

Balance assessment in people with COPD: An evidence-based guide

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Abstract

Balance problems and an increased rate and risk of falls are common in people with chronic obstructive pulmonary disease (COPD). Although a balance assessment is now recommended by clinical practice guidelines for pulmonary rehabilitation, specific tests have yet to be suggested. The purpose of this review is to provide an evidence-based synthesis of balance measurement in older adults and in people with COPD, to guide practice in this area. An overview of best practices for assessing balance and fall risk in older adults is provided along with a practical synthesis of evidence to date on common balance measures used in people with COPD such as the Timed Up and Go, Single Leg Stance, Berg Balance, and Mini and Full Balance Evaluation Systems Tests. Finally, two clinical scenarios are described to illustrate the process of evidence-based clinical decision-making with respect to balance assessment in people with COPD. Ultimately, the selection of balance test and its interpretation will depend on the purpose of the assessment, available data on psychometric properties, the patient's individual characteristics, and the resources available to the clinician.

Keywords

Measurement, balance assessment, fall risk, postural control, pulmonary rehabilitation, physical function, clinical decision-making, evidence-based practice, postural balance, accidental falls

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Introduction

Balance, or postural control, is a complex skill that is necessary for independent mobility and avoiding falls.¹ Defined as the ability to maintain one's center of mass within the base of support, balance is best understood using the systems' approach to postural control.² In this model, balance is viewed as resulting from the complex integration of underlying neuromuscular, somatosensory, and central nervous system inputs. Balance performance naturally decreases with age; however, certain conditions are associated with more pronounced and rapid declines. Over the last 10 years, a growing body of work has shown that people with chronic obstructive pulmonary disease (COPD) have deficits in balance that cannot be explained by age-related processes alone.^{3–11} A number of investigations using both clinical and instrumented measures of balance have documented reduced

balance performance in people with COPD; deficits that are linked to an increased risk of falls in this population.^{4,9,12–16} For this reason, there is increased interest in balance assessment and treatment as part of pulmonary rehabilitation for people with COPD. For example, the most recent American Thoracic Society/European Respiratory Society (ATS/ERS) statement recommends that balance be included as one of the outcome assessments in pulmonary

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rehabilitation.¹⁷ However, no specific tests are recommended for this purpose. The aim of this review is to provide a critical evidence-based review of balance measurement in older adults and in people with COPD to help guide clinical practice in this area.

Best practice for balance assessment in older adults

Deficits in balance are one of the leading risk factors for falls in older adults.¹⁸ As such, balance assessment and treatment are a major foci of fall prevention initiatives and rehabilitation programs for older adults with a wide range of health conditions.^{18,19} Many different tools have been developed to assess balance in adult populations. In fact, in a scoping review of standardized balance measures, we identified 66 different validated measures of standing balance.²⁰ However, each balance tool assesses balance to a varying degree, that is, not all balance measures offer an assessment of all the different systems underlying balance. The specific choice of balance measure will ultimately depend on the purpose of the assessment and evidence for its psychometric properties in a particular context or population.

There is some variation in which balance measures are recommended for specific purposes. In terms of fall prevention, shorter balance screening tests are typically suggested as part of fall risk screening algorithms to identify individuals at the highest risk of falls who require further assessment and intervention. Clinical practice guidelines (CPGs) for fall prevention have been published by several international organizations including the Centers for Disease Control's Stopping Elderly Accidents, Deaths & Injuries (CDC STEADI),²¹ the United Kingdom's National Institute for Health Care Excellence (NICE),²² and the American Geriatrics Society/British Geriatrics Society (AGS/BGS).²³ Common to all of the CPGs is a first-level screening process (Figure 1). The first step involves asking older adults: (i) if they have fallen in past 12 months and (ii) if they feel unsteady when standing or walking.^{21,23} If an older adult indicates yes to either of the key questions, the health provider should then screen for a balance/mobility impairment using a balance screening test. The purpose of this test is to perform a rapid screen to determine whether an individual has a high risk of falls. If balance is deemed impaired, the patient is referred for multifactorial fall risk assessment and tailored intervention. Although no single balance screening test is universally

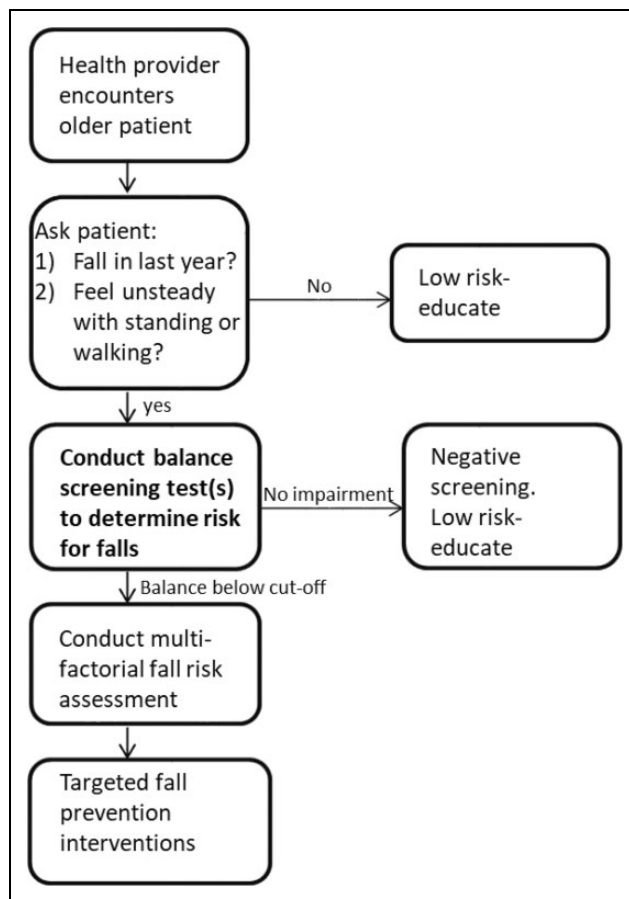


Figure 1. Simplified summary of best practice guidelines for fall prevention in community-dwelling older adults.

endorsed, the Timed Up and Go (TUG),²⁴ a timed test of a patient's ability to get out of a chair, walk 3 meters, turn around, and return to sit in the chair, with a 12-second cut-off, is the most commonly recommended test for this purpose.^{23,25} Other suggested tests that may be suitable for fall risk screening include the single leg stance (SLS) test and five repetition chair-stand test.²¹

In terms of a more comprehensive assessment of balance as part of a detailed falls risk assessment, and for guiding exercise training, an international expert consensus group has recently proposed a core balance outcome set—an agreed upon set of instruments for assessing standing balance in adults.²⁶ A combination of scoping reviews, literature appraisal, meetings, and voting with an international panel of balance experts was conducted to achieve consensus on the core outcome set. From a total of 56 balance measures that were evaluated, at minimum, at least one of the following two tests is recommended as part of the core balance outcome set: the Berg Balance Scale (BBS)

and the Mini-Balance Evaluation Systems Test (Mini-BESTest). Both the Mini-BESTest and the BBS take approximately 15 minutes to administer and are typically conducted by a single physiotherapist or trained assessor with clinical background. The tests are described in more detail below; the selection of one versus the other depends on several factors.

The BBS²⁷ is perhaps the most widely used measure of balance among older adults with robust evidence for its psychometric properties, including predictive validity for falls.^{28–33} It measures 14 different performance-based tasks ranging from getting out of a chair to standing on one leg; each task is scored on an ordinal scale with higher scores awarded for better balance performance and a total score out of 56. However, a frequently encountered limitation of the BBS is a ceiling effect for higher functioning patient populations and a limited scope of components or systems of balance evaluated.^{20,30} In particular, the BBS does not include an assessment of reactive balance (i.e. a person's ability to recover their balance from an unexpected perturbation) or an assessment of cognitive influences on balance. Both these aspects of balance have been shown to be important for fall avoidance. These limitations notwithstanding, the BBS is a good choice for patients with lower balance abilities, is easy to administer, and has an abundance of data supporting its measurement properties and interpretability.

The Mini-BESTest³⁴ is a more recently developed tool which is a shortened version of the more comprehensive Balance Evaluation Systems Test (BESTest). Similar to the BBS, the Mini-BESTest consists of 14 performance-based tasks measured on a three-point ordinal scale with a total score of 28 (higher scores indicate better balance). It has less of a ceiling effect than the BBS and it also evaluates more aspects of balance than the BBS, including an explicit assessment of reactive balance and cognitive influences.^{20,26,35} However, due to its more recent development (2010 vs. 1989 for the BBS), there is relatively less data on its psychometric properties and interpretability, and clinicians are less familiar with its administration. Nonetheless, evidence supporting the psychometric properties of the Mini-BESTest is growing,^{35–40} and it likely provides a more optimal assessment of balance for a wider range of abilities. This test is a good choice if a more comprehensive test is desired and for higher functioning patients. There are also freely available instructional videos

to assist clinicians with training for test administration and scoring (<http://bestest.us/>).

Evidence to date on balance assessment in people with COPD

An abundance of studies conducted by our team and others have shown that individuals with COPD have important deficits in balance.^{3–11} These balance problems have been shown using both clinical- and laboratory-based balance tests in patients with varying degrees of COPD severity compared to age-matched controls.¹¹ Importantly, several studies have highlighted a direct link between impaired balance performance and an increased risk of falls in patients with COPD.^{4,9} Given these data and the surge in evidence showing increased falls in people with COPD,^{12–16} it is not surprising that the updated ATS/ERS Statement on pulmonary rehabilitation recommended expanding the scope of outcomes assessment in COPD to include balance.¹⁷

Several different tests have been used to assess balance in people with COPD. In a 2013 systematic review of balance measures used in this population, the BBS, short physical performance battery, SLS test, and functional reach test were the most commonly used tests in the COPD literature.⁴¹ However, after an analysis of evidence for their psychometric properties in COPD and their breadth of content, the authors of the review recommended the BBS and the comprehensive BESTest for assessing balance in this population. Indeed, work by our team and others have shown that both measures are responsive to pulmonary rehabilitation,^{42,43} and we recently published data on their minimal clinically important difference values (5 points for the BBS and 13 for the BESTest), data which are helpful for supporting their interpretability in COPD.⁴⁴ However, while the BESTest has strong construct validity in people with COPD and is regarded as the most comprehensive balance measure available in any population,²⁰ a notable limitation is its long administration time (45 minutes). A reasonable alternative, the shorter Mini-BESTest recommended by the international balance core outcomes panel²⁶ and developed based on the full BESTest, has only been used recently in two small studies of patients with COPD.^{45,46} Preliminary data from these studies support the construct validity of the Mini-BESTest and its reliability in people with COPD; however, further study with larger sample sizes and longitudinal evaluation is needed.

In recognition of the extent of functional disability in COPD, there is growing interest in the use of short and clinically feasible functional tests that have prognostic value for adverse outcomes. As such, a number of studies have examined the measurement properties of the TUG in people with COPD.^{47–56} These studies support the TUG's convergent validity with other longer tests of balance, its ability to identify those with balance and functional deficits, and in line with previous work,³ the TUG appears to be able to discriminate between those with and without a history of falls. In a retrospective study of 119 patients with COPD, the TUG showed excellent reliability and adequate accuracy in identifying people with a history of falls⁴⁷; however, larger prospective studies are needed to confirm these results. Finally, the SLS is another short balance test commonly used in older adults but with limited data supporting its psychometric properties in people with COPD^{54,56,57,58} and no studies evaluating its ability to identify those with high fall risk status.

Recommendations for balance measurement in people with COPD

In selection of the optimal balance test for people with COPD, it is important to consider the purpose of the assessment, best practice guidelines in older adults, and the available evidence in people with COPD. A summary of the more commonly used balance tests, their psychometric properties and relevant considerations for their use, is provided in Table 1. The clinical scenarios below are useful for illustrating an evidence-based clinical decision-making process for two of the most common applications of balance testing.

Clinical scenario #1: A 70-year-old woman with COPD walks into your office. She has had several exacerbations over the winter and reports feeling more unsteady on her feet lately. She also has long-standing hip pain from osteoarthritis. She denies any prior falls. You would like to assess her falls risk and whether she might need a tailored fall prevention intervention.

The patient's age, diagnosis of COPD, and self-report of unsteady gait should prompt a falls risk assessment. The patient's history of exacerbations is important given that balance may be further impaired following exacerbations of COPD as a result of deconditioning and loss of muscle strength.^{54,59,60} It

is also relevant to note the patient's osteoarthritis which may further contribute to gait impairment and muscle weakness, impacting balance and fall risk. In situations such as the one above, a short balance screening test is preferred to quickly determine the patient's risk of falls and her need for additional assessment and intervention. Best practice recommendations for fall risk screening in older adults suggest single-task balance measures such as the TUG for screening for fall risk in older patients with a positive fall history or who report feeling unsteady while standing or walking.^{18,21} In community-dwelling older adults, the recommended cut-off value on this test is 12 seconds.²¹ In people with COPD, there are no prospective studies examining thresholds for risk of falls but one cross-sectional study noted a TUG score of ≥ 12 seconds had 74% sensitivity and specificity for a history of a fall in the previous year.⁴⁷ Additionally, in a study of lower functioning patients with moderate-to-severe COPD (mean 6-minute walk distance (6MWD) 303 m), non-fallers had a mean TUG of 14 seconds, whereas fallers had a mean TUG score of 17 seconds.³ These data along with observation of gait quality while the patient performs the test will support the optimal interpretation of the TUG for screening for fall risk in this patient.

Clinical scenario #2: A 65-year-old man with COPD is beginning pulmonary rehabilitation at your center. You observe that his gait is unsteady during his 6MWT and he reports that he fell on his stairs 2 months ago while at home. You would like to incorporate balance training as part of his exercise program and monitor his progress over the course of the program.

Based on this patient's presentation (positive fall history and observable balance problems), it is clear that he has a high risk of falls and would benefit from targeted balance exercises as part of his rehabilitation program. The recommended core balance tests for assessing balance in adults are the BBS and Mini BESTest.²⁶ Of the two, there is more data to support the psychometric properties of the BBS in people with COPD; in particular, the BBS is responsive to pulmonary rehabilitation and its MCID is 5 points⁴⁴ whereas there is currently no data on responsiveness of the Mini-BESTest in COPD. However, the BBS is also known to have a ceiling effect. In an inpatient sample of patients with moderate-to-severe COPD undergoing PR (mean 6MWD 295 m), the mean BBS

Table 1. Description and psychometric properties of commonly used balance tests in individuals with COPD.

Measure	Type	Tasks (#)	Rating and scoring	Time to complete	Validity in COPD	Reliability	Responsiveness and MCID	Comments
Berg Balance	Core balance outcome	14 functional tasks	Total score: 0–56 (higher = better balance)	15 minutes	Construct ^{3,4,45}	Test–retest ⁵⁸ Intrater and inter-rater ⁴⁵	Responsive to PR ^{42,43,57} MCID (5 points) ⁴⁴	Ceiling effect for high functioning patients Does not assess all aspects of balance Indicated for lower level patients
BESTest	Comprehensive balance test	36 tasks broken into 6 postural control subsystems	Total score: 0–108 (higher = better balance)	45 minutes	Construct ^{3,4,45}	Intrater and inter-rater ⁴⁵	Responsive to PR ^{42,43} MCID (13 points) ⁴⁴	Long administration time Most comprehensive test available Useful for guiding exercise prescription
Mini-BESTest	Core balance outcome	14 tasks based on parent BESTest	Total score: 0–28 (higher = better balance)	15 minutes	Construct ^{45,46}	Intrater and inter-rater ⁴⁵	N/A	Minimal data on psychometric properties in COPD Assesses most aspects of balance across a wide range of abilities
Timed Up and Go	Balance/fall risk screening	Stand up from chair, walk 3 m, turn around, walk back and sit down	Time to complete	<5 minutes	Construct ^{3,47,53,54}	Test–retest ⁵⁸ (in men only) Intrater and inter-rater ⁵¹	Responsive to PR ^{43,53,57} MCID (0.9–1.4 sec) ⁵³	Recommended for fall risk screening in older adults No cut-off value for determining fall risk in COPD from prospective studies
SLS Test	Balance/fall risk screening	Stand on one leg	Mean of 3 trials	<5 minutes	Construct ^{54,56}	Test–retest ⁵⁸ (in men only)	Responsive to PR ⁵⁷	Recommended for fall risk screening in older adults No evaluation of its ability to determine fall risk in COPD

MCID: Minimal Clinically Important Difference; SLS: single leg stance; BESTest: Balance Evaluation Systems Test; Mini-BESTest: Mini-Balance Evaluation Systems Test; COPD: chronic obstructive pulmonary disease.

score was 47⁴³; however in an outpatient sample with less severe COPD, the mean BBS score was 50.⁴⁵ Therefore, depending on the individual patient's characteristics, it may be appropriate to consider the longer and more comprehensive BESTest, if time allows. This test would offer the advantage of breaking down the patient's balance performance by component of balance affected which would be useful for guiding his balance exercise prescription. The BESTest is also responsive PR with an MCID of 13 points corresponding to change that is perceptible to patients and beyond measurement error.⁴⁴ The choice of test in this situation will therefore depend on the patient's level of functioning and on the time available. It is also important for the clinician to follow up with questions regarding the specific circumstances of the patient's fall (e.g. was the patient breathless, were there any physical hazards, was the fall during the day or at night) and any resulting injuries that may further help to guide the assessment and exercise prescription for this patient.

Conclusion

Balance deficits are an important and common problem in people with COPD that contribute to an increased risk of falling. In older patients who present with a history of falls or who report a balance problem, a shorter balance test such as the TUG may provide useful information on fall risk. Longer more comprehensive tests such as the BBS, BESTest and Mini-BESTest may be useful for a more detailed balance assessment to guide exercise prescription depending on the patient's characteristics and ability, and the resources available to the clinician. Evidence-based clinical decision-making for assessing and treating balance deficits in people with COPD will continue to evolve as results from longitudinal studies examining the context-specific measurement properties of these tests become available.

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