



## One minute sit-to-stand test as an alternative to measure functional capacity in patients with pulmonary arterial hypertension

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### TO THE EDITOR,

The 6-minute walk test (6MWT) is a widely used approach to evaluate functional capacity in patients with Pulmonary Arterial Hypertension (PAH).<sup>(1)</sup> Despite its reproducibility and ease to perform, adequate space and standardized proceedings are required in order to guarantee its reliability.<sup>(2)</sup>

The 1-min sit-to-stand test (1-STST) has been proposed as an alternative to the 6MWT as a reliable method for individuals with various respiratory diseases.<sup>(3,4)</sup> It is an easy-to-apply and time-saving test, making it feasible to perform at home, in clinical care, or during pulmonary telerehabilitation.<sup>(4)</sup> Sit-to-standing is an ordinary movement that people are generally familiar with, in addition to being linked to the individual's autonomy.

A shorter STST (30 sec) was evaluated in patients with pulmonary hypertension (PH) and showed a good correlation with the 6MWT.<sup>(5)</sup> We aimed to investigate whether a longer version (1-STST) would correlate with the 6MWT and daily activity levels in patients with PAH.

A cross-sectional, observational study was carried out with a convenience sample of patients diagnosed with PAH. We recruited and included patients from the PH outpatient clinic of the State University of Campinas' (UNICAMP) teaching hospital between 2016 and 2018. All patients were required to be clinically stable, without any changes in therapy eight weeks prior. Patients with other lung diseases or orthopedic problems were not included. The institution's Research Ethics Committee approved the study (protocol No. 76543617.9.0000.5404/2017), and the patients signed an informed consent form before enrollment.

After collecting the patients' history and grading their functional class of dyspnea, the subjects underwent the 6MWT and 1-STST and had their steps counted by an accelerometer for seven days. All proceedings were carried out in one week, and the 6MWT and 1-STST were not performed on the same day. The 6MWT was conducted according to ATS Statement guidelines.<sup>(2)</sup> We analyzed the distance walked (6MWD, in meters and % predicted) and the patients' vital signs at the beginning and end of the test.

The 1-STST assesses the ability to perform physical exercises and the muscular strength of the lower limbs. The individual is asked to sit in a chair of standard

height (46-48 centimeters) positioned against a wall. The knees and hips are to be flexed at 90 degrees, and the feet should be flat on the floor and hip-width apart. The patients' hands should rest on their hips, and no support is to be used. Over the course of one minute, the patient must sit and stand up from the chair repeatedly, as quickly as possible. The test starts following verbal command, and the patient is notified when 15 seconds remain. The number of repetitions performed is counted, and the modified Borg scale is used to assess dyspnea and fatigue.

The repetitions of the 1-STST and 6MWT were normalized for body weight.<sup>(6)</sup> Spearman's correlation coefficient (*r*) was used in the analysis of the 1-STST and 6MWT and the accelerometer variables. A *p*-value of less than 0.05 was considered significant. Correlation coefficients of  $\geq 0.6$  denoted a strong correlation, 0.4 to 0.6 a moderate correlation, and  $< 0.4$  a weak correlation. The Mann-Whitney U test was applied to compare the final Borg scores of the 1-STST and 6MWT using the SAS System software for Windows, version 9.4. (SAS Institute Inc., 2002-2012, Cary, NC, USA).

A total of twenty patients (mean age of 44.3 years, 80% female) took part in the study. The baseline characteristics and the results (tests, variables, and correlation analysis) are shown in Table 1. The mean number of repetitions in the 1-STST was 23.8, and the final Borg score was 4.5 ( $\pm 1.5$ ). Meanwhile, the mean value for the 6MWD was 451 meters, and the final Borg score was 4.9 ( $\pm 2.0$ ). The sit-to-stand repetitions correlated with the 6MWD and accelerometer variables. The 6MWD also showed a moderate correlation with the step counts and activity duration (Table 1).

Patients with PAH showed a lower number of repetitions in the 1-STST than healthy subjects,<sup>(7)</sup> in keeping with studies with patients with COPD.<sup>(12)</sup> Similarly, Kahraman et al. (2020) reported a mean of  $12.23 \pm 3.77$  repetitions in a 30-second sit-to-stand test in patients with PH.<sup>(5)</sup>

The number of repetitions in the 1-STST showed a strong correlation with the 6MWD and a moderate correlation with the daily step counts and activity duration measured by the accelerometer. Some studies have shown correlations between the 1-STST and the 6MWD in patients with COPD<sup>(8)</sup> and PH.<sup>(5)</sup>

The 1-STST and 6MWT are both submaximal tests for assessing functional capacity. Nevertheless, there are

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**Table 1.** Descriptive data of the patients and correlation analysis results.

Clinical variables	PAH patients (N = 20)	
Female / Male sex (n, %)	16 (80%) / 4 (20%)	
Age (years)	44.30 ± 13.20	
BMI (kg/m <sup>2</sup> )	26.90 ± 6.00	
Comorbidities	14 (70%)	
Hypertension	4 (20%)	
Diabetes Mellitus	1 (5%)	
Hypothyroidism	4 (20%)	
IPAH / PAH long-term responders to calcium channel blockers / PAH-CD (n, %)	12 (60%) / 4 (20%) / 4 (20%)	
FC I / II / III (n) (%)	7 (35%) / 10 (50%) / 3 (15%)	
<b>1-STST</b>		
Number of repetitions	23.80 ± 6.10	
Final Borg score	4.50 ± 1.50	
<b>6MWT</b>		
Walked Distance (m)	451.50 ± 96.40	
Walked Distance (% predicted value) *	75.60 ± 16.70	
SpO <sub>2</sub> baseline (%)	94.00 ± 2.80	
Final SpO <sub>2</sub> (%)	87.80 ± 7.00	
Final Borg score	4.90 ± 2.00	
<b>Echo variables</b>		
SPAP (mmHg)	70 ± 27	
TRV (m/s)	4 ± 1	
Right ventricle diameter (mm)	40 ± 14	
TAPSE (mm)	16 ± 3	
<b>Accelerometer</b>		
Step counts / day	4,280 ± 2,352	
Activity duration (min)	42 ± 19	
<b>Correlation analysis (1-STST versus 6MWT and accelerometer results)</b>		
	<b>r</b>	<b>p-value</b>
<b>6MWT</b>		
Distance (m)	0.45	0.05
Distance (m/kg)	0.84*	<0.001
Distance (% predicted) ##	0.62	0.003
<b>Accelerometer</b>		
Step counts	0.59	0.006
Activity duration	0.58	0.007

Descriptive data expressed as absolute number and percentage or mean ± standard deviation. 6MWT: Six-Minute Walk Test; SPAP: Systolic Pulmonary Arterial Pressure; TRV: Tricuspid Regurgitation Velocity; TAPSE: Tricuspid Annular Plane Systolic Excursion; ## Enright and Sherril equation. \* Correlation with 1-STST repetitions/kg.

some differences between the two, such as the ability of the 1-STST to evaluate lower limb muscle strength. Several studies have revealed a correlation between the 1-STST and lower limb strength.<sup>(8)</sup> Skeletal muscle strength in the upper and lower limbs is significantly reduced in patients with PH when compared to control subjects,<sup>(9)</sup> and among the mechanisms involved are increased muscle protein breakdown, switching from type I to type II fibers, and reduced capillary density and aerobic enzyme capacity.<sup>(10)</sup> Despite not measuring muscle strength in the present study, it is plausible to assume that the reduction in the number of repetitions in the 1-STST translates into a decrease in the muscular strength of the lower limbs.

We found moderate correlations of the 1-STST and daily step counts and activity duration. Such correlations have already been demonstrated in patients with COPD, although we did not identify studies in patients with PAH. Longer sit-to-stand tests assess exercise tolerance and muscle endurance, features that could have supported the association found herein.<sup>(4)</sup>

This small and single-centered study involved patients who were NYHA Class II and III. Thus, some differences may not have been identified, a fact that hinders generalization to all patients with PH. In spite of this limitation, the results allow us to consider the 1-STST as a promising complementary tool in the multidimensional assessment of exercise limitation

and to measure the functional capacity of individuals with PAH. However, further studies are needed to validate the 1-STST in this context.

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