

## Effects of resistance training on the functional capacity of hospitalized COPD patients: systematic review

### Efeitos do treinamento resistido na capacidade funcional de pacientes com DPOC hospitalizados: revisão sistemática

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**RESUMO | INTRODUÇÃO:** A reabilitação pulmonar (RP) vem sido descrita como uma forma de tratamento para pacientes com doença pulmonar obstrutiva crônica (DPOC), tendo o treino resistido como seu principal componente. Apesar de estar clara na literatura a importância e reais benefícios adquiridos com programa de reabilitação, este muitas vezes só é iniciado após a alta hospitalar, adiando os potenciais efeitos e intensificando o comprometimento funcional do paciente. **OBJETIVO:** Revisar sistematicamente as publicações presentes na literatura relacionados aos efeitos do treino resistido sobre a capacidade funcional de pacientes com DPOC, considerando a viabilidade, segurança e características da prescrição do exercício durante o processo de reabilitação. **MATERIAIS E MÉTODOS:** Trata-se de um estudo de revisão sistemática (CRD42020158760) sobre os efeitos do treino resistido sobre a capacidade funcional de pacientes com DPOC. Foram selecionados artigos científicos no período de setembro de 2018 a fevereiro de 2019 que continham os seguintes descritores: "DPOC", "treinamento de resistência", "fraqueza muscular", "hospitalização" e "hospital". **RESULTADOS:** Foram incluídos dois estudos nesta revisão sistemática atendendo aos critérios de elegibilidade. Ambos utilizaram como forma de avaliação da capacidade funcional o teste de caminhada de 6 minutos e obtiveram resultados favoráveis ao treinamento iniciado em ambiente hospitalar. **CONCLUSÃO:** O treinamento resistido foi capaz de melhorar a capacidade funcional refletindo sobre a melhora na realização de atividades de vida diária e qualidade de vida. Demonstrou ser segura, de viável implementação e sem riscos para eventos adversos.

**PALAVRAS-CHAVE:** Doença pulmonar obstrutiva crônica. Treinamento de resistência. Fraqueza muscular. Hospitalização.

**ABSTRACT | INTRODUCTION:** Pulmonary rehabilitation (PR) has been described as a form of treatment for patients with chronic obstructive pulmonary disease, with resistance training as its main component. Although the importance and real benefits of a rehabilitation program are clear in the literature, it is often only started after hospital discharge, postponing the potential effects and intensifying the patient's functional impairment. **OBJECTIVE:** Systematically review publications in the literature regarding the effects of resistance training on the functional capacity of patients with COPD, considering the feasibility, safety and characteristics of exercise prescription during the rehabilitation process. **MATERIALS AND METHODS:** This is a systematic review study (CRD42020158760) of the effects of resistance training on the functional capacity of patients with COPD. Scientific articles were selected from september 2018 to february 2019 that contained the following descriptors: "COPD", "resistance training", "muscle weakness", "hospitalization" and "hospital". **RESULTS:** Two studies were included in this systematic review meeting the eligibility criteria. Both used the 6-minute walk test as a means of assessing functional capacity and had favorable effects on training initiated in a hospital setting. **CONCLUSION:** Resistance training was able to improve functional capacity reflecting on the improvement in the performance of activities of daily living and quality of life. It has been shown to be safe, feasible to implement and without risk for adverse events.

**KEYWORDS:** Chronic obstructive pulmonary disease. Resistance training. Muscle weakness. Hospitalization.

## Introduction

Hospitalized patients with chronic obstructive pulmonary disease (COPD) commonly have a high morbidity and mortality rate, as well as a significant reduction in quality of life, a high number of rehospitalizations, and increased costs of resources and health services<sup>1</sup>. When in an acute moment the treatment of these patients is restricted to the management of respiratory dysfunction and during the hospitalization process the effects of the disease on the physical condition are sometimes underestimated<sup>2,3</sup>.

In addition to pulmonary alterations, individuals with COPD have systemic repercussions, including generalized dysfunction of skeletal muscles. Dysfunction is represented by muscle weakness especially lower limbs, reduced muscle mass, decreased resistance and the presence of fatigue on small efforts<sup>4,5</sup>. These manifestations lead to reduced level and ability to perform daily physical activity and limited exercise tolerance, contributing to loss of mobility, functional decline and reduced quality of life<sup>6,7</sup>.

Pulmonary rehabilitation (PR) programs have been employed and indicated in the treatment of patients with symptomatic chronic respiratory diseases who have decreased activities of daily living<sup>8,9</sup>. According to the American College of Chest Physicians and the American Association of Cardiovascular and Pulmonary Rehabilitation<sup>10</sup> the pulmonary rehabilitation brings numerous benefits to the patient, including improved exercise tolerance and quality of life and reduced dyspnea. The PR program can be performed in hospitalized individuals, in outpatient or home patients whereas the second modality is the most commonly performed and is the one with the highest scientific description<sup>11</sup>.

Currently the number of evidences that address the importance of exercise is increasing especially the resistance training mode as a means favoring increased physical capacity, mass and peripheral muscle strength, as well as quality of life in this

patient profile<sup>4,12,13</sup>. However it is observed that the introduction of this exercise modality as part of pulmonary rehabilitation (PR) begins only after hospital discharge, postponing the benefits achieved with treatment and intensifying the patient's functional impairment<sup>6</sup>. Although physical training has been shown to be an important component of hospitalized patient care, few studies address its effects during the hospitalization phase, especially on COPD.

The objective of this study was to systematically review the publications in the literature about the effects of resistance training on functional capacity of patients with COPD.

## Materials and methods

This systematic review was performed according to the PRISMA criteria (Preferred Reporting Items for Systematic Reviews and Meta-Analyzes) by two investigators. The study protocol was registered in the international database of systematic reviews registration (Prospero) with the number: CRD42020158760.

### Search Strategy

This article is characterized by being a systematic review in which studies were evaluated in electronic databases: Scientific Electronic Library Online (SciELO), National Library of Medicine (Medline), Latin American and Caribbean Health Sciences Literature (Lilacs), Pubmed and Physiotherapy Evidence Database (PEDro), from September 2018 to February 2019 without restriction for year of publication. For each database combinations were used with the boolean operator "AND" of the following descriptors in portuguese: "DPOC", "treinamento de resistência", "fraqueza muscular", "hospitalização", and "hospital" with the correlates in english: "COPD", resistance training", "muscle weakness" and "hospitalization". The complete search strategy for the Pubmed database is shown in Chart 1.

**Chart 1.** Search strategy in the PubMed database

"COPD" AND "resistance training"
"COPD" AND " muscle weakness"
"COPD" AND "resistance training" AND "hospitalization"
"COPD" AND "muscle weakness" AND "hospitalization"
"DPOC" AND "treinamento de resistência"
"DPOC" AND "fraqueza muscular"
"DPOC" AND "treinamento de resistência" AND "hospitalização"
"DPOC" AND "fraqueza muscular" AND "hospitalização"
"DPOC" AND "hospital"
"DPOC" AND "treinamento de resistência" AND "hospital"
"DPOC" AND "fraqueza muscular" AND "hospital"

### **Selection Criteria**

The research was limited to studies in elderly with COPD in hospital. Randomized clinical trials written in Portuguese or English were included, involving resistance training as a treatment component and its effects on functional capacity in this patient profile. Studies involving other components of the PR program such as respiratory muscle training or aerobic training, outpatient and / or home PR program, which did not address functional capacity as na outcome.

### **Methodological Quality Assessment**

The studies found were systematically analyzed through a specific methodological quality assessment instrument. The PEDRo scale was elaborated based on the Delphi scale developed by Verhagen and collaborators, consisting of 11 criteria. The final score is given by the sum of the number of these criteria, excluding the first item and ranging from 0 to 10 points. The higher score is better quality of the study<sup>14</sup>.

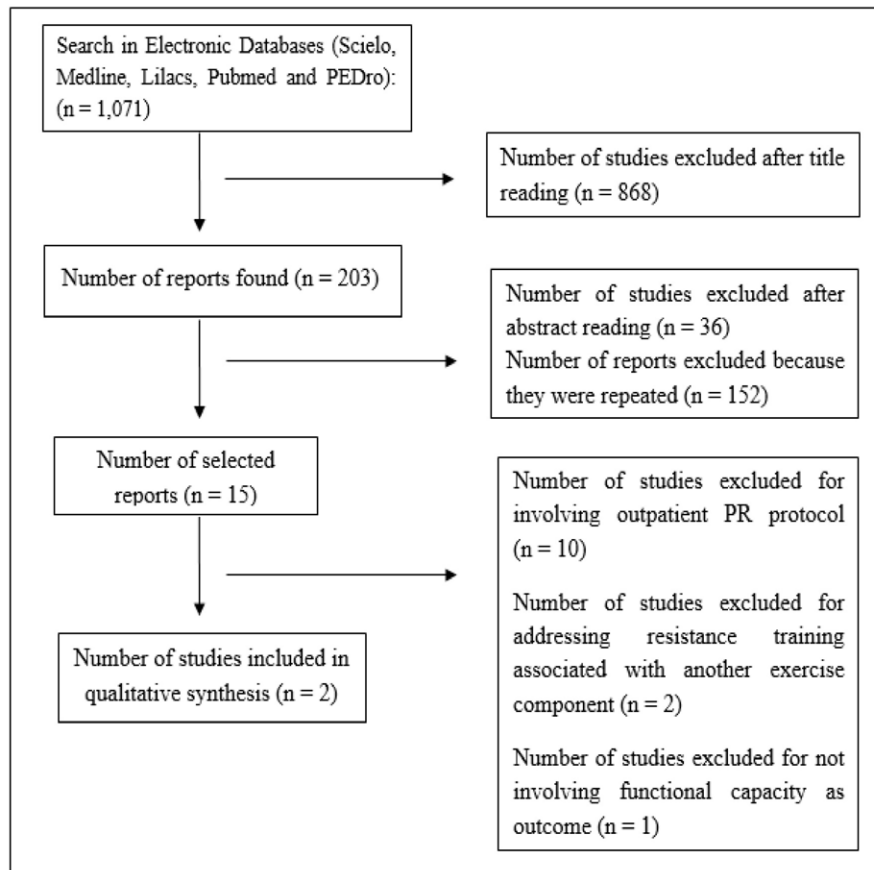
### **Data Extraction**

The selection of articles was based on the verification and consistency of the titles of each study followed by reading the available abstracts. Those who were eligible were later applied at full read and evaluated by the previously established inclusion criteria. At the end a critical summary was prepared summarizing the information provided by the articles included in the review.

## Results

In the initial search performed in the databases a total of 1,071 articles were identified. 868 were excluded after reading the title then 203 articles were evaluated for reading the abstracts however 36 were considered unrelated to the topic. 152 articles were excluded because they were repeated. After a complete reading of the articles, 10 studies were excluded because they were outpatient rehabilitation, 2 for addressing resistance training associated with another exercise component and 1 for not presenting functional capacity as an outcome. Lastly 2 studies were included for this systematic review meeting the proposed eligibility criteria. The research strategy flowchart is presented in figure 1.

**Figure 1.** Search and selection of studies for inclusion in the systematic review according to the PRISMA methodology



Regarding the methodological quality of the articles included, the two studies under analysis were considered of high quality, once they reached a score higher than 5 on the PEDro Scale. The criteria evaluated by the scale and the scores obtained by each study are presented in detail in Table 1.

**Table 1.** Methodological quality of studies by the PEDro Scale

AUTHOR	1	2	3	4	5	6	7	8	9	10	11	TOTAL
Borges; Carvalho. 2014 <sup>15</sup>		X	X	X			X			X	X	6
Troosters <i>et al.</i> , 2010 <sup>16</sup>	X	X	X	X				X		X	X	6

1) specification of inclusion criteria (item not scored); 2) subjects were randomly allocated to groups; 3) allocation was concealed; 4) similarity of the groups in the initial phase or basal; 5) there was blinding of all subjects; 6) there was blinding of all therapists who administered the therapy; 7) there was blinding of all advisors who measured at least one key outcome; 8) measurement of at least one primary outcome in 85% of the allocated subjects; 9) "intention to treat" analysis; 10) comparison between groups of at least one primary outcome and 11) reporting of variability measurements and estimation of parameters of at least one primary variable.

Abbreviation: X = Present Item.

The articles included in this systematic review had publication year 2010 and 2014 with samples composed of 36 and 29 subjects respectively and average age ranging from 64 to 69 years among study participants. Table 2 presents the sample characterization, participants clinical profile, treatment protocol, frequency and form of resistance training treatment and outcomes of each included study. In both studies, the assessment instrument for the variable exercise capacity was the 6-minute walk test (6MWT).

**Tabela 2.** Caracterização da amostra, metodologia, instrumento de avaliação da variável e desfechos dos estudos

AUTHOR	SAMPLE	CLINICAL PROFILE	TREATMENT PROTOCOL	FREQUENCY	CONDUCTING RESISTANCE TRAINING	VARIABLE / ASSESSMENT INSTRUMENT	OUTCOMES
Borges and Carvalho. 2014 <sup>15</sup>	29 (middle ages: CG 67.8 ± 9.0, TG 64.1 ± 12.5).	COPD patients hospitalized due to disease exacerbation admitted to the ward.	<b>CG:</b> received normal daily care (14 patients) <b>TG:</b> received normal daily care + upper and lower limb resistance training program (15 patients).	Started from the third day of hospitalization with morning sessions. Patients completed a minimum of 3 sessions during the study.	Upper limb exercises - shoulder flexion and abduction, elbow extension. Lower limb exercises - knee flexion and extension and hip flexion. Performed in a sitting position, using free weights, 2 sets of 8 repetitions and 80% initial load on 1RM test.	Exercise capacity / 6MWT	- Safe and viable training. - No increase in systemic inflammation or length of hospital stay was observed - There was an improvement in upper and lower limb muscle strength. - There were no significant effects on QoL of participants. - There was an improvement in the distance covered in the 6MWT with a larger increase in the TG and a statistically significant intergroup difference was observed.
Troosters et al., 2010 <sup>16</sup>	36 (middle ages: CG 69 ± 7, TG 67 ± 8).	COPD patients hospitalized with exacerbation of the disease, admitted to the ward.	<b>CG:</b> received usual care (19 patients) <b>TG:</b> received usual care + daily quadriceps resistance training (17 patients).	7 days.	Exercise using knee extension chair performed 3 sets of 8 repetitions with initial load of 70% of 1RM.	Exercise capacity / 6MWT	- Safe, viable and effective training. - No impact on markers of systemic inflammation, length of hospital stay or readmission rate. - There was a significant increase in quadriceps muscle strength being higher in TG. - There was an improvement in the distance covered in the 6MWT in the TG, but no change in the CG. There were no significant intergroup differences.

CG = Control Group; TG = Training Group; 1RM = 1 repetition maximum test; QoL = quality of life; 6MWT = 6-minute walk test.

## Discussion

Hospitalizations for acute or chronic diseases impose some degree of immobility on hospitalized patients and functional decline can be established rapidly especially in the elderly. The activities of daily living and instrumental activities of daily living can be extremely impaired after hospitalization, creating difficulty in these patients to perform them autonomously<sup>17</sup>. Individuals with COPD present important systemic manifestations, including nutritional changes and musculoskeletal dysfunction which result in decreased functional capacity. Exacerbations of the disease with later hospitalization become a reason for intensification of functional decline<sup>18,19</sup>.

Although the importance of PRP in the treatment of COPD patients has been widely described in the literature, there are few studies that address its performance in hospitals, especially the resistance training component. After analysis was found that only two studies addressed the isolated effects of training on functional capacity in this patient profile.

Physical training is part of a PRP stage. It consists of resistance training of the upper limbs, using weights, elastic bands or sticks, and lower limbs through weightlifting exercises. The commonly used training load is based on an initial incremental test adopting 50% of the maximum load obtained<sup>11</sup>. In the analyzed articles there was divergence as to the training load used, the exercise volume and the training frequency. The study by Borges and Carvalho<sup>15</sup> adopted the load corresponding to 80% of 1RM, exercise volume with 2 sets of 8 repetitions and minimum frequency of 3 sessions throughout the study. Troosters et al.<sup>16</sup> adopted 70% of 1RM, exercise volume with 3 sets of 8 repetitions and daily training frequency for 7 days. In both studies, load adjustment was performed based on participants' symptoms of dyspnea and fatigue.

Functional capacity reflects the physical ability of individuals to perform daily tasks. In contrast, functional disability represents the difficulty or need for external help to perform their basic and instrumental activities of daily living, as well as

those related to mobility<sup>20,21</sup>. In COPD functional impairment leads to increased episodes of disease exacerbation, hospitalization and mortality. Thus the functional capacity becomes essential in the evaluation of these patients and consequent marker in the proper planning of PR program<sup>22</sup>.

There are several ways to assess functional capacity, including questionnaires and functional tests. Lawton and Brody and the Katz Index are used to evaluate instrumental and basic activities of daily living respectively<sup>20</sup>. Among the most commonly used tests in clinical practice are the 6-minute walk test (6MWT), which is widely performed due to its simple execution, low cost and clinical validity. The outcome variable of the test is the distance traveled indicating that the higher the better the individual's functional capacity<sup>22,23</sup>.

Both articles included in the study used the 6MWT as a method of assessment and comparison of functional capacity before and after treatment. A 54 m increase in the distance covered in the 6MWT has traditionally been shown to be clinically significant<sup>24,25</sup>. In the study by Borges and Carvalho<sup>11</sup> during hospitalization patients in the training group showed an increase of 160 ( $\pm$  61) m in the test compared to the control group which presented an increase of 11 ( $\pm$  83) m. The clinically significant improvement observed in the 6MWT of the training group was maintained in patients up to 1 month after hospital discharge. However in the study by Troosters et al.<sup>12</sup> the 6MWT distance improved in the training group after discharge (61-14 m;  $P = 0.002$ ), while it remained unchanged in the control group (62-41 m;  $p = 0.59$ ). Although there was a difference between the groups, it was not significant ( $p = 0.23$ ).

Most studies available in the literature approach the patient and refer them to rehabilitation when they are considered to have stable COPD. However, some studies have showing that the exercise program can be considered safe and feasible to implement during acute exacerbation of the disease. Both the article by Borges and Carvalho<sup>11</sup> and Troosters et al.<sup>12</sup> positive effects on the training group were observed. There was no increase in inflammatory marker levels,



adverse effects during treatment or increased length of stay. These results were similar to a study that evaluated a resistance exercise program associated with aerobic training to determine its safety and viability<sup>26</sup>. It was seen that the program in the training groups was beneficial in improving exercise tolerance seen by increasing the distance in the 3-minute walk test after treatment and not having increased length of stay. These results indicate that exercise during a period of acute exacerbation did not negatively affect the recovery of COPD patients.

As limitations, Borges and Carvalho<sup>15</sup> considered the sample of patients included in the study as small, as well as a percentage considered large in the loss following the treatment protocol. In addition, the prolonged duration of some resistance training sessions, around 90 minutes, makes their implementation difficult in clinical practice. However, the study reveals that working fewer muscle groups would reduce attendance time by making the protocol more reproducible. Troosters et al.<sup>16</sup> considered that larger studies are needed to investigate the impact of resistance training on long-term outcomes. These limiting factors demonstrate the need for further studies for better data reproducibility.

## Conclusion

Based on this systematic review pulmonary rehabilitation with the resisted training component as a focus has shown beneficial results when initiated in-hospital in patients with COPD in the acute exacerbation phase of the disease. The training was able to improve the patients' functional capacity reflected by increasing the 6MWT distance. In addition, the exercise prescribed in this modality has been shown to be safe and feasible to implement due to the low frequency and no risk of adverse events observed during treatment.

Due to the high incidence of the disease and its refractory functional impairment further studies are needed especially randomized clinical trials with more

representative samples in order to evaluate the impact of resistance exercise on the functional condition of this population in the short and long term. Additionally, further studies will facilitate the establishment of stronger recommendations regarding the configuration of physical training in this scenario.

## Author contributions

Couto LC was responsible for the execution of the search strategy, compilation and analysis of the information, methodological quality evaluation and writing of the article. Melo TA was responsible for the study design, methodological review and evaluation of the final quality of the article.

## Conflicts of interest

No financial, legal or political conflicts involving third parties (government, companies and private foundations, etc.) have been declared for any aspect of the work submitted (including but not limited to grants and funding, advisory board membership, study design, preparation manuscript, statistical analysis, etc.).

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