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Short Communication

The 1-min sit-to-stand test—A simple functional capacity test in cystic fibrosis?

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Abstract

Background: We aimed to assess the measurement properties and the minimal important difference (MID) of the 1-min sit-to-stand (STS) test in cystic fibrosis (CF). **Methods:** Patients with CF were tested during a pulmonary rehabilitation program. Five STS tests were performed during the program; two tests at the beginning (STS_0 and STS_1) and three tests at the end ($STS_{2a–2c}$). Exercise capacity, pulmonary function, and health-related quality of life (HRQoL) and patient-reported health status were measured at the beginning and end of the program. We calculated overall mean, standard deviation, coefficient of variation (CV), and intraclass correlation coefficient (ICC) of the STS test. The MID was calculated using anchor-based and distributional methods. **Results:** Fourteen participants (8 female, mean age 30.4 ± 6.1 years) were included. STS test performance increased significantly from STS_0 to STS_1 indicative of a learning effect. Test–retest reliability for the subsequent $STS_{2a–2c}$ tests was excellent (ICC 0.98, 95% CI 0.96–0.99). The estimated MID for the STS test was 5 repetitions. STS test performance was responsive to change (effect size of 0.97) and correlated with exercise capacity (r = 0.63–0.73) and with the physical functioning HRQoL scale (r = 0.72). **Conclusions:** The 1-min STS test appears to be a reliable, valid, and feasible test to measure functional capacity in patients with CF.

Keywords: Exercise testing; Muscle function; Functional capacity; Minimal important difference

1. Introduction

Cardiopulmonary exercise testing (CPET) with online gas analysis is considered the gold standard method to measure the function and interaction of the lung, heart, and muscles during a standardised load. Simple field tests cannot replace a full CPET, but they are often used as an alternative to assess a patients' functional capacity [1–3] and treatment effects [4].

The 1-min sit-to-stand (STS) test is a simple test to measure predominantly anaerobic capacity and lower limb muscle strength [5]. The assessment of muscle strength (anaerobic capacity) is clinically useful in CF, as muscle strength is related to aerobic capacity [6] and improvements in muscle strength after training are related to health-related quality of life (HRQoL) [7]. The STS test is increasingly used in respiratory disease [5,8] and was found to be a strong predictor of mortality in patients with chronic obstructive pulmonary disease [8]. Importantly, measurement properties and the minimal important difference (MID) have not been established for the 1-min STS test, and the test has not been applied and evaluated in patients with CF lung disease. We aimed to assess the measurement properties and MID for the 1-min STS in patients with moderate to severe CF.

2. Patients and methods

2.1. Patients

Adult patients with CF that participated in a 3-week pulmonary rehabilitation program were included.

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2.2. Methods

Two STS tests were performed at the beginning (STS_0 and STS_1) to control for a potential learning effect and three tests ($STS_{2a–2c}$) were performed at the end of the program for the purpose of evaluating test–retest reliability and the MID. Recovery was at least 15 min if multiple STS were performed on the same day. An example of an STS test with simultaneous gas analysis is shown in Figure S1. The MID was estimated using anchor-based and distributional methods [9]. Maximal exercise capacity (cycle ergometer), functional capacity (1-min STS test), spirometry and HRQoL were measured.

2.3. Statistical analysis

All statistical analyses were performed with the statistical software package SPSS version 22 (IBM Corp. Armont, NY, USA). The full methods and statistical analyses are provided as supplementary data.

3. Results

3.1. Study population

Baseline characteristics of the participants are shown in Table 1.

3.2. Learning effect

The median (IQR) number of STS test repetitions increased significantly from STS_0 ((47.5 (38.5; 60.0)) to STS_1 ((56.0 (48.0; 61.5)) (Fig. 1).

Table 1
Patient characteristics.

	Study participants
N	14
Sex (male/female)	6/8
Age (years)	29 (25.5, 36.0)
Height (m)	1.68 (1.61, 1.77)
Weight (kg)	53.9 (49.0, 65.9)
BMI ($kg.m^{-2}$)	19.7 (18.8, 21.0)
Exocrine pancreatic insufficiency (*N* (%))	13 (92)
Pseudomonas aeruginosa (*N* (%))	14 (100)
CF-related diabetes (*N* (%))	3 (21)
FEV_1 (% predicted)	53.0 (43.0, 56.5)
FVC (% predicted)	67.0 (60.0, 76.5)
SaO_2 at rest (%)	97.0 (96.0, 97.5)
Maximum power ($W.kg^{-1}$)	2.8 (2.0, 3.2)
Peak VO_2 ($mL\ kg^{-1}\ min^{-1}$)	31.9 (22.6, 37.5)
Peak VO_2 (% predicted)	72.6 (53.5, 80.0)
Peak heart rate ($beats\ min^{-1}$)	171.0 (164.0, 179.0)
RER	1.13 (1.06, 1.15)

Data are median (IQR) or *N* (%). BMI, body mass index; CF, cystic fibrosis; FEV_1, forced expiratory volume in one second; FVC; forced vital capacity; SaO_2, transcutaneous arterial oxygen saturation; VO_2, oxygen consumption; RER, respiratory exchange ratio.

3.3. Test–retest reliability

Performance characteristics of STS test parameters are summarized in Table S2, and Bland–Altman plots for comparisons between the three reliability STS tests are shown in Figure S2. The CV for the mean number of repetitions from three reliability STS tests was 3.84%, and the ICC was 0.98 (95% CI 0.96 to 0.99). The mean bias of STS repetitions was 2.29 (95% CI 0.95 to 3.63) and 1.36 (95% CI 0.09 to 2.62) compared to STS_{2a} vs. STS_{2b} and STS_{2b} vs. STS_{2c}, respectively.

3.4. Construct validity

Strong correlations were found between mean STS test repetitions ($STS_{2a–2c}$) and peakVO_2 (% predicted, $r = 0.627$), maximum power (% predicted, $r = 0.733$), and the physical functioning scale of the CFQ-R questionnaire ($r = 0.720$, see Fig. 2). A strong correlation was observed between patient-reported health status (feeling thermometer) and peakVO_2 (% predicted, $r = 0.862$). There were weak to moderate correlations between STS test performance and parameters of pulmonary function (FEV_1% predicted $r = 0.23$; FVC% predicted $r = 0.11$) or body mass index ($r = 0.32$).

3.5. Responsiveness to pulmonary rehabilitation

At the end of the pulmonary rehabilitation program, improvements were observed for STS test performance and peak VO_2, pulmonary function (FVC), and HRQoL scales (Table S2).

3.6. Minimal important difference

The anchor-based analysis, using a change of 4 units in the respiratory symptoms scale (CFQ-R questionnaire) as the anchor, translated into an estimated MID of 5.4 STS test repetitions. This estimate was based on a moderately strong correlation between changes in STS performance ($STS_{2a–2c}$–STS_1) and the respiratory symptom scale during pulmonary rehabilitation ($r = 0.483$).

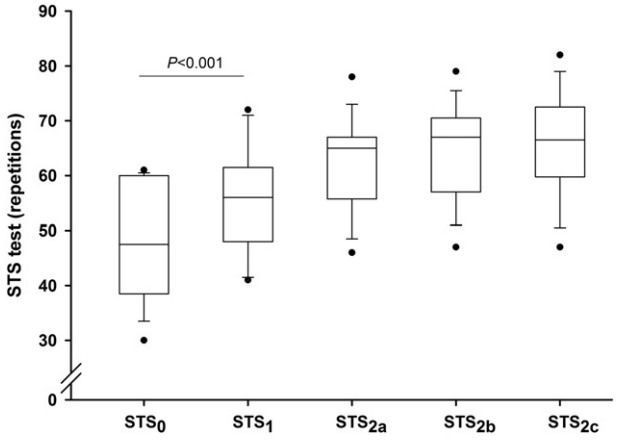

Fig. 1. Boxplots showing median (25th, 75th percentiles) sit-to-stand (STS) repetitions from all STS tests during the pulmonary rehabilitation program. Significant differences were observed between STS_0 and STS_1 indicative of a learning effect ($P < 0.001$). $STS_{2a–2c}$ were used to determine test–retest reliability.