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CARDIOPULMONARY REHABILITATION (MN. BARTELS)

Alternative field exercise tests for people with respiratory conditions

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Abstract Assessment of exercise capacity and physical function is critical in individuals with respiratory conditions. While field walking tests are well-established measures of exercise capacity, alternative options involving walking of a shorter duration, stair or step climbing, and functional activities are also available. This review outlines these alternative tests and their relevant measurement properties, including comparisons with established field walking tests and their clinical applications. The 4-m gait speed and 30-m walking test are walking tests of shorter duration than traditional tests and may be a surrogate marker for exercise capacity. Stair climbing tests require greater body movement against gravity, often imposing a greater workload compared to field walking tests. Functional tests such as sit-to-stand tests provide information related to strength and general functioning. The current measurement properties established, together with the emerging evidence for responsiveness to interventions suggest potential for broader clinical use of these alternative field tests.

Keywords Step tests · Stair tests · Gait tests · Sit-to-stand tests · Activities of daily living · Respiratory disease

Introduction

In people with respiratory conditions, impaired exercise tolerance is a common clinical feature often associated with reduced physical activity [1–3]. Formal exercise testing is frequently undertaken in this population as a method of assessing exercise and physical capabilities [4–6]. The gold standard is the cardiopulmonary exercise test (CPET) [7], which provides a comprehensive overview of integrated cardiopulmonary and metabolic exercise limitations. With the complexity of specialist equipment and training required for CPET, field walking tests including the 6-min walk test (6MWT), incremental shuttle walk test (ISWT), and endurance shuttle walk test (ESWT) emerged as suitable alternatives [5, 8, 9]. These field walking tests are reliable, valid, and responsive measures of exercise capacity in individuals with respiratory disease [10] and easier to implement compared to CPET. However, some practical issues may influence their use, including the need for specific equipment and sufficient space and time required to complete testing, especially when more than one test at baseline is required [5]. Alternative field tests, which have either recently emerged [11••, 12••] or are commonly used in geriatric rehabilitation, have been applied in individuals with respiratory diseases [13–16].

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These tests incorporated activities including walking shorter distances, stair or step climbing, and functional tasks. This paper will review these alternative instruments, the evidence for their measurement properties, and associations with well-established field walking tests (6MWT, ISWT, and ESWT), and will provide suggestions for their clinical role in respiratory conditions.

Walking-based tests

Two variations of the field walking tests, the 4-m gait speed which was originally developed as a marker of multisystemic wellbeing [17] and the 30-m walk test, have been recently applied in people with chronic obstructive pulmonary disease (COPD).

4-M gait speed (4mGS)

From a standing start, individuals walk at their usual pace over a 4-m distance and the speed is calculated using the distance in meters and the time to complete the walk in seconds [18, 19]. Gait speed has gained recent attention as a functional outcome measure in COPD [20]. Usual gait speed over 4 m has shown excellent reliability ($r = 0.97$–0.99) in this population [21] and good convergent validity with the 6MWT ($r = 0.77$–0.82) [22] and ISWT ($r = 0.78$) [21]. In addition, it is associated with COPD severity, symptoms, and quality of life [21, 23]. The 4mGS is responsive to PR with a change of 0.08–0.11 suggested as the minimal important difference (MID) in COPD [12••]. The 4mGS may be useful as a global functional test, particularly in individuals with COPD who demonstrate degrees of frailty [12••], as well as a simple surrogate for the 6-min walk distance (6MWD) in severe COPD [24].

30-M walk test

The 30-m walk test (30mWT) assesses lower extremity muscle function and walking performance. The test requires the individual to walk at a self-selected speed and a maximal walking speed over a distance of 30 m [25]. Self-selected and maximal walking speeds are calculated by recording the time taken to complete this distance from a static start. Strong reliability for the self-selected and maximal speeds of the 30mWT is evident for COPD (ICCs reported as 0.87 and 0.93 respectively) [26•]. Walking speed on the 30mWT is highly correlated with the 6MWD [$r = 0.73$ (self-selected)] and [$r = 0.78$ (maximal)] [26•]. However, a greater change in heart rate (HR), dyspnea, exertion, and peak oxygen consumption (VO_2 peak) was evident with the 6MWT compared to the 30mWT [26•]. The 30mWT is predictive of physical activity levels (PAL) in COPD, with a moderate correlation between self-selected speeds and PAL ($r = 0.424$) [27]. The 30mWT (maximal speed) was responsive to heavy resistance training in COPD [28].

Both the 4mGS and the 30mWT involve walking, a task which is frequently limited in individuals with respiratory disease [6, 29]. Specific advantages and disadvantages of these tests are outlined in Table 1. While gait speed can be derived from the traditional field walking tests or the 10-m walk test or timed up and go [30–33], the short duration of the 4mGS and 30mWT may make testing of exercise capacity less time consuming and strenuous compared to other field walking tests. A track of 4m is feasible in 90 % of households [34], suggesting a possible role of the 4mGS in community- or home-based clinical practice. Although a 30 m track is still required for the 30mWT, the need to increase walking speed from a self-selected speed reflects daily activity [26•], information which is not readily captured in the traditional field walking tests. For a quick screen of exercise capacity incorporating walking in clinical practice, either the 4mGS or 30mWT may be suitable. However, if the goal of exercise testing is to identify individuals who may desaturate during physical activity, a field walking test of a longer duration is preferable. While further work is required to establish the measurement properties of these tests in respiratory diseases other than COPD, the presence of frailty in individuals with pulmonary hypertension and interstitial lung disease (ILD) [35] together with the short duration of both the 4mGS and 30mWT lends support for use of these tests in these conditions. In addition, the preliminary evidence of responsiveness of the 4mGS and 30mWT (maximal speed) to interventions suggests that their clinical application has potential for growth and comparison of their responsiveness to PR with other field walking tests may be worthwhile.

Stair climbing tests

Stair climbing is a task which may induce dyspnea in individuals with cardiopulmonary conditions. For this reason, formal measures of stair climbing capacity and step testing may be useful modes of assessing exertional dyspnea in a task which involves large muscle groups and movement against gravity [36].

Stair climb power test (SCPT)

The SCPT is a functional performance measure requiring individuals to ascend a flight of 10 stairs as quickly and safely as possible, using a handrail if necessary [37]. Stair climb power (power = force × velocity) is calculated using the individual's weight, the vertical stair height of the stairs, and the speed at which they ascended. Two trials are typically performed with the average recorded [38].

Table 1 Advantages and disadvantages of field exercise tests in respiratory disease

Tests	Construct	Advantages	Disadvantages
4mGS	Gait speed, exercise capacity	Easy to perform, no specialist operator training, short distance required, data available for reliability and validity, and some responsiveness for COPD	No data on measurement properties for other respiratory diseases
30mWT	LL muscle function, walking performance	Easy to perform, requires minimal equipment, less time to complete (15 min), data available for reliability and validity, and some responsiveness for COPD	Requires track distance of 30 m, no data on measurement properties for other respiratory diseases. Does not detect desaturation during physical activity
Stair climbing tests	Exercise capacity, leg power	Easy to administer, require little equipment, SCPT is valid and reliable in COPD, practical test for clinical situation when stairs are available	Lack of standardization for SCT, lack of reliability for SCT, no data on responsiveness for any type of SCT
		SCT valid measure of exercise capacity, morbidity, and mortality following lung resection	
Step tests	Exercise capacity	Require minimal equipment, little space required, multiple options for protocols and workload available, data available for reliability, validity, and responsiveness for selected tests	Data not available for a broad variety of respiratory conditions, selected protocols may not assess maximal exercise capacity, depending on lung disease
Sit-to-stand tests	Lower limb strength	Easy to implement, quick to perform, requires minimal equipment, easy to standardize, data available for reliability and validity for COPD	Data not available for measurement properties for many respiratory conditions, limited information related to responsiveness
ADL-based tests	Function	Incorporates a mix of functional, sequential tasks, data available for validity, reliability, and responsiveness in COPD	Data for reliability and responsiveness of the GST and Glittre not available for other respiratory conditions, GST requires specific equipment, including set table height (90 cm) and specific shelf height (15 cm above individual 90 deg shoulder flexion), Glittre requires 2-step rise and shelving unit, and cartons of set weights

4mGS 4-m gait speed, *30mWT* 30m walk test, *LL* lower limb, *COPD* chronic obstructive pulmonary disease, *mins* minutes, *SCPT* stair climb power test, *SCT* stair climbing test, *ADL* activities of daily living, *GST* grocery shelving task

While the SCPT was originally developed as a measure of leg power associated with mobility performance in older adults [38], this test has shown high test–retest reliability and convergent validity with measures of muscle strength ($r = 0.23$–0.53), mobility ($r = 0.46$), and the 6MWT ($r = 0.68$) [39] in COPD. Its potential as a test of functional muscle power in COPD supports further exploration of its association with other measures of exercise performance and muscle power.

Stair climbing test (SCT)

The SCT was originally applied in people with osteoarthritis as a measure of mobility and climbing [40]; however, the SCT has been used as a measure of exercise capacity in individuals with respiratory disease [13, 41, 42•, 43, 44]. Performance of the SCT has not been standardized, with stair height and number, initial instructions, and the use of encouragement varying between studies [13, 41, 42•, 43, 44]. Key outcome measures include time, stairs climbed, stair climbing power calculated accounting for patient's body mass, work, total height of stairs, and estimated or maximal oxygen consumption [13, 41, 42•, 43, 44].

In respiratory disease, the reliability and responsiveness of the SCT have not been established, nor has the SCT been used to evaluate the effect of interventions [4]. However, it has demonstrated convergent validity, with a positive association between step number and lung function in individuals undergoing lung resection. When related to VO_2 peak, a strong correlation with height achieved [45, 46], testing speed ($r = 0.67$) [47], and time spent climbing the steps ($r = -0.71$) [48, 49] was evident in individuals either undergoing or who have undergone lung resection, with similar findings in COPD [50].

Mortality following major lung resection is related to the number of steps climbed during the SCT [51]; those unable to perform a preoperative SCT had a higher risk of mortality [52]. While there is no agreement regarding the minimum height predictive of postoperative complications (POC) [13, 43, 53]; those climbing less than 12 m had a mortality rate which was 13-fold greater compared to those climbing more than 22 m [43]. Performance of the SCT is a significant long-term prognostic factor in resected non-small cell lung cancer, with 5-year survival rates significantly longer in those climbing greater than 18 m [42•]. The time taken to reach a specific height is clinically

relevant; completing the SCT in less than 30 s was associated with a reduced rate of POC compared to those requiring 50 s [41]. Oxygen desaturation during the SCT is a significant predictor of complications [44] and mortality in patients undergoing a lobectomy [54].

While there are advantages and disadvantages of stair climbing tests (Table 1), the existing measurement properties will influence the choice of test. Standardization is critical in their clinical application to determine their response to interventions. Despite the lack of broad application in respiratory conditions, either the SCPT or SCT could be an option for assessing exercise capacity in settings with access to stairs. When used to derive information on muscle power, the stair climb tests can offer unique information not captured in the 6MWT, ISWT, or ESWT. Further study of measurement properties, including responsiveness to interventions, will facilitate their broader clinical use.

Step tests

Several types of step tests (involving a single step rather than consecutive stairs) have been applied in respiratory conditions, with protocols of varying duration, workload, and pacing.

Self-paced step tests

6-M step test (6MST)

The 6MST is similar to the 6MWT, but uses a 20 cm step, with individuals instructed to step up and down as fast as possible in 6 min. Standard encouragement is given with the number of steps/minute recorded [55]. In individuals with ILD, it is a highly reproducible test (mean difference of 1.1 steps) and demonstrates strong convergent validity with VO_2 peak in CPET ($r = 0.52$). The VO_2 peak in a 6MST is 90 % of that achieved during a CPET, while desaturation was comparable between tests. This suggests that in ILD, this field test is a suitable reflection of maximal exercise capacity, but may be better tolerated compared to a CPET [55].

A slight variation of this protocol with a 4-min duration demonstrated that desaturation to 89 % correlated with a 39 % 4-year survival rate in individuals with idiopathic pulmonary fibrosis (IPF), compared to 96 % in those with no desaturation [56]. This protocol was sensitive to change following PR in IPF and in COPD [57, 58].

6-Min stepper test

The 6-min stepper test utilizes a stepper with hydraulics, set at a height of 20 cm, with an individual instructed to complete as many strokes as possible over 6 min. The number of complete strokes (step up and down with both feet) is recorded each minute, with individuals determining their own cadence [59, 60]. In COPD, this test has demonstrated strong reliability (ICC = 0.92) [60], although there is evidence of a learning effect [59, 60], attributed to the necessity to warm up equipment hydraulics [60]. When validated against the 6MWT, stepper performance moderately correlated with the 6MWD ($r = 0.42$) [60] and achieved a similar level of leg fatigue, although the stepper test was associated with higher VO_2 peak [59]. In individuals with IPF, this test was sensitive to change following PR [57].

The hydraulic test may be a suitable alternative to regular step tests for assessing exercise capacity in individuals with respiratory diseases who are at risk of falls, with this test eliminating the need for stepping on and off a platform. It could also serve as a means of exercise training as part of PR in various clinical environments; however, the cost of this equipment and potential financial constraints of specific PR programs may limit the wide use of this test.

Externally paced tests

3-Min step test (3MST)

The 3MST is conducted on a 15 cm step, with a constant rate of 30 steps/min, with the cadence controlled by a metronome. Standardized encouragement is given with monitoring of HR, SpO_2, and number of steps recorded, and the test is ceased if the participant becomes too tired to continue or if SpO_2 falls below 75 % [61]. Individuals can change leading legs to minimize fatigue [58].

In patients with mild cystic fibrosis (CF) and in children and adults with moderate to severe disease, the 3MST is a reproducible test for physiological and symptom parameters [61], step number, and oxygen desaturation [16, 61, 62], which may be attributable to the external pacing. In children with CF, a greater maximum HR response was demonstrated with the 3MST compared to the 6MWT [61, 62]. Desaturation occurred over a shorter time frame in the 3MST [61], suggesting the test induces a greater challenge to the respiratory system in CF compared to the 6MWT, particularly in children and adults with moderate to severe disease [16, 63]. In contrast, a ceiling effect was evident in those with mild CF [61, 63]. Of clinical importance is this tests' responsiveness to antibiotic therapy in children with CF [64] and its prediction of total hospital days over a 12-month period in adults who desaturated below 90 % during the test [16].

As a diagnostic tool, when applied to individuals with asthma, the 3MST was able to induce exercise-induced asthma (EIA) in 55 % of patients, demonstrating a strong reproducibility for fall in FEV_1 (mean difference 0.7 % (limits of agreement −4.5 to 5.9 %) [62] and stronger

diagnostic sensitivity (sensitivity of 88 % and specificity of 97 %) compared to a treadmill test [65].

Constant load tests

An alternative step test designed to maintain a constant load involves an individual stepping on a 25 cm platform at a rate of 15 steps/min for 10 min, with the individual continuing for as long as possible [66]. The number of steps strongly correlated with workload on CPET ($r = 0.74$) and 12-min walking distance ($r = 0.52$) in COPD. Similar to other paced step tests, a higher minute ventilation and VO_2 peak was reached compared to a CPET or 12MWT [66], reflecting the metabolic and ventilator stress imposed by this test in COPD.

15-Step exercise test (15-SET)

The 15-SET requires an individual to step up and down a platform (height: 25 cm), 15 times as fast as possible with the total exercise time and time to lowest saturation level (desaturation time) recorded [67]. Although the stepping rate is not as carefully controlled as the 15 steps/min test, it is completed within a short time frame. However, the limited duration is likely to limit the tests' association with other exercise measures. In IPF, the degree of desaturation was a predictor of VO_2 peak ($r = 0.43$) [68], but this was not related to 6MWD in COPD [69]. Although not widely used, it could provide some value in circumstances in which a quick, easy step test is required. For selected diagnoses (including IPF and other types of ILD), this test may provide an accurate reflection of maximal exercise capacity and extent of desaturation due to the test intensity.

Other variations of step tests which incorporate a constant workload have been tested in individuals with asthma. Stepping up and down on a single step of 15–20 cm in height (adjusted to meet individuals' height) requires individuals to step at a rate sufficient to maintain a HR between 150 and 200 bpm. When applied in school-aged children with asthma to assess exercise-induced bronchospasm, this test accurately diagnosed EIA in 88 % of students [70].

Incremental step tests

Chester step test (CST)

The CST is performed using a 20 cm single step (without handles) and is composed of an incremental protocol, including five stages, each of which is 2 min in duration. Test cadence is determined by a metronome, which commences at 15 steps/min and increases by 5 steps/min. The test terminated on the following criteria: maximum time of 10 min, intolerable dyspnea or fatigue, or inability to maintain cadence for 15 s [71]. The outcome of the test is number of steps.

The CST is reproducible in COPD, for step number (ICC = 0.99), symptoms (ICCs > 0.86), and physiological responses (ICCs > 0.91). This reproducibility is likely to be influenced by the incremental protocol; a change in cadence and the associated increase in perceived exertion may be precipitated by individuals [71]. The number of steps is also moderately related to 6MWD ($r = 0.60$) and peak workload achieved during CPET ($r = 0.69$) [71]. This association between CST and CPET suggests that the step test could be an alternate measure of maximal exercise capacity in COPD, but the shorter duration of the CST may be better tolerated by patients, yet still fulfilling the criteria of at least 8 to 10 min for a maximal exercise test [7].

Modified incremental step test (MIST)

The MIST is similar to the CST, but with a slower initial step rate (10 steps/min) and incremental size (2 steps/min), with the same criteria for test cessation [55, 72], with the addition of an inability to maintain the pace for 15 s [72]. In moderate to severe COPD, this test was reproducible for step number (ICC = 0.99) and physiological parameters (ICCs > 0.93) [55], although a learning effect was demonstrated. However, VO_2 peak was higher in MIST compared to the CST in COPD [72].

A slight variation of this protocol is that it comprises four bouts of 3 min of exercise at a constant stepping rate of 18, 22, 26, or 32 steps/min, designed to reflect energy requirements equivalent to VO_2 between 15 and 25 ml O_2/kg/min [73]. When applied in COPD, it is feasible in those with Stage II–IV disease [29], with no adverse events.

Like a stair climbing test, a step test, irrespective of its protocol, is a measure of an individuals' work against gravity and therefore is relevant to mobility both within and beyond the home. It is also often incorporated as a measure of frailty in broader tests of physical function [74]. With evaluation of frailty growing in significance in chronic respiratory conditions, the near maximal effort required for a step test maximizes the ability to reveal the presence and extent of frailty [75]. There are several advantages and disadvantages of this class of test (Table 1). When compared to field walking tests, different protocols can impose a greater metabolic and cardiovascular stress, although the ability to measure maximal exercise capacity is specific to the protocol, the respiratory condition and degree of disease severity. Its potentially portable nature is appealing to different clinical environments. The responsiveness of selected tests (6MST and 6-min stepper test) to PR supports their role as outcome measures for this intervention. This may be particularly

useful in home or community settings, where corridors of sufficient length for a field walking test may not be readily available and shortened track lengths may underestimate exercise capacity [76]. The choice of step test will depend on the test objective and the patient tolerance.

Sit-to-stand tests

The sit-to-stand (STS) test is a widely used test to measure basic mobility and functional lower limb muscle strength in older adults, and can be easily performed in different settings (home, primary care, and hospital). Similarly to different forms of step tests, STS tests are included as part of broad assessment of frailty [74], measuring lower body strength and the possible contribution of fatigue during a demanding daily activity [77]. There are different versions of the STS test, each test commencing with the individual seated in a straight-backed chair, feet flat on the floor.

Five repetition sit-to-stand test (5STS)

The five repetition sit-to-stand test (5STS) requires the individual to stand up fully and sit down 5 times as quickly as they can, with time recorded. One practice trial is necessary [78, 79]. With normative values for the elderly established [78, 79], individuals with COPD generally take 21–46 % longer to perform the test [39, 80].

When applied in COPD, the 5STS is reproducible (ICC = 0.97) [11••] and demonstrates moderate convergent validity with the incremental shuttle walk distance (ISWD) ($r = -0.59$), quadriceps maximal voluntary contraction ($r = -0.38$), and a weak to moderate relationship with QOL ($r = 0.35$) and dyspnea indices ($r = 0.42$–0.46) [11••]. It is also responsive to PR in COPD, with a MID of −1.7 s established [11••, 81].

1 Min sit-to-stand (1-min STS)

In the 1-min sit-to-stand (1-min STS) test, following one practice demonstration, the individual is instructed to stand up fully and sit down again as many times as possible over 1 min, with the number of repetitions recorded. Normative values for the elderly are available [82]. A slight variation in this protocol is the duration of 2 min [83].

In COPD, the number of repetitions on a 1-min STS significantly correlates to dyspnea severity ($r = 0.80$) [14], quadriceps strength ($r = 0.65$) [14, 84], and physical activity ($r = 0.51$) [85], while both the 1-min STS and 2-min STS test were associated with the BODE index [83, 86]. Although the 1-min STS test cannot be used to predict physical inactivity [85], it is a strong predictor of 2-year mortality in COPD [87]. Despite the strong correlations between the 1-min STS test and the 6MWD ($r = 0.75$) and lower limb muscle activity in COPD [14], the lack of change in cardiovascular parameters with a 1-min STS test compared to the 6MWT suggests that this step test induces a similar muscle effort, but a lower cardiovascular stress [14].

30-S sit-to-stand (30 s STS)

The 30 s STS test is a measure of functional lower extremity strength [85]. An individual is asked to stand up fully and sit down repeatedly for 30 s, with the number of full stands completed recorded [88, 89]. In COPD, the 30 s STS is moderately correlated with measures of leg strength (One repetition maximum) ($r = 0.46$) [90, 91].

3-Min chair rise test (3-min CRT)

For the 3-min CRT, an individual stands and sits for 3 min with their hands on the hips. The therapist provides the rhythm for the first minute by a verbal order "sit," "stand" or by sitting and standing with the patient [92]. For the remaining 2 min, patients are asked to stand and sit as many times as possible. The number of repetitions performed during the 3 min is recorded.

For each of the three 3-min CRT variations (repetition number), strong reliability has been demonstrated for the total number of rises ($R^2 = 0.83$–0.94) [92], with physiological variables of HR, SpO_2, fatigue, and dyspnea shown to be highly reproducible in COPD. The number of rises in each CRT has been shown to be significantly related to 6MWD ($r = 0.82$–0.90). This test exerts a higher intensity of dyspnea and fatigue compared to the 6MWT in COPD [92].

The advantage of these sit-to-stand protocols is their simplicity in execution [93] and their applicability within multiple settings. Although originally developed as a measure of strength, in COPD, they can also reflect exercise capacity and possibly cardiorespiratory limitations to exercise, although the presence of a floor effect observed for the 5STS and 1-min STS test may limit their clinical application. Aside from COPD, these tests have been applied in asthma [94] and lung transplant recipients [95]. Evidence of responsiveness of the 5STS to exercise training is encouraging and suggests the potential for greater use as a marker of functional strength in COPD.

ADL-based tests

Glittre test

The Glittre test is a simple, standardized test of functional status focusing on the capacity of the individual to perform activities of daily living (ADL). Activities included are

walking, lifting objects, carrying, bending, and rising from a seated position [96]. The main outcome is ADL-time (minutes) which is significantly higher in COPD compared to healthy age-matched controls [97].

Two tests, performed on consecutive days, demonstrated test–retest reliability ($r = 0.93$) in COPD and ADL-time and 6MWD were also strongly correlated ($r = -0.82$) [962]. Notably, the Glitter test appears to lead to significantly higher oxygen uptake than the 6MWT in COPD, perhaps as a consequence of involving a greater number of muscle groups [98]. The test was also responsive to PR in COPD [96].

Grocery shelving task (GST)

The GST is a standardized measure of functional performance involving both upper and lower limb movement [99]. Activities included are rising from a seated position, bending, and lifting [99], with time required to complete the task recorded. In COPD, it has demonstrated strong reliability (ICC = 0.97); the VO_2 peak of the GST is strongly correlated with VO_2 peak of an upper limb exercise test ($r = 0.82$) and is responsive to PR [99].

As tasks which incorporate upper and lower limb movement, the GST or the Glitter may be a suitable substitute for the assessment of exercise capacity by importing a measure of functional capacity required for daily life which is not readily captured with field walking tests or CPET, but is a recommended outcome measure in PR [100].

Conclusion

Assessing exercise capacity and physical function is an important outcome in individuals with pulmonary conditions. Together with the CPET and well-established field walking tests, alternative tests involving walking of a shorter duration, step/stair climbing, sit-to-stand, and ADL-tasks are also available. With established reliability and validity largely in COPD, as well as other selected respiratory conditions, these alternative tests not only require minimal training, space, and equipment, but are likely completed in less time and therefore may be more practical to undertake in some clinical settings depending on the goal of the assessment. Finally, emerging evidence supporting their responsiveness to interventions suggests the potential for greater clinical use across a broader range of respiratory conditions.

Compliance with Ethics Standards

Conflicts of Interest No authors have any potential conflicts of interest relevant to this article.

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- •• Of major importance

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