


The effects of pulmonary rehabilitation associated with balance training in patients with chronic obstructive pulmonary disease: a systematic review with metanalysis

Efeitos da reabilitação pulmonar associada ao treino de equilíbrio em pacientes com doença pulmonar obstrutiva crônica: revisão sistemática com metanálise

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ABSTRACT | INTRODUCTION: balance is an outcome that has been extensively studied in recent years in patients with chronic obstructive pulmonary disease (COPD), but the effects of pulmonary rehabilitation (PR) associated with balance training (BT) are not yet clear. **OBJECTIVE:** to evaluate the effects of PR associated to BT in patients with COPD through a systematic review with meta-analysis. **METHODS:** it was performed a review of articles published in indexed journals between 2013 and 2019 in the databases PUBMED, PUBMED, LILACS, SciELO e PEDro. All searches were conducted between March and April 2020 and the descriptors combined were: "pulmonary rehabilitation" OR "rehabilitation" AND "balance" OR "falls" OR "risk of falls" and their respective translations into Spanish and Portuguese. **RESULTS:** A total of 2052 studies were identified, but only 3 articles met the eligibility criteria. The PEDro methodological quality scores varied between 5 and 7 scores, which demonstrates a good methodological design. Of the 3 selected studies, 2 performed conventional BT (on the ground involving functional balance, gait and posture) and 1 used specific equipment (vibrating platform). The intervention protocol lasted between 6 and 24 weeks, mean daily time between 30 and 60 minutes and frequency of 2 to 3 times a week. **CONCLUSION:** The findings of this systematic review with meta-analysis suggest that PR associated to BT seems to improve balance of patients with stable COPD when compared to usual PR.

KEYWORDS: Chronic obstructive pulmonary disease. Postural balance. Risk of falls. Rehabilitation.

RESUMO | INTRODUÇÃO: O equilíbrio é um desfecho que vem sendo bastante estudado nos últimos anos em pacientes com doença pulmonar obstrutiva crônica (DPOC), porém ainda não se sabe ao certo os efeitos da reabilitação pulmonar (RP) associada a um treino de equilíbrio (TE). **OBJETIVO:** Avaliar os efeitos da reabilitação pulmonar (RP) associada ao treino de equilíbrio em pacientes com DPOC por meio de uma revisão sistemática com metanálise. **MÉTODOS:** Foi realizado um levantamento de artigos publicados em revistas indexadas entre os anos de 2013 e 2019 nas bases de dados: PUBMED, LILACS, SciELO e PEDro. As buscas foram conduzidas entre março e abril de 2020 e os descritores combinados foram: "pulmonary rehabilitation" OR "rehabilitation" AND "balance" OR "falls" OR "risk of falls" e suas respectivas traduções para o espanhol e português. **RESULTADOS:** Um total de 2052 estudos foram identificados, porém somente 4 cumpriram os critérios de elegibilidade. A pontuação da qualidade metodológica na escala PEDro variou entre 5 e 7 foi escores, o que demonstra um bom desenho metodológico. Dos 3 estudos selecionados, 2 realizaram treinamento de equilíbrio convencional (em solo envolvendo equilíbrio funcional, marcha e postura) e 1 utilizou equipamento específico (plataforma vibratória). O protocolo de intervenção teve duração entre 6 e 24 semanas, tempo médio diário entre 30 e 60 minutos e frequência semanal de 2 a 3 vezes. **CONCLUSÃO:** Os achados desta revisão sistemática com metanálise sugerem que a RP associada ao TE parece promover efeitos benéficos no equilíbrio funcional de pacientes com DPOC estáveis quando comparado a RP ambulatorial usual.

PALAVRAS-CHAVE: Doença pulmonar obstrutiva crônica. Equilíbrio postural. Risco de quedas. Reabilitação.

Chronic Obstructive Pulmonary Disease (COPD) is a pulmonary disease characterized by progressive airflow limitations. During the course of the disease patients may experience manifestations such as systemic inflammation, cardiovascular comorbidities, peripheral muscle dysfunction, weight loss and psychological changes^{1,2}.

Studies have reported a 24.2% increase in death rates between 2005 and 2016, thus confirming COPD as the second leading cause of mortality worldwide, which is in line with estimates from previous studies that have warned that this disease will be the third leading cause of death only by 2030. Additionally, the number of cases of the disease and its consequences are still thought to be underestimated because its diagnosis is usually late when the disease is in an advanced stage³⁻⁵.

Regardless of the changes occurring in the lung, systemic changes in patients with COPD hinder prognosis as they lead to a worsening of quality of life (QoL), increased symptoms of anxiety and depression, reduced tolerance to exercise and several skeletal muscle manifestations, such as generalized muscle weakness, reduced mobility, malnutrition and bone demineralization, which culminate in an important balance deficit and an increased risk of falls^{6,7}.

Risk of falls is considered a relevant issue in public health because in addition to leading to mortality and morbidity it is also related to overall functionality in individuals susceptible to balance deficit. Furthermore, this event is associated with early admission to long-term care institutions; therefore, reducing the risk of falling is an important public health goal².

The pulmonary rehabilitation (PR) program is extremely important within this context as it is a strategy that involves physical training, health education and self-management and which leads to important improvements in physical and functional capacity. In addition, it improves QoL and symptoms of anxiety and depression and features strong degrees of scientific recommendation⁸⁻¹².

The aim of this study was to evaluate the effects of PR associated with balance training in patients with COPD through a systematic review with meta-analysis.

This review was conducted in accordance with the recommendations provided in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement¹³.

Search strategies

Scientific articles published in indexed journals between 2013 and 2020 were searched in the following electronic databases: PUBMED, Latin American and Caribbean Health Sciences Literature (LILACS), and in the Scientific Electronic Library Online (SciELO) collection PEDro. The PICO (population/intervention/control/outcomes) framework was used as follows: P = patients with stable COPD; I = pulmonary rehabilitation associated with specific balance training; C = COPD patients who underwent usual PR; O = functional balance-related outcomes.

All the searches were conducted between January 1 and March 1, 2020 and the descriptors used and combined were: "pulmonary rehabilitation" OR "rehabilitation" AND "balance" OR "falls" OR "risk of falls" and their respective Spanish and Portuguese translations. Such terms were chosen based on a search on the lists of PUBMED Medical Subject Headings (MeSH) and the Virtual Health Library Health Sciences Descriptors (DECS).

The articles were independently selected by two examiners after analysis of the title, abstract and full text, respectively. If no consensus on the selection of any study was reached, a third author made the final judgment on the inclusion or exclusion of articles.

Eligibility criteria

The study included original articles of randomized controlled trials published in English, Spanish or Portuguese and conducted with adults with stable COPD who underwent an usual outpatient PR program with a minimum duration of 6 weeks and whose study outcome was balance evaluated by the Berg Balance Scale (BBS), which is the instrument most used in the literature. Articles indexed in more than one database and studies in which COPD patients had other chronic respiratory diseases were excluded from this review.

Data extraction

A standardized form was used to retrieve relevant information from eligible articles, including information on authors, year of publication, country of origin, sample size, time/frequency/duration of the intervention protocols, instruments used to measure balance, and main outcomes.

Analysis of the methodological quality of the studies

The methodological quality of the studies was assessed using the PEDro Scale, which is a valid and reliable instrument composed of 11 items that analyze the methodological design and the results of clinical trials. Its 11 items assess the description of the criteria for inclusion and exclusion, the blinding of evaluators, therapists and patients, the allocation of subjects, the similarity of prognostic indicators between groups, evaluation of key outcomes in at least 85% of subjects randomized between groups, analysis of key outcomes by "intention to treat" when it was not possible to receive the treatment or control condition as allocated, and the statistical description of intergroup differences or measures of variability for at least one key outcome^{14,15}.

Statistical analysis of data

Os dados foram analisados por meio do software da Cochrane (Review Manager – RevMan, versão 5.3). Os estudos elegíveis foram analisados utilizando-se a média e os desvio padrão (DP) para mensurar a mudança do baseline e o final de cada intervenção. Como todos os resultados foram variáveis contínuas, a diferença das médias (DM) e o intervalo de confiança de 95% (IC95%) foram calculados quando os estudos descreveram em seus resultados as variáveis com as mesmas unidades de medida. Os resultados foram expostos em formato de gráficos de forest plot.

The data were analyzed using the Cochrane software (Review Manager – RevMan, version 5.3). The eligible studies were analyzed using means and standard deviations (SD) to measure the change from baseline and at the end of each intervention. As all the results were continuous variables, the difference in means (DM) and the 95% confidence intervals (95%CI) were calculated when the studies described in their results the variables with the same units of measurement. The results were displayed in forest plots.

Results

A total of 2052 studies were identified in the databases, but only 3 articles met the review eligibility criteria (Figure 1).

A summary of the characteristics of the articles selected for the study, including the intervention protocols, the instruments used, the methodological quality and the main outcomes, is depicted in Table 1.

The methodological quality scores ranged from 5 to 7 on the PEDro scale, which designates a good methodological design in all the selected studies (Table 2).

In all, 2 out of the 3 selected studies that assessed the impact of PR on balance performed conventional balance training (on the ground featuring improved functional balance, gait and posture) and 1 used specific equipment (vibration platform).

The intervention protocol lasted between 6 and 24 weeks, with an average daily time ranging from 30 to 60 minutes and a frequency of 2 to 3 times a week.

The study by Beauchamp et al.¹⁶ showed that patients who received usual PR combined with balance training consisting of static and dynamic transfer, gait and functional muscle strengthening exercises presented significant improvements in the outcome measured by the BBS score compared with the group that received only the usual PR (mean difference: 5.4 scores; 95%CI: 2.31 to 8.49; $p < 0.01$) (Figure 1).

The findings of the study conducted by Mkcher et al.¹⁷ showed that patients who received usual PR combined with balance training consisting of posture, transfer, transition, gait and functional muscle strengthening exercises presented significant improvements in the BBS score compared with the group that received usual PR (mean difference: 7.30 scores; 95%CI: 6.66 to 7.94; $p < 0.01$).

The study by Spielmanns et al.¹⁸ (2016) found that patients who received balance training performed on a vibration platform in combination with usual PR presented similar improvements in BBS scores compared with the group that received usual PR (mean difference: 1.5 scores; 95%CI: -1.03 to 4.03; $p = 0.3$).

Figure 1. Flowchart for selection of studies on “the effects of PR associated with balance training in patients with COPD”, 2013 to 2020

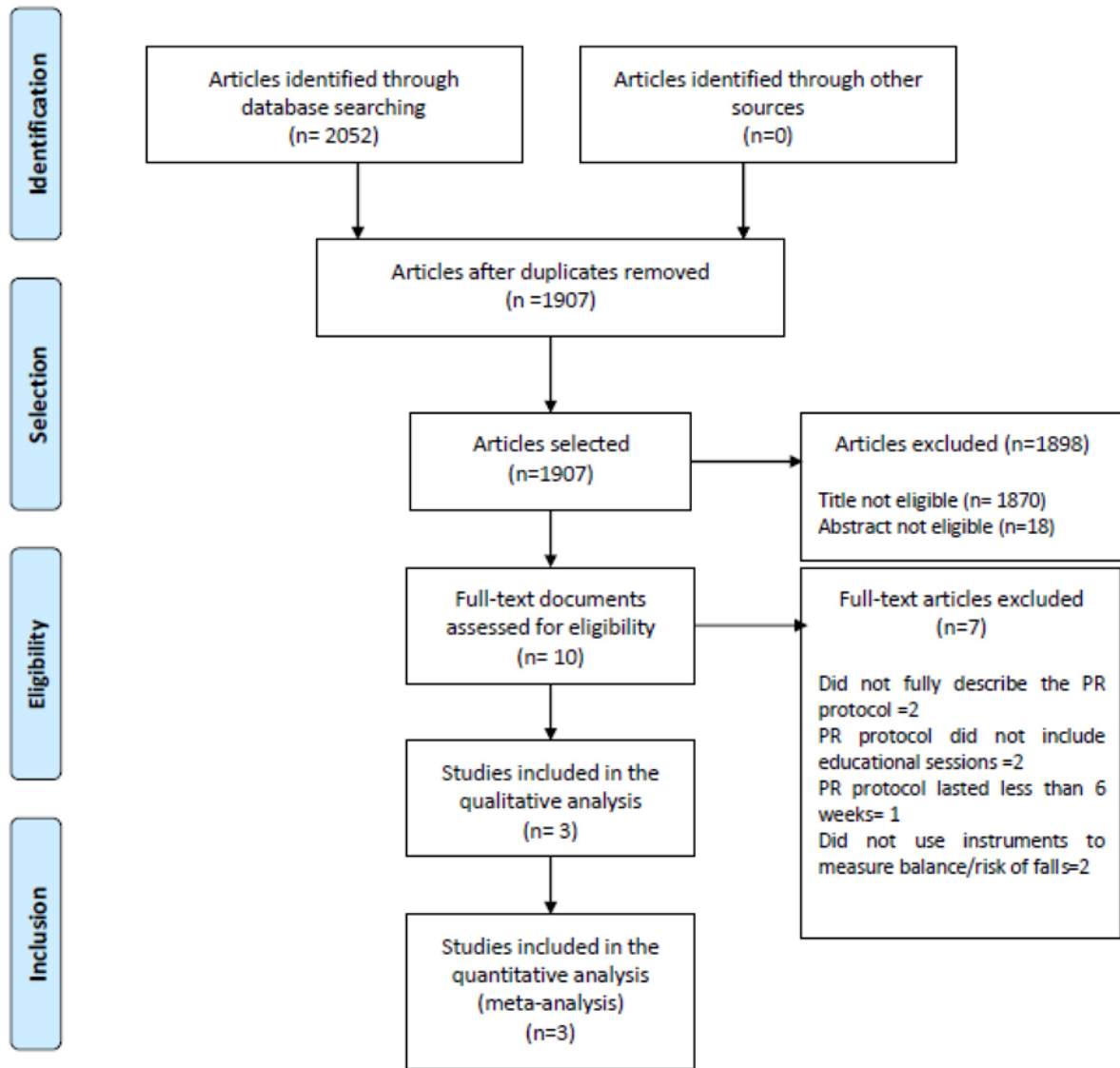


Figure 2. Comparison of the Berg Balance Scale scores in patients undergoing pulmonary rehabilitation associated with balance training versus usual outpatient pulmonary rehabilitation

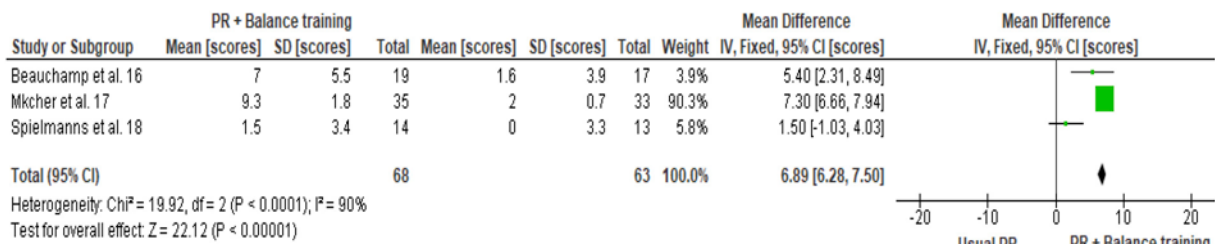


Table 1. Characterization of the studies selected for the systematic review described by author/year, country of origin, sample size, intervention protocol, methodological quality and main outcomes 2013 to 2020

Author/year	Country	Sample size	Intervention protocol	Methodological quality	Main outcomes (mean difference between groups; 95%CI)
Beauchamp et al., 2013 ¹⁶	Canada	39 patients, 21 in the IG (usual PR + balance training and 18 in the CG (usual PR)	6 weeks, 3x/week, 30 min	7	5.4 scores; 95%CI: 2.31 to 8.49; p<0.01
Mkcher et al., 2015 ¹⁷	Tunisia	68 patients, 35 in the IG (usual PR + balance training and 33 in the CG (usual PR)	24 weeks, 3x/week, 30 min	5	7.30 scores; 95%CI: 6.66 to 7.94; p<0.01
Spielmanns et al., 2016 ¹⁸	Germany	29 patients, 14 in the IG (balance training) and 13 in the CG (usual PR)	12 weeks, 2x/week, 30 min	5	1.5 scores; 95%CI: -1.03 to 4.03; p=0.3

BBS= Berg balance scale; COPD= chronic obstructive pulmonary disease; CG= control group; IG= intervention group; min= minutes; PR= pulmonary rehabilitation.

Table 2. Analysis of the methodological quality of the studies on “the effects of PR associated with balance training in patients with COPD”, 2013 to 2020, selected using the PEDro Scale

PEDro Scale Criteria	Beauchamp et al. ¹⁶	Mkcher et al. ¹⁷	Spielmanns et al. ¹⁸
Selected inclusion criteria	Yes	No	Yes
Random allocation	Yes	Yes	Yes
Allocation concealment	Yes	No	No
Similarity of groups at baseline	Yes	Yes	Yes
Blinding of subjects	No	No	No
Blinding of therapists	No	No	No
Blinding of assessors	Yes	No	No
Follow up of 85% of the participants	Yes	Yes	Yes
Intention to treat	No	No	No
Between-group statistical comparisons	Yes	Yes	Yes
Provision of measures of variability	Yes	Yes	Yes
Total score	7	5	5

PEDro: Physiotherapy evidence database.

Discussion

To the best of our knowledge, no systematic review studies with meta-analysis available in the current literature have evaluated the effects of PR in combination with balance training in patients with COPD, which makes the results of this study relevant as they show that this strategy significantly improved functional balance. This finding can be particularly useful as it may assist in the clinical management of this population group, provide the basis for more effective protocols and prevent possible associated complications.

COPD features several pulmonary and extrapulmonary manifestations and is associated with many comorbidities, including cardiovascular disease, diabetes mellitus, osteoporosis, depression, muscle weakness, reduced mobility and consequent impairment of balance, which are predictors of falls and lead to an important compromise of quality of life in this population¹⁹.

The systematic review study by Hakamy et al.²⁰ points out that the scientific evidence of the effects of PR on balance and survival is scarce and inconclusive. However, the studies on the issue included in the present review showed beneficial results despite the small sample size and the small differences in the mean scores on the BBS.

Previous studies have shown that exercise reduces falls in older adults and that the usual PR in combination with a balance training component had a better effect on the functional balance and muscle strength of patients with COPD, which can lead to a reduction in falls²¹⁻²³. Thus, we believe that prospective follow-up studies would be important to evaluate the effects of PR in combination with BT in this population in the short, medium and long term.

Following that line of thought, Verfasser²⁴ emphasizes there is a moderate degree of recommendation for balance training exercises and these should be implemented to prevent falls in older adults, which corroborates the findings of this study as COPD patients are mostly older adults and it was possible to observe benefits in the group that received both PR in combination with balance training and usual outpatient PR.

Within this context, the importance of the participation of COPD patients in PR programs should be emphasized as the gains in physical (exercise tolerance, functional capacity), mental (symptoms of anxiety and depression) and social (reduction of social isolation) domains are already well established in the literature. Additionally, the findings of this study show that this intervention also results in improved balance; therefore, a combination of all these gains can lead to a possible reduction in falls^{12,25}.

An observational cohort study found that the incidence of falls in COPD patients is 1.2 persons per year, which is 4 times higher than the reported incidence in older adults²⁶. Furthermore, other studies that evaluated whether postural control could discriminate "fallers" from "non-fallers" found that 46% of the participants had reported at least one fall in the previous year^{2,27}.

With regard to treatment duration, there was an important variation in intervention duration (6 to 24 weeks), which is in agreement with evidence from classic studies^{9,11,12} that report a minimum duration of PR programs ranging from 6 to 12 weeks. The decision to increase duration was made after a previous study by the same group found low effectiveness of balance training in combination with PR in patients with moderate to severe COPD²⁸. In addition, the same study points out that guidelines for fall prevention recommend ongoing balance training beyond 6 months in order to achieve the most favorable effects on reducing falls in older adults.

The three studies selected for the meta-analysis were carried out in Canada, Germany and Tunisia. We believe that sociocultural issues can influence the outcomes of the intervention as it takes technological support and funding to carry out study protocols involving specific balance training for COPD patients.

The only study that did not show a significant result regarding the improvement of functional balance was the one conducted by Spielmanns et al.¹⁸. We believe that this may have occurred due to the low weekly frequency of the intervention protocol and because the authors used only the vibration platform as a tool for balance training. Within this context, future studies should compare training protocols combining or not the use of the vibration platform with the training of ground-based exercises.

The methodological design of this study has its strengths, but it also has limitations since the number of selected articles was reduced. Moreover, we only used a single functional balance test (BBS) and the usual PR and balance training protocols were heterogeneous.

Conclusion

The findings of this systematic review with meta-analysis suggest that PR in combination with balance training promotes beneficial effects on the functional balance of patients with stable COPD compared with the usual outpatient PR.

Author contributions

Pinto APF, Nunes CBLO, Alencar HBO, Colasso JTB were responsible for the research conception and design, analysis and interpretation of data, manuscript writing. Silva GPF was responsible for the research conception and design; analysis and interpretation of data, manuscript writing and critical review of the final version.

Competing interests

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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