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The effect of lower limb resistance and endurance training on the clinical picture and quality of life of patients with chronic obstructive pulmonary disease: A narrative review

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Abstract

The aim of the present review is to study the effect of different types of training on the clinical picture and quality of life of chronic obstructive pulmonary disease (COPD) patients. A bibliographic review was performed in international databases (PubMed and PEDro) from 2002 up to date. Eight clinical studies were included in this review. The evaluation of the internal validity of the studies was based on the PEDro scale. Results: The results showed that the application of a combined exercise program in patients with COPD that includes both types of exercise for 12 weeks and frequency 2-3 times per week, can have positive effects on their clinical picture and quality of life. However, few of the included studies performed follow-ups after the end of the intervention, so it is not known whether these benefits persisted for a long time. Conclusions: Both lower limb progressive resistance training as well as aerobic training significantly improve the clinical picture and quality of life of COPD patients, whether applied alone or in combination. However, more studies are needed in the future to study the long-term effects of exercise on patients with COPD.

Keywords: chronic obstructive pulmonary disease, pulmonary rehabilitation, physiotherapy, exercise

1. Introduction

Chronic obstructive pulmonary disease (COPD) is a common, *yet also* preventable and treatable, disease^[1]. Airflow is persistently obstructed, usually in a progressive manner. This obstruction is a product of the lungs and airways reacting to toxic gases and particles. The response is of a pathological chronic inflammatory nature and is contributed to by the exacerbations and comorbidities of each patient, which affect the severity of the disease in each case^[2]. COPD is very important due to its recent rapid growth. Projections show that by 2021 it will be the 3rd greatest health concern.

The conservative treatment of the disease that aims at pulmonary rehabilitation necessitates the coordination of a team consisting of many different specialties^[3]. This treatment method includes: Dyspnea control (relaxation and breathing techniques), secretion bronchial cleansing, breathing exercises (breathing muscle exercises), aerobic and anaerobic exercise (improving cardiorespiratory capacity, increasing muscle strength and endurance of peripheral muscles), patient information and education (smoking cessation, secretion self-management, compliance with medication, etc.), dietary intervention and psychological support^[2, 4, 5].

Symptoms of COPD are greatly relieved with exercise^[6, 7]. By exercising, COPD patients counter shortness of breath and fatigue due to an increase of their aerobic capacity. Furthermore, exercise helps patients better their quality of life and increase their physical activity levels by improving their functional ability. Lastly, secondary complications risk is also reduced^[4]. Final stage COPD patients were shown to be positively affected by exercise, thus reaffirming that exercise can help all patients, regardless of their disease progression stage and age^[5].

Resistance training is suggested to accompany endurance training in every COPD patient, but in particular in those that experience muscle weakness. Peripheral muscle weakness creates difficulty in exercising, intensifies the symptoms of COPD and is very commonly attributed to the disease [8,9]. Resistance exercise has been presumed to aid in that area by improving muscle weakness and thus lowering the intensity of COPD symptoms [3,10,11].

Endurance training has been proven to be beneficial to all COPD patients regardless of their disease progression, making it the 1st treatment choice [9,12,13]. The daily activities of COPD patients involve aerobic elements and are thus improved by endurance training, due to the fact that this type of exercise aims at enhancing their maximal oxygen uptake and aerobic capacity [13]. Peripheral muscle function has also been found to be benefited by endurance training [8]. Concerning the intensity of endurance exercises, higher-intensity has been found to be more advantageous physiologically. However, lower-intensity interval endurance training is preferred more by therapists, because the symptoms of patients at progressed stages of the disease make it more difficult for them to perform vigorous endurance exercises [6]. The aim of the present review is to study the effect of different types of training on the clinical picture and quality of life of COPD patients.

2. Materials and methods

2.1 Article search process

A literature review was conducted by two independent researchers with the 2nd three months after the 1st, in international databases (PubMed and PEDro) with the following keywords: Chronic Obstructive Pulmonary Disease

(COPD), pulmonary rehabilitation, physiotherapy, exercise.

The selection criteria for the articles included in this review were: (1) published material, (2) studies conducted from 2002 to 2020, (3) studies examining the effects of progressive resistance or endurance training programs in patients with COPD, (4) studies that used exercise as an individual intervention either in a laboratory setting or without specialized laboratory equipment, (5) studies included in randomized controlled trials and (6) studies examining the effects of exercise on parameters such as dyspnea, functional ability, strength and quality of life. Criteria for rejecting the studies were (1) articles that had not been published in English and (2) articles that did not have a control group or a 2nd intervention group in their design.

2.2 Evaluation of the internal validity of the articles included in this review

The internal validity assessment was performed on the basis of the PEDro scale. Articles with a score of 6 and above were selected.

2.3 Search results

The search strategy generated a total of 432 articles from both searches. The online searches were conducted on 16 October 2020 and 10 December 2020 respectively. All articles were collected and duplicates were removed (43 articles). 346 articles were then reviewed by reading the abstracts to determine whether they met the inclusion and exclusion criteria. Finally, from the final scanning process, eight studies resulted, which were included in this review. The study selection process is shown in Figure 1.

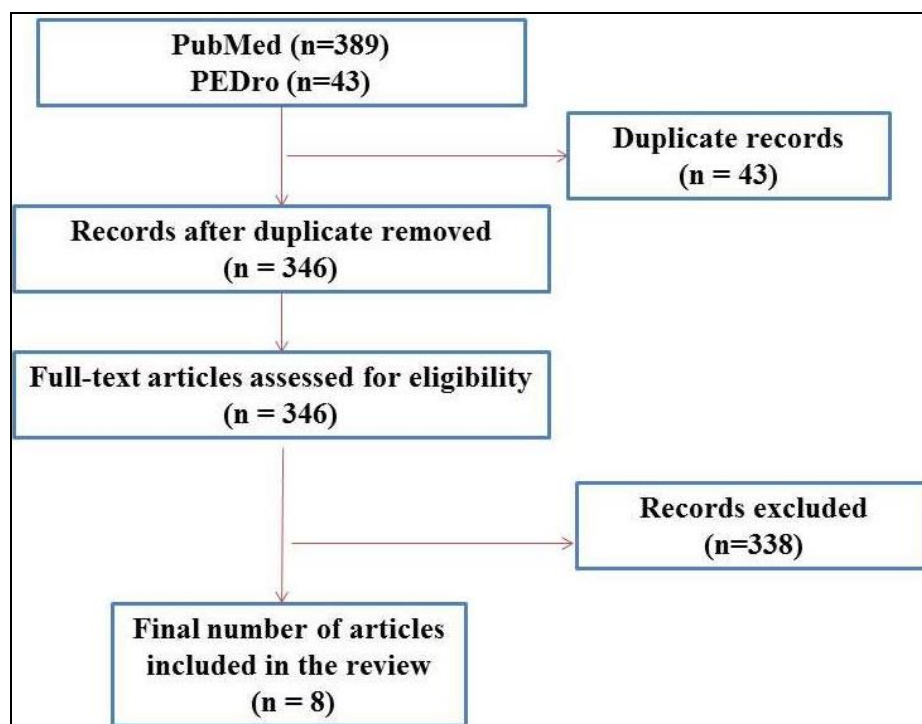


Fig 1: Study selection process flow chart.

3. Results & Discussion

The following are the studies included in the review as well as their main findings:

In the study of Spruit *et al.* [14], 48 patients with COPD participated in two rehabilitation programs for 12 weeks. The aim of the study was to compare the effect of resistance and

endurance training on COPD symptoms. According to their findings, both types of training yielded close positive results in the areas of quality of life, peripheral muscle strength and oxygen uptake of the participants.

Skumlien *et al.* [15] implemented a 12-week program with 40 COPD participants that had a frequency of two times per

week and involved both resistance and endurance exercises. They concluded that, when performed under supervision, both types of exercise benefit COPD patients after pulmonary rehabilitation.

Breyer *et al.* [16] employed a sample of 46 hospitalized COPD patients due to acute exacerbation. They implemented a lower limb resistance exercise program that had a duration from the 2nd day of the hospitalization of the patients until up to 30 days after their discharge. No statistically significant difference was observed in their daily life physical activity. On the contrary, based on the increased 6-Minute Walk Distance (6MWD) score, the researchers found an improvement on quality of life, functional ability and muscle strength of the patients.

In the study of Covey *et al.* [17], 75 COPD patients underwent a 16-week resistance training in preparation for a following aerobic exercise program. The researchers found that the combination of both types of exercise had positive effects on the functional ability of the patients, in contrast to the implementation of each one separately.

To add to that, Vonbank *et al.* [18] conducted a 12-week 3-group study consisting of 36 COPD patients in total and involved both types of exercise (progressive resistance and endurance) and a combination of the two, each assigned to a specific group. The aim of the study was to control the COPD symptom of dyspnea and increase the exercise tolerance of the participants. The findings showed that the group which followed the combined exercise program improved further than the other two in their exercise ability and quality of life.

Furthermore, Panton *et al.* [19] also studied a combined exercise protocol in a 12-week study (frequency twice per week) that involved 17 participants, in order to evaluate the efficacy of combining resistance with aerobic exercise. While patients already benefited from aerobic exercise alone, the addition of progressive resistance training further improved their condition.

The effect of resistance exercise on the performance of daily activities and general pulmonary function was the main research point of Wright *et al.* [20]. Their study involved 28 COPD patients, had a duration of 12 weeks and a frequency of twice per week and found that the daily activities performance of the intervention group had been positively impacted in relation to the control group.

Lastly, Ortega *et al.* [21] also found that combining resistance exercises and endurance training provides the best results in their 12-week study that involved 47 COPD patients and compared the two types of exercise.

The main characteristics of the studies included in the review are presented in Table 1.

3.1 Synthesis of the results included in the review

The included studies were applied to a total sample of 297

patients with COPD. The duration of the exercise programs was predominantly 12 weeks while changes were also observed in 8-week interventions. The frequency of exercises ranged from two to five times a week with an average of three times a week. The intensity of the exercises was determined by the degree of dyspnea and oxygen saturation of the patients during the exercise. In the majority of studies regarding resistance exercises, three sets of 6-12 repetitions were applied in the large muscle groups of the lower limbs with a load of approximately 60% of 1RM. In strength training programs the exercises included gait endurance training or 20-45 minutes on the stationary bike, while the exercise load was determined based on the Borg scale (cessation of exercise when the patient reached 3-5 on the scale) (see table 1).

In the above studies one or more of the following measures were evaluated: Bronchostasis indicators with ergospirometry (FEV1), dyspnea with the Borg scale, level of functionality with the 6MWD or Seat-to-stand test, ability to perform daily skills with Activities of Daily Living and Instrumental Activities of Daily Living (ADL and IADL), oxygen saturation with an oximeter, isometric strength of the quadriceps with a dynamometer, quality of life with the Chronic Respiratory Disease or SF-36 questionnaires and satisfaction of patients with the Global Perceived Effect scale. Regarding the effect of exercise, in all studies in which resistance or endurance exercise programs were implemented, positive effects were observed both in the clinical picture and in the quality of life before and after the intervention. However, no statistically significant differences were observed in studies comparing the two types of training (see table 1). Both types of training increased the strength of the lower limb muscles (quadriceps), the quality of life but also the ability to perform daily skills (walking distance, aerobic capacity, maximal oxygen uptake, etc.) which means that the improvement of these parameters is due to the increase in the level of physical activity and does not depend on the type of training.

In some cases there was, a small further increase in muscle strength with resistance training compared to endurance training, but this is not statistically significant [15].

On the other hand, a large percentage of those who practiced one type of training had a high dropout rate, which was significantly reduced in studies that applied a combination of both types of training (see table one). It is also worth noting that research that has implemented resistance or endurance programs in preparation for aerobic exercise has had much better results, which means that combining aerobic programs with weight training in the lower limbs produces better results. Finally, none of the above studies performed a follow-up beyond the 6-month to determine whether these benefits persisted for a long time as well as to check the adherence to exercise of COPD patients.

Table 1: Main characteristics of included studies

Author, Year	Number of participants	Intervention duration	Intervention	Conclusions
Spuit <i>et al.</i> , 2002 [14]	n = 8	12w	Comparison: effect of endurance exercise and effect of progressive resistance exercise.	Endurance training and resistance training had similar benefits to peripheral muscle strength, oxygen uptake, and quality of life in COPD patients.
Skumlier <i>et al.</i> , 2008 [15]	n = 40	12w	Endurance exercises and resistance exercises respectively.	Both types of exercise (resistance and endurance) twice a week maintain and improve patient benefits after pulmonary rehabilitation when the exercises are supervised.
Breyer <i>et al.</i> , 2010 [16]	n = 46	8w	Lower limb resistance exercise program.	Resistance exercises in the lower limbs improved both muscle strength and functional ability of patients as the distance in the 6MWD was significantly increased. The quality of life of the patients also improved.

Covey <i>et al.</i> , 2014 [17]	n = 75	16w	Resistance exercises in preparation for an aerobic exercise program.	The combination of aerobic exercise and resistance exercise showed more adjustments in the functional ability of the patients than the application of only one of the two types of exercise.
Vonbank <i>et al.</i> , 2012 [18]	n = 36	12w	Resistance program aimed at increasing maximal exercise ability (dyspnea control).	The combination of both types of exercise further increases muscle strength, quality of life and the ability to exercise in patients with COPD.
Panton <i>et al.</i> , 2003 [19]	n = 17	12w	Explored the benefits of resistance exercise in conjunction with aerobic exercise.	Progressive resistance training further increased the functional outcomes of COPD patients who had already participated in an aerobic exercise program.
Wright <i>et al.</i> , 2002 [20]	n = 28	12w	Effect of resistance exercise on pulmonary function and performance of daily activities of COPD patients.	The researchers found an improvement in the performance of daily activities after the intervention in relation to the control group.
Ortega <i>et al.</i> , 2002 [21]	n = 47	12w	Compared the benefits of resistance and endurance training in COPD patients.	The combination of resistance exercises and endurance training has the best results.

4. Conclusions

The studies included in this review seem to conclude that in a sufficient time period preceding the aerobic exercises, a combined resistance and endurance training protocol should be implemented. Its duration is recommended to be 12 weeks with a frequency of 2-3 times per week (table 1). A combined resistance and interval endurance exercise protocol is preferable for COPD patients with severe symptoms. Resistance training adds to their rehabilitation in two ways: dyspnea is less prevalent in this type of training and as a result it is more tolerable than endurance exercise, and it also helps patients build more muscle mass and strength compared to endurance training. Despite the fact that all studies found the combination of resistance and endurance training to be beneficial to COPD patients on their quality of life and clinical picture, the lack of long-term follow-ups beyond the 6- or 12-month mark does not provide enough evidence for the longevity of the results. Most COPD patients face financial difficulties and inability to access the rehabilitation facilities, making it hard for them to follow these programs in the long run. Consequently, even though changes are observed in these patients, they are eventually lost.

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