distance walked vs number of repetitions) for 1st and 2nd repetition of 6MWT & 1STST was done using Karl Pearson correlation coefficient (r).

For all the statistical tests, $p < 0.05$ was considered statistically significant and $p < 0.01$ as statistically highly significant.

Results

The demographic data of participants is shown in table 1. Both within and between group comparison using paired “t” test revealed that there were highly significant comparison for the differences between the effect of serial repetition of 6MWT intervention (group-A) and serial repetition of 1STST intervention (Group-B) on outcome measures including HR, SBP, DBP, SpO₂, dyspnea and NADIR SpO₂ recorded before and after performance of either of two tests i.e. PRE-A1 vs PRE-A2, POST-A1 vs POST-A2, PRE-B1 vs PRE B2 and POST-B1 vs POST-B2 was done using paired sample “t” test. Comparison for the difference between the effect of 6MWT (group-A) and 1STST (group-B) on outcome measures including HR, SBP, DBP, SpO₂, dyspnea and NADIR SpO₂ with first repetition (PRE-A1 vs PRE-B1, POST-A1 vs POST-B1) and second repetition (PRE-A2 vs PRE-B2, POST-A2 vs POST-B2) was done using paired sample “t” test. Bland-Altman plots were used to interpret between group mean differences for NADIR SpO₂ also revealed that there was no significant difference between the NADIR SpO₂ level achieved with 1st and 2nd repetition of 6MWT vs 1STST (Table 2 and 3, Figure 1 and 2).

Table 1: Demographic distribution of participants

Characteristics		Mean $\pm$ SD (Range)
Age (years)		54.8 $\pm$ 9.23 (37)
Gender	Male	21 (26.3%)

	Female	59 (73.8%)
Height (cm)		159.16 ± 8.17 (49.8)
Weight (kg)		65.3 ± 12.26 (58)
Duration of ILD (in years)		4.2 ± 3.98 (19)
PFT Values	FVC%	66.26 ± 16.36 (98)
	FEV1%	64.86 ± 17.6 (99)
	FEV1/FVC%	98.8 ± 11.27 (62)

Table 2: Comparison of 6MWT and 1STST assessments for Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure, SpO₂, Dyspnea and NADIR SpO₂ Analysis across different time intervals

		1 st test repetition/ test-A				2 nd test repetition / test -B			
		6MWT-1	1STST-1	t value	p value	6MWT -2	1STST-2	t value	p value
HR	PRE	92.5 ± 13.41	92.84 ± 13.82	-0.4	0.692 (ns)	93.13 ± 14.86	92.94 ± 13.72	0.24	0.808 (ns)
	POST	103.28 ± 13.82	103.39 ± 13.78	-0.13	0.898 (ns)	107.99 ± 15.43	106.96 ± 15.91	1.08	0.283 (ns)
	t value	-10.5	-9.88	-	-	-16.75	-12.86	-	-
	p value	<0.001**	<0.001**	-	-	<0.001**	<0.001**	-	-
SBP	PRE	119.21 ± 15.94	120.54 ± 18.19	-0.85	0.4 (ns)	117.13 ± 16.73	116.21 ± 17.9	0.58	0.563 (ns)
	POST	127.61 ± 20.59	129.44 ± 20.31	-1.17	0.247 (ns)	125.69 ± 20.36	127.05 ± 19.26	-0.97	0.336 (ns)
	t value	-6.79	-7.58	-	-	-5.73	-10.08	-	-
	p value	<0.001**	<0.001**	-	-	<0.001**	<0.001**	-	-
DBP	PRE	78.96 ± 12.34	79.8 ± 9.77	-0.85	0.398 (ns)	78.68 ± 9.73	79.36 ± 10.83	-1.21	0.23 (ns)
	POST	81.34 ± 8.29	81.53 ± 8.69	-0.72	0.472 (ns)	82.66 ± 10.52	83.54 ± 11.79	-0.71	0.478 (ns)
	t value	-1.87	-1.99	-	-	-3.21	-4.82	-	-
	p value	0.066 (ns)	0.05 (ns)	-	-	<0.002**	<0.001**	-	-
SpO₂	PRE	94.7 ± 3.44	93.88 ± 4.96	1.84	0.07 (ns)	94.31 ± 3.87	94.76 ± 4.59	-1.61	0.112 (ns)
	POST	89.46 ± 7.5	89.49 ± 6.79	-0.03	0.974 (ns)	89.81 ± 5.84	90.11 ± 6.03	-1.09	0.281 (ns)

	t value	7.31	7.19	-	-	8.05	7.41	-	-
	p value	<0.001**	<0.001**	-	-	<0.001**	<0.001**	-	-
Dyspnea	PRE	0.95± 1.24	0.96± 1.23	-0.3	0.766 (ns)	1.23± 1.62	1.04± 1.11	1.96	0.053 (ns)
	POST	3.66± 2.24	3.51 ±2.1	1.29	0.2 (ns)	3.95± 2.48	3.9± 2.43	0.3	0.765 (ns)
	t value	-14.78	-14.74	-	-	-11.1	-14.1	-	-
	p value	<0.001**	<0.001**	-	-	<0.001**	<0.001**	-	-
Nadir SpO2	PRE	94.7± 3.44	94.01 ±4.97	1.63	0.107 (ns)	94.31 ±3.87	94.76 ±4.59	- 1.61	0.112 (ns)
	POST	95.48 ±2.57	95.1 ±3.51	1.26	0.213 (ns)	94.5± 3.35	94.93 ±4.09	-1.65	0.102 (ns)
	t value	-2.49	-3.5	-	-	-1.75	-1.42	-	-
	p value	0.015**	0.001**	-	-	0.001**	0.001**	-	-

**highly significant at P <0.01, *significant at P<0.05, NS non-significant at P >0.05

Table 3: Comparison of cardiorespiratory parameters recorded after serial repetitions of 6MWT (POST-A1 and POST-A2) and 1STST (POST-B1 and POST-B2)

Cardiorespiratory variable	Test Time interval	ICC	95% Confidence interval	p-value
HR	Post-A1 vs Post-B1	0.84	0.76-0.9	<.001
	Post-A2 vs Post-B2	0.85	0.78-0.9	<.001
SBP	Post-A1 vs Post-B1	0.77	0.66-0.84	<.001
	Post-A2 vs Post-B2	0.8	0.7-0.87	<.001
DBP	Post-A1 vs Post-B1	0.96	0.94-0.98	<.001
	Post-A2 vs Post-B2	0.52	0.34-0.66	<.001
SpO2	Post-A1 vs Post-B1	0.55	0.37-0.69	<.001
	Post-A2 vs Post-B2	0.91	0.87-0.94	<.001
Dyspnea	Post-A1 vs Post-B1	0.89	0.84-0.93	<.001
	Post-A2 vs Post-B2	0.82	0.73-0.88	<.001
NADIR SpO2	Post-A1 vs Post-B1	0.62	0.47-0.74	<.001
	Post-A2 vs Post-B2	0.81	0.71-0.87	<.001

Figure 1. Bland-Altman plot between NADIR SpO2 mean values of POST-A1 and POST-B1

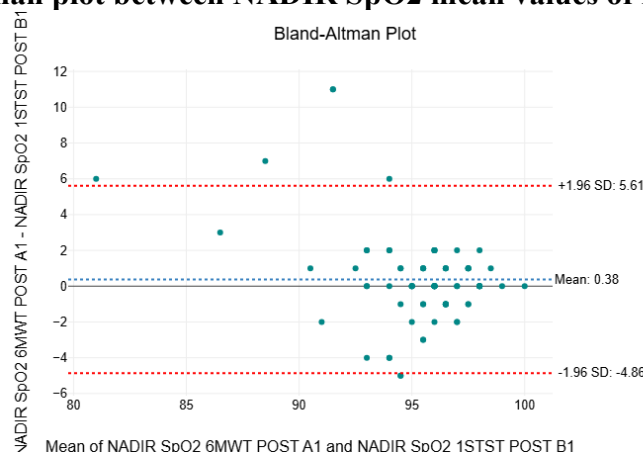
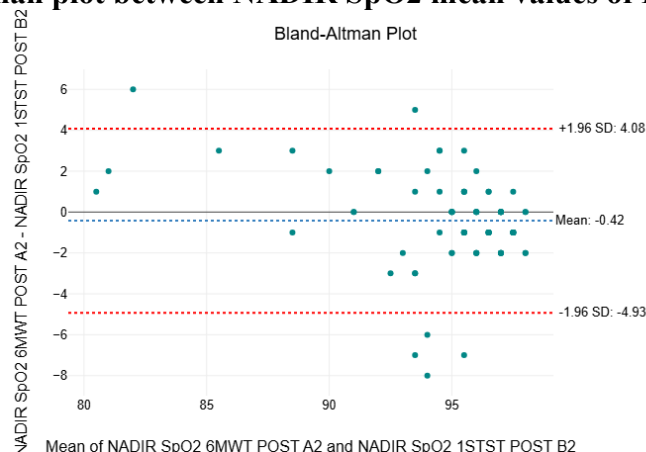


Figure 2. Bland-Altman plot between NADIR SpO2 mean values of POST-A2 and POST-B2



The mean values of distance walked with 6MWT, and number of sit-to-stand(s) recorded with 1st and 2nd repetition of 6MWT and 1STST are shown in table 4. There is significant correlation between the 6MWT distance (A1&A2) and number of times sit-to-stand in 1STST (B1&B2). Pearson correlation of 0.28 suggests a weak positive correlation between 6MWT distance and 1STST repetitions. The p-value for all correlations is 0.013, indicating the correlations were highly statistically significant at a significance level of 0.05. (table 5, fig 3,4)

Table 4: Comparison of 6MWT distance (m) and 1STST repetition

	6MWT A1 distance (m)	6MWT A2 distance (m)	1STST B1 repetitions	1STST B2 repetitions
Mean ± SD	386.24 ± 87.85	375.43 ± 90.84	18.2 ± 4.14	18.06 ± 4.02

Table 5: Correlation of 6MWT with 1STST repetition

		1STST	
6MWT		B1 Repetition	B2 Repetition
A1 Distance (m)	Pearson correlation (r)	0.28	-
	p value	0.013**	-
A2 Distance (m)	Pearson correlation (r)	-	0.28
	p value	-	0.013**

**highly significant at P <0.01, *significant at P<0.05, NS non-significant at P >0.05

Figure 3. Scatter Diagram between 6MWT A1 distance and 1STST B1 repetition

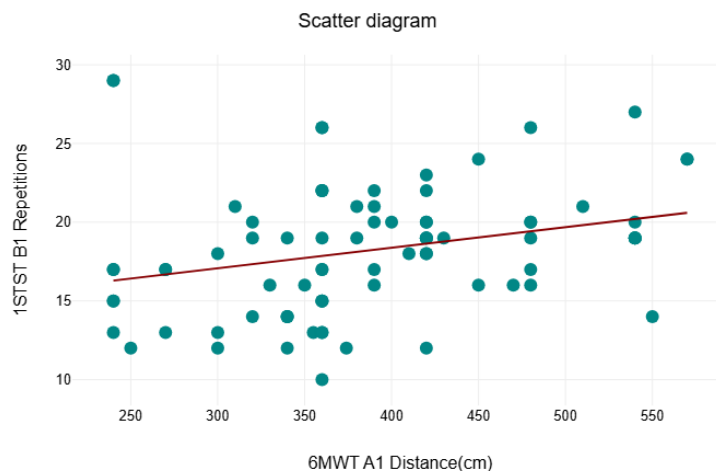
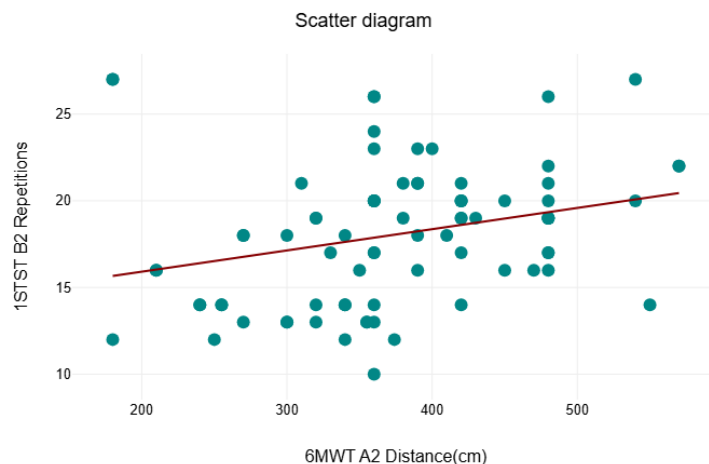


Figure 4. Scatter Diagram between 6MWT A2 distance and 1STST B2 repetition



Discussion

The present study was conducted on ILD because there was dearth of literature evaluating the NADIR SpO₂ and the repetition effect. Thereby in the present study we have calculated the NADIR SpO₂ with the repetition effect, recognizing that repeated testing may alter physiological responses and provide additional insight into patient performance. By examining both the lowest SpO₂ values and the impact of repeated measures, our study seeks to contribute meaningful data that can guide future clinical assessment and management strategies in ILD.

Demographic distribution-

Age:- Mean age of participants was 54.8 years with its range 37 years, reflects the midlife onset and chronic progression commonly observed in ILD population. Our study also highlighted a similar distribution of age groups, suggesting that our study population aligns closely with previously observed patterns. Similar age demographics reported by Fedi et al. (2021)⁹.

Gender:- Predominance of females was 73.8%, there were larger number of female participants as compared to the male participants, and this is being supported by other studies conducted on ILD patients which also concluded that ILD was more prevalent in female gender. Briand et al. (2018) also reported a predominance of women among their study population, suggesting that this gender distribution reflects a broader trend observed in similar research contexts⁵.

Duration of ILD:- The mean duration of ILD at 4.2 years with its range 19 years that corresponds with chronic disease phases documented in similar studies PF TL et al. (2020)¹, Singh et al., (2023)². The consistency of these results highlights that many of the participants were not in the early stages of ILD but rather were experiencing a more established course of the disease.

This demographic information provides context for interpreting the physiological responses observed and ensures that the study findings are relevant and comparable to those from other studies.

Equivalence Between the 6-Minute Walk Tests and 1-Minute Sit-to-Stand in ILD Patients

Heart Rate:- In the results of the present study, first and second repetition of 6MWT and 1STST showed highly significant differences for within group for heart rate because after both tests there was rise in the heart rate values and for both the repetitions conducted. However, when comparing between groups, no significant differences were observed, indicating that the changes in heart rate patterns were similar regardless of the specific test performed. The mean difference between both the tests showed non-significant differences for heart rate in the first repetition as well as in the second repetition. This indicates that both the tests were highly correlated between the PRE and POST values of both the tests and covariance shows highly significant p-value. The ICC of both POST A1&B1 and POST A2&B2 was also highly significantly correlated with these values. These values indicate good reliability between heart rate measurements for both sets that suggest consistency in these variables. Similar results were supported by previous studies which have concluded that heart rate before and after tests were correlated with in ILD patients but in our study, we have done a second repetition also in which also this variable is found to be correlated with the previous one. Previous research such as that by PF TL et al. (2020) and Oishi et al. (2022)^{1,7}, who reported similar cardiovascular stress levels induced by both exercise modalities. The good reliability shown by the Intraclass Correlation Coefficient (ICC) analysis between HR measurements POST 6MWT and POST1STST aligns with the consistency reported in studies by Briand et al. (2018) and Fedi et al. (2021), further supporting the interchangeability of these tests for monitoring cardiopulmonary responses^{5,9}.

Systolic Blood Pressure:- In the result of the present study, the patterns of SBP response during both the 6-minute walk test (6MWT) and the 1-minute sit-to-stand test (1STST) were similar regardless of the specific tests performed. Within group comparison for SBP for first and second repetition of 6MWT and 1STST were highly significant. However, comparing between groups no significant differences were observed. The mean difference between both the tests, there were non-significant differences for SBP in the first repetition as well as second repetition this indicates that both are highly correlated between the PRE and POST values of the tests and covariance shows highly significant p-value the ICC of both POST A1&B1 and POST A2&B2 was also highly significantly correlated with these values these values indicate good reliability between SBP measurements post 6MWT and 1STST for both set of variables, suggesting consistent variables. Similar results were supported by previous studies which concluded that SBP before and after tests were correlated with in ILD patients but in our study, we have done a second repetition also in which also this variable is found to be correlated with the previous one. Singh and colleagues (2023) found that both the 1-minute sit-to-stand test (1STST) and the 6-minute walk test (6MWT) produced similar rises in systolic blood pressure, showing that the shorter, space-saving 1STST can create stress levels comparable to the longer test². In the same line, PF TL et al. (2020) showed that the 1STST reliably triggered meaningful physiological responses in patients with interstitial lung disease (ILD)¹.

Diastolic Blood Pressure:- The result of the present study found that diastolic blood pressure (DBP) responses during the 1-minute sit-to-stand test (1STST) closely match those observed in the 6-minute walk test (6MWT) among patients with interstitial lung disease (ILD). First repetition of

6MWT and 1STST, shows non-significant difference for within group comparison but for second repetition there was highly significant difference for repetition conducted. When comparing between groups, no significant differences were observed, indicating that the changes in DBP patterns were similar regardless of the specific tests performed. The mean difference between both the tests were non-significant differences for DBP in the first repetition as well as second repetition. This indicates that both the tests were highly correlated between the PRE and post values of both the tests and covariance shows highly significant p-values but in Δ mean of POST 2 – PRE 2 covariance is non-significant. The ICC analysis shows strong agreement between DBP measurement post 6MWT A1 and post 1STST B1. Moderate agreement between DBP measurement POST 6MWT A2 and POST 1STST B2. Similar results were supported by previous studies which concluded that heart rate before and after tests were correlated with ILD patients but in our study, we have done a second repetition also in which also this variable is found to be correlated with the previous one. These findings are in line with earlier studies showing that the 1-minute sit-to-stand test (1STST) can serve as a practical alternative to the 6-minute walk test (6MWT) when assessing cardiorespiratory responses in patients with interstitial lung disease (ILD) (Briand et al., 2018; Oishi et al., 2022; PF TL et al., 2020; Fedi et al., 2021; Singh et al., 2023)^{5,7,1,9,2}.

SpO2:- Result of present study compared oxygen desaturation responses during the 6-minute walk test (6MWT) and the 1-minute sit-to-stand test (1STST) in patients with interstitial lung disease (ILD). The findings demonstrate that both tests show similar patterns of decline and recovery in peripheral oxygen saturation (SpO₂), with no statistically significant differences between them. Within group comparisons for SpO₂ for first and second repetition of 6MWT and 1STST were highly significant. However, comparing between groups no significant differences were observed in PRE and POST values of 6MWT and 1STST. The mean difference between both the tests showed non-significant differences for SpO₂ in the first repetition as well as second repetition this indicates that both are highly correlated between the PRE and POST values of the tests and covariance shows highly significant p-value. The ICC of both POST A1&B1 and POST A2&B2 was also highly significantly correlated with these values that indicate moderate to good reliability between SpO₂ measurements in A1 & B1 and excellent reliability between SpO₂ measurements in A2 & B2. Similar results were supported by previous studies which concluded that heart rate before and after tests were correlated with ILD patients but in our study, we have done a second repetition also in which also this variable is found to be correlated with the previous one. Fedi et al. (2021) showed strong concordance between the sit-to-stand protocol and more traditional walking tests in patients with idiopathic pulmonary fibrosis. As highlighted by PF et al. (2020) and Singh et al. (2023), the 1-minute sit-to-stand test (1STST) is not only practical but also well tolerated by patients across different levels of disease severity^{1,2}. In our study, we found that the 1STST led to oxygen desaturation patterns very similar to those seen with the 6-minute walk test (6MWT), showing strong consistency and agreement in post-exercise measurements.

Dyspnea:- In the result of the present study, dyspnea or breathlessness during both the 6-minute walk test (6MWT) and the 1-minute sit-to-stand test (1STST) were similar regardless of the specific tests performed. Within group comparison for dyspnea for first and second repetition of 6MWT and 1STST were highly significant. However, comparing between groups no significant differences were observed in PRE and POST values of 6MWT and 1STST. The mean difference between both the tests showed non-significant differences for dyspnea in the first repetition as well as second repetition this indicates that both are highly correlated between the PRE and POST values of the tests and covariance shows highly significant p-value. The ICC of both POST A1&B1 and POST A2&B2 was also highly significantly correlated with these values indicating good reliability between dyspnea measurements in A1 & B1 and A2 & B2. Similar results were supported by previous studies which concluded that heart rate before and after tests were correlated with ILD patients but in our study, we have done a second repetition also in which also this variable is found to be correlated

with the previous one. These findings support earlier research by Briand et al. (2018), who showed that the 1-minute sit-to-stand test (1STST) can reveal symptoms, and the risk of oxygen drops in patients with interstitial lung disease (ILD)⁵. Oishi et al. (2022) backed this up by demonstrating that patients experienced similar drops in oxygen levels and breathlessness during both the 1STST and the 6-minute walk test (6MWT), even when their resting oxygen levels were normal⁷. Additionally, Fedi et al. (2021) and PF TL et al. (2020) pointed out that the 1STST can bring out symptoms that are just as helpful for understanding a patient's condition as the longer walk test^{9,1}.

NADIR SpO2:- In the result of the present study, in first and second repetition of 6MWT and 1STST there were highly significant differences for within group for NADIR SpO2 because after 4 minute⁶ both the tests there was rise in NADIR SpO2 values for both of the repetitions conducted. However, when comparing between groups, no significant difference was observed, indicating that the changes in NADIR SpO2 patterns were similar regardless of the specific tests performed. The mean difference between both the tests was non-significant for NADIR SpO2 in the first repetition as well as for the second repetition. This indicates that both the tests were highly correlated between PRE and POST values of both tests and covariance shows highly significant p-value. The ICC of both the tests POST A1&B1 and POST A2&B2 were highly correlated with these values. These values indicate good reliability between NADIR SpO2 measurements in A1&B1 and A2&B2 suggests consistency in these variables. Similar results were supported by previous studies which concluded that heart rate before and after tests were correlated with in ILD patients (Singh et al. (2023) but in our study, we have done a second repetition also in which also this variable is found to be correlated with the previous one². Findings of Briand et al. (2018) and Oishi et al. (2022), who showed that the 1-minute sit-to-stand test (1STST) can pick up exercise-related drops in oxygen levels just as effectively as the 6-minute walk test (6MWT) in patients with interstitial lung disease (ILD)^{5,7}.

Distance and repetition:- Result of the present study showed a positive but modest correlation between the distance covered during the 6-minute walk test (6MWT) and the number of repetitions completed in the 1-minute sit-to-stand test (1STST) among patients with interstitial lung disease (ILD). Similar results were supported by previous studies which concluded that heart rate before and after tests were correlated with in ILD patients (SINGH) but in our study, we have done a second repetition also in which also this variable is found to be correlated with the previous one. These results align with previous studies that have also observed positive associations between the 1STST and 6MWT in ILD populations. Briand et al. (2018), Oishi et al. (2022), and PF TL et al. (2020) demonstrated that the 1STST reflects exercise capacity and physiological responses comparable to those recorded during the 6MWT^{5,7,1}. Fedi et al. (2021) and Singh et al. (2023) further supported the feasibility of using 1STST^{9,2}.

Severity of ILD and Correlation between these two tests-

The mean age of participants was 54.8 and FVC% of patients enrolled in study was 66.26 ± 16.36 . As per index, the patients who have FVC% within 60-70% predicted are in moderate ILD category¹⁰. Patients in present study also were in moderate ILD category as per the mean FVC percentage.

Thereby, inference could be drawn that both 6MWT and 1STST are well correlated in terms of their effect on various outcome measures, namely HR, SBP, DBP, SpO2, Dyspnea, NADIR SpO2 and Distance and Repetition. Also, the result is consistent with 1st and 2nd repetition of the tests.

Thereby, we conclude that in this age population with moderate degree of ILD, both these tests are correlated with each other in terms of cardiorespiratory response for first repetition as well as for second repetition. Also, since correlation is positive for moderate ILD, so it can be said that this correlation between both tests holds true for mild ILD also,

but we cannot uniformly apply these results to severe ILD because in severe ILD that might have a separate state of lung restriction, so there is need to further assess the correlation between these tests in severe ILD.

Strengths of the study

- The present study had sufficient power of 95% with 1% level of significance compared to previous studies done by Singh et al.² and Briand et al with less power and 5% level of significance⁵.
- A relatively large sample size was included, which improves the reliability and generalizability of the findings.
- Earlier studies performed only one repetition of the 6-minute walk test (6MWT) and the 1-minute sit-to-stand test (1STST), present study carried out two repetitions.
- The present study evaluated a comprehensive set of outcome measures (heart rate, systolic blood pressure, diastolic blood pressure, dyspnea, oxygen saturation, lowest SpO₂, distance, and repetition), whereas earlier studies often assessed only a limited set of variables.
- Response of these tests has been seen in conjunction with ILD severity in present study which had not been done in previous studies.

Limitations of the study

The findings of present study are based on patients with moderate ILD; therefore, including patients with severe ILD in future studies would make the results more useful.

Conclusions

The findings of the present study lead us to accept the alternate hypothesis that there is strong correlation between the performance of 1STST and 6MWT and effect of these exercise tests on common respiratory variables including HR, SBP, DBP, SpO₂, dyspnea and NADIR SpO₂ in cohort of ILD's patients in age range 45-70 years and with moderate degree of ILD.

Also, the results were consistent in terms of correlation between the performance of two tests and the effect of these two tests on cardiorespiratory variables with both first and second repetition. Serial testing of the 1-minute sit-to-stand and 6-minute walk tests demonstrated the prognostic value of changes in functional capacity and cardiorespiratory parameters over time in patients with interstitial lung disease.

This result indicates that 1STST, being shorter and simpler, can be a valid alternative of 6MWT. This has practical implications, especially in clinical settings where time, space, or patient tolerance is limited. Overall present study provides evidence supporting the interchangeability of these tests in moderate ILD.

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Conflicts of interest

The authors declare no conflict of interest.

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