

The role of balance training in enhancing pulmonary rehabilitation outcomes in patients with chronic obstructive pulmonary disease (COPD): A narrative review

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Abstract: Background. Chronic obstructive pulmonary disease (COPD) is a common, preventable and treatable condition defined by persistent respiratory symptoms and airflow limitation arising from airway and alveolar abnormalities, usually following prolonged exposure to noxious particles or gases. Its consequences extend beyond the lungs to peripheral muscle dysfunction and impaired postural control, and people with COPD fall considerably more often than would be expected for their age alone.

Objective. This narrative review examines whether adding structured balance training to conventional pulmonary rehabilitation improves balance, fall-related outcomes, exercise capacity and health-related quality of life in adults with COPD, and identifies where the evidence remains unsettled.

Approach. Trials, observational studies and systematic reviews addressing pulmonary rehabilitation and balance in COPD were examined, together with guideline literature on rehabilitation practice.

Findings. Balance impairment in COPD is consistently reported and improves with pulmonary rehabilitation alone. Adding balance training produced further gains in balance measures, balance confidence, fatigue, mood and quality of life in single-centre trials, but the largest multicentre trial found no reduction in fall incidence at twelve months. Marked heterogeneity in the outcomes chosen across rehabilitation trials limits comparison and pooling.

Conclusion. Balance training is a low-burden addition to pulmonary rehabilitation that improves balance and confidence measures, but current evidence does not establish that it reduces falls. Adequately powered trials with falls as the primary endpoint, and agreement on a core outcome set, are the principal needs.

Keywords: chronic obstructive pulmonary disease; pulmonary rehabilitation; balance training; postural control; falls; health-related quality of life

1. INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is characterised by persistent respiratory symptoms and airflow limitation that follow abnormalities of the airways and alveoli, most often caused by long-term inhalation of harmful particles or gases. It is common, preventable and treatable, yet it remains among the leading causes of death worldwide, and projections of

the global burden of disease anticipated that it would rise further in rank over the following decades [1].

The consequences of COPD are not confined to the lungs. Reduced habitual activity lowers muscle strength and endurance, and the metabolic capacity of skeletal muscle is diminished. Lower-limb muscles consume more oxygen at any given workload, fatigue earlier and produce more lactate. Oxidative capacity falls with the loss of muscle mass, a lower proportion of oxidative fibres, reduced myoglobin content, fewer capillary connections per fibre and reduced enzyme activity in oxidative pathways. Intracellular oxygen utilisation is therefore inefficient even where oxygen delivery is only modestly impaired.

Against this background, postural control deteriorates. Loss of balance raises the likelihood of falling, and falls carry particular consequences for older adults with COPD. Even a fall without serious injury can begin a cycle of muscle atrophy, impaired motor control, altered trunk mechanics, somatosensory deficit and growing dependence on others for everyday tasks. Polypharmacy, cognitive impairment and comorbidities such as osteoarthritis and osteoporosis compound the risk. Reported annual fall rates in COPD populations substantially exceed what age alone would predict.

Pulmonary rehabilitation is the established response where pharmacological treatment alone fails to control symptoms, and it compares favourably with drug therapy on cost-effectiveness. Whether balance training should form a routine component of that programme, rather than an optional addition, is the question this review addresses.

2. SCOPE OF THIS REVIEW

This is a narrative review. It draws on randomised controlled trials, observational studies and systematic reviews concerned with pulmonary rehabilitation, postural control and falls in adults with stable COPD, together with professional guideline literature on rehabilitation practice.

3. PULMONARY REHABILITATION IN COPD

Pulmonary rehabilitation is a structured, multidisciplinary intervention combining supervised exercise training, breathing techniques, education and self-management support. Joint clinical practice guidelines have set out its evidence base and the standards expected of programme delivery [2]. Randomised evidence from outpatient multidisciplinary programmes showed

benefit sustained at one year [3], and long-term follow-up of rehabilitated patients was reported as early as the 1970s [4].

Delivery models have since diversified. Home-based programmes have been trialled for housebound older patients who cannot attend hospital-based services [5]. Ground-based walking training improved quality of life and exercise capacity [6], and short-course exercise training has been examined for its effect on exacerbation frequency and habitual physical activity [7]. Mind-body modalities have also been assessed, including yoga, whose risks and benefits have been reviewed systematically [8], and modified Tai Chi adapted for people with COPD [9].

Across this literature, exercise capacity, health-related quality of life and activity-related symptoms such as breathlessness and fatigue improve reliably. Interpretation is nonetheless complicated by the sheer variety of outcomes and instruments in use. A systematic review of 267 studies covering 43,153 patients identified 217 distinct domains, outcomes and measures, with the same construct assessed by different instruments across trials; exercise capacity, health-related quality of life and symptoms dominated, while comorbidities, adverse events and patient knowledge were reported least often [10]. This heterogeneity is the main obstacle to synthesising rehabilitation evidence, and it bears directly on the balance question examined below.

4. BALANCE IMPAIRMENT AND FALL RISK IN COPD

Compared with healthy individuals of the same age, patients with COPD show measurable deficits in both static and dynamic postural control. These deficits are usually attributed to the combination of peripheral muscle weakness, reduced functional mobility and diminished exercise capacity already described, and they are detectable with standard clinical instruments rather than requiring laboratory posturography.

Conventional pulmonary rehabilitation, without any balance-specific component, appears to improve these measures. In a study of 37 patients with chronic obstructive lung disease (24 men and 13 women, mean age 57 ± 6 years) attending a rehabilitation facility, static balance assessed by the One Leg Standing Test and Tandem Romberg test and dynamic balance assessed by the Berg Balance Scale and Timed Up and Go test were compared before and after rehabilitation. Significant improvement was recorded in both domains, with the One Leg

Standing Test improving on both sides at $P < 0.001$ [11]. This finding sets the baseline against which any additional benefit from dedicated balance training must be judged.

5. BALANCE TRAINING ADDED TO PULMONARY REHABILITATION

Three intervention studies address the specific question of whether balance training adds value beyond rehabilitation alone, and they do not agree.

In a randomised trial, 62 patients were allocated either to pulmonary rehabilitation alone ($n = 30$) or to rehabilitation with three balance training sessions weekly for six months ($n = 32$). Quality of life measured by the St George's Respiratory Questionnaire improved in both arms across activity, impact and total scores, with a significant difference favouring the intervention arm ($P < .05$). General fatigue, physical fatigue and reduced activity improved in both arms, again favouring the intervention arm ($P < .05$). Anxiety fell in both groups, more markedly with balance training ($P < .01$), and reduced depression was observed only in the intervention arm [12].

A second randomised trial allocated 133 patients with moderate COPD to conventional rehabilitation or to conventional rehabilitation plus eight weeks of balance training. Statistically significant improvements were recorded across the Berg Balance Scale, Timed Up and Go, Single Leg Stance, Activities-specific Balance Confidence score, Elderly Falls Screening Test, six-minute walk distance and St George's Respiratory Questionnaire, and the authors recommended that eight weeks of balance training be added to conventional programmes [13].

The largest and most methodologically demanding study reached a different conclusion. A multicentre randomised controlled trial enrolled 258 people with COPD judged to be at high risk of falling and allocated them 1:1. Both arms received standard rehabilitation two to three times weekly for eight to twelve weeks; the intervention arm additionally received 90 minutes of individualised balance training per week. The primary outcome was the number of falls recorded in monthly fall diaries at twelve months. Falls were reported by 178 participants, and at least one fall occurred in 45% of the intervention group and 38% of the control group ($P = 0.34$). Mean fall incidence at twelve months was identical between arms at 128 per 100 person-years, with a mean difference of 0.30 (95% CI -0.76 to 1.36), and the result held after multiple imputation of 67 missing observations [14].

The pattern is therefore that intermediate measures of balance, confidence, mood and quality of life respond to balance training, while the clinical endpoint that matters most — the number of falls actually sustained — did not shift in the one trial designed and powered to detect it.

Table 1. Studies of balance and pulmonary rehabilitation in COPD discussed in this review.

Study	Design and participants	Intervention	Key findings
Mkacher et al. (2015) [12]	Randomised controlled trial; 62 patients with COPD (32 intervention, 30 rehabilitation only)	Six months of pulmonary rehabilitation, with three balance sessions weekly added in the intervention arm	Quality of life, general and physical fatigue improved in both arms with greater gains in the intervention arm ($P < .05$); anxiety fell in both arms, more so with balance training ($P < .01$); depression improved only in the intervention arm
Suresh et al. (2021) [13]	Randomised controlled trial; 133 patients with moderate COPD	Conventional pulmonary rehabilitation versus rehabilitation plus eight weeks of balance training	Significant improvement in Berg Balance Scale, Timed Up and Go, Single Leg Stance, Activities-specific Balance Confidence, Elderly Falls Screening Test, six-minute walk distance and St George's Respiratory Questionnaire
Hao et al. (2024) [14]	Multicentre randomised	Standard rehabilitation in	No difference in fall incidence at twelve

Study	Design and participants	Intervention	Key findings
	controlled trial; 258 patients with COPD at high fall risk	both arms, plus 90 minutes of individualised balance training weekly in the intervention arm	months (128 versus 128 per 100 person-years; mean difference 0.30, 95% CI -0.76 to 1.36)
Öztürk et al. (2018) [11]	Observational study; 37 patients (24 men, 13 women; mean age 57 ± 6 years)	Conventional pulmonary rehabilitation without a balance component	Significant improvement in static and dynamic balance; One Leg Standing Test improved bilaterally ($P < 0.001$)
Souto-Miranda et al. (2021) [10]	Systematic review; 267 studies, 43,153 patients with stable COPD	Pulmonary rehabilitation trials of any design	217 distinct domains, outcomes and measures reported; exercise capacity, quality of life and symptoms most frequent; comorbidities, adverse events and knowledge least reported

6. DISCUSSION

Three explanations may account for the divergence between the smaller positive trials and the null result of the large fall-endpoint trial. The first is measurement. Balance scales and confidence questionnaires capture capability and perceived stability under test conditions; falls occur in unstructured environments where fatigue, footwear, lighting, distraction and comorbidity all intervene. A gain on the Berg Balance Scale need not translate into fewer falls at home.

The second is power and duration. The trials reporting benefit were single-centre, with intervention periods of six months and eight weeks respectively and with balance measures as primary outcomes. The trial reporting no effect followed participants for twelve months with falls prospectively recorded in monthly diaries, a design far less forgiving of small effects and of attrition.

The third is adherence. Engagement with rehabilitation is not uniform, and self-reported adherence has been shown to relate to psychosocial factors and mild cognitive impairment in this population [15]. A weekly balance session delivered in a supervised setting may not persist as habitual practice once the programme ends, and fall risk is a year-round exposure.

These considerations do not argue against balance training. It is inexpensive, carries little risk, and improves domains — balance confidence, fatigue, mood and quality of life — that matter to patients in their own right. They do argue against claiming a fall-reduction benefit that the strongest available trial did not find. They also reinforce the case made in the outcome-heterogeneity literature for agreement on a core outcome set in pulmonary rehabilitation, so that future trials of balance training can be compared and combined rather than read in isolation [10].

7. LIMITATIONS OF THIS REVIEW

This is a narrative rather than a systematic review. Studies were not identified through a registered protocol, no formal risk-of-bias appraisal was undertaken, and no quantitative synthesis was attempted. The intervention studies discussed differ in duration, intensity, participant severity and outcome selection to a degree that would in any case preclude pooling. Conclusions drawn here should therefore be read as an orientation to the current evidence rather than as an estimate of effect.

8. CONCLUSION

Balance impairment is a consistent and clinically relevant feature of COPD, and it responds to pulmonary rehabilitation with or without a dedicated balance component. Adding structured balance training produces further improvement in balance measures, balance confidence, fatigue, mood and health-related quality of life across single-centre randomised trials. Evidence that it reduces the number of falls sustained is currently absent: the one multicentre trial powered for that endpoint found no difference at twelve months. Balance training can reasonably be offered as a low-risk adjunct on the strength of its effect on patient-reported and

functional outcomes, but it should not be presented to patients or commissioners as an established fall-prevention measure until trials designed for that endpoint show otherwise.

References

1. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Med.* 2006;3(11):e442.
2. Ries AL, Bauldoff GS, Carlin B, et al. Pulmonary rehabilitation: joint ACCP/AACVPR evidence-based clinical practice guidelines. *Chest.* 2007;131(5):4S–42S.
3. Griffiths TL, Burr ML, Campbell IA, et al. Results at 1 year of outpatient multidisciplinary pulmonary rehabilitation: a randomised controlled trial. *Lancet.* 2000;355(9201):362–368.
4. Gimenez M, Pham Q, Uffholtz H, et al. Ten years follow up in patients with chronic obstructive lung disease submitted to a programme of pulmonary rehabilitation. London: SAGE Publications; 1978.
5. Boxall AM, Barclay L, Sayers A, et al. Managing chronic obstructive pulmonary disease in the community. A randomized controlled trial of home-based pulmonary rehabilitation for elderly housebound patients. *J Cardiopulm Rehabil.* 2005;25(6):378–385.
6. Wootton SL, Ng LW, McKeough ZJ, et al. Ground-based walking training improves quality of life and exercise capacity in COPD. *Eur Respir J.* 2014;44(4):885–894.
7. Ko FW, Tam W, Siu EHS, et al. Effect of short-course exercise training on the frequency of exacerbations and physical activity in patients with COPD: a randomized controlled trial. *Respirology.* 2021;26(1):72–79.
8. Cramer H, Haller H, Klose P, et al. The risks and benefits of yoga for patients with chronic obstructive pulmonary disease: a systematic review and meta-analysis. *Clin Rehabil.* 2019;33(12):1847–1862.
9. Zhu S, Shi K, Yan J, et al. A modified 6-form Tai Chi for patients with COPD. *Complement Ther Med.* 2018;39:36–42.

10. Souto-Miranda S, Rodrigues G, Spruit MA, Marques A. Pulmonary rehabilitation outcomes in individuals with chronic obstructive pulmonary disease: a systematic review. *Ann Phys Rehabil Med*. 2022;65(3):101564.
11. Öztürk M, Ozmen İ, Polat M, Özari Yildirim E, Karakış M. Effect of pulmonary rehabilitation on balance control in patients with COPD. *Eur Respir J*. 2018;52(Suppl 62):PA838.
12. Mkacher W, Mekki M, Chaieb F, Tabka Z, Trabelsi Y. Balance training in pulmonary rehabilitation. *J Cardiopulm Rehabil Prev*. 2015;35(4):278–285.
13. Suresh A, Srinivasan N, Anil T, Vinod Babu, Alaparathi GK, Reddy K. The effect of balance training and conventional pulmonary rehabilitation in patients with moderate chronic obstructive pulmonary disease. *Int J Res Pharm Sci*. 2021;12(1):757–767.
14. Hao Q, Brooks D, Ellerton C, et al. Pulmonary rehabilitation with balance training for fall reduction in chronic obstructive pulmonary disease: a randomized controlled trial. *BMC Pulm Med*. 2024;24:406.
15. Pierobon A, Bottelli ES, Ranzini L, et al. COPD patients' self-reported adherence, psychosocial factors and mild cognitive impairment in pulmonary rehabilitation. *Int J Chron Obstruct Pulmon Dis*. 2017;12:2059–2067.