

Cardiorespiratory Fitness in Patients with Chronic Obstructive Pulmonary Disease



Ângela Maria Pereira^{1, 2, 3}, Ana Rita Correia¹

¹Physiotherapy, Escola Superior de Saúde Egas Moniz; ²Hospital Garcia de Orta; ³Centro de Investigação Interdisciplinar Egas Moniz, Almada, Portugal



ABSTRACT

Cardiorespiratory fitness (CRF) reflects the integrated ability to transport oxygen from the atmosphere to the mitochondria to perform physical work. It quantifies the individual functional capacity and it is directly related to the integrated function of numerous systems as pulmonary ventilation and diffusion, cardiovascular functions and muscle cells capability to receive and use the O₂ and nutrients delivered by the blood, as well as to communicate these metabolic demands to the cardiovascular control center and, thus it is considered a reflection of total body health (1). Chronic Obstructive Pulmonary Disease (COPD) is a chronic lung disease characterized by a progressive airflow limitation that is not fully reversible (2). Daily life activities (DLA) in patients with COPD are limited by exertional dyspnea and reduced exercise capacity with reduction in exercise tolerance measured as peak oxygen uptake (VO_{2peak}) (3). It has been found to be related to ventilatory limitations, pulmonary gas exchange abnormalities, peripheral muscle dysfunction or any combination of these factors (4). The aim of this study was to assess differences in Cardiorespiratory fitness after a combined exercise program in COPD patients.

Materials and Methods: Twenty men with moderate COPD (FEV1 49.8±10.5%) were randomly assigned; age 65±6.5 yrs; weight, 72.9±10 kg; height, 167±7.8 cm, were included to a combined exercise (strength and aerobic exercise) training program, for 6 month, three times a week. Cardiopulmonary exercise test (CPET) and 6-min walk distance test (6MWD), were performed before and after the training program. The study was approved by the Ethics Committee of the Garcia de Orta Hospital and all participants gave their informed consent. **Results:** The values of the CRF measured by VO_{2peak} increased (p<.001) (15.38±5.0 vs 25.7±5.4 mL.kg⁻¹.min⁻¹); ventilatory efficiency improved VE/VO_{2peak} (36.7±15.1 vs 29.2±6.6), Vt (1.52±0.35 L.min⁻¹ vs 1.82±0.41 L.min⁻¹); increased work peak (4.3±1.7 min vs 9.18±1.9 min) and also 6MWD (491.8±74.0 m vs 620.2±50.4 m); and peak dyspnea decrease (4.6±2.6 vs 1.2±1.2). **Discussion and Conclusions:** An increase in cardiorespiratory capacity reflects a better integrated response of the pulmonary, cardiovascular and neuromuscular systems in exercise and an improvement in functional fitness for DLA of these subjects, which was observed by an increase in exercise tolerance, in distance of 6MWD, and VO_{2peak}, accompanied by a decrease in dyspnea at the exercise peak. These improvements demonstrate a good correlation with the capability of effectively perform DLA (5). In conclusion, combined exercise training provides an increase Cardiorespiratory fitness in COPD subjects.

RESULTS

- Twenty men with moderate COPD (6) (FEV1 49.8±10.5%); age 65±6.5 yrs; weight, 72.9±10 kg; height, 167±7.8 cm, were randomly assigned to a combined (strength and aerobic exercise) training program, for 6 month, 3 times a week.
- To be eligible, subjects had to be tobacco-free for at least 6 months prior the study, have no exacerbations and no hospital admission 8 months prior the study, no relevant cardiac or musculoskeletal disease and no use of oxygen therapy. All subjects provided written informed consent prior to participation. The study was approved by the Garcia de Orta Hospital Ethics Board.
- Muscle strength was determined using the 1-RM method according a protocol previously published (8), on each of the 5 weight exercises using variable resistance machines.
- Exercise protocols – aerobic training, 30 minutes per session at 60-70% heart rate reserve. Weight training: 5 exercises, 1-2 sets, 2 min rest, 6-12 reps, @ 50-70% of 1-RM (9).

METHODS

Table 1 - Mean and standard deviation values for basal and final values of VO_{2peak}, VCO_{2peak}, VE_{peak}, VE/VO_{2peak}, Vt, work peak, dyspnea peak and 6-minute walk distance

	Befor	After	p*
VO _{2peak} (mL.kg ⁻¹ .min ⁻¹)	15.38±5.0	25.7±5.4	.000
VCO _{2peak} (L.min ⁻¹)	0.88±0.36	1.19±0.45	.005
VE _{peak} (L.min ⁻¹)	45.1±6.6	37.8±5.4	.002
VE/VO _{2peak}	36.7±15.1	29.2±6.6	.000
Vt (L.min ⁻¹)	1.52±0.35	1.82±0.41	.001
Work peak (min.)	4.3±1.7	9.18±1.9	.000
Dyspnea peak (Borg)	4.6±2.6	1.2±1.2	.000
6-minute walk distance (m)	491.8±74.0	620.2±50.4	.000

* Differences between groups p<.01

CONCLUSIONS

In this sample combined exercise improved muscular function with positive impact on pulmonary and cardiovascular function with improvement in cardiorespiratory fitness. An increase in cardiorespiratory capacity reflects a better integrated response of the pulmonary, cardiovascular and neuromuscular systems in exercise and an improvement in functional fitness for DLA, with desensitization of dyspnea.

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BACKGROUND

COPD is a major cause of chronic morbidity and mortality worldwide and it is currently defined as a disease state characterized by airflow limitation that is not fully reversible. This airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lungs to noxious conditions. The characteristic symptoms of COPD are coughing, sputum production, dyspnea, fatigue, decreased exercise tolerance, skeletal muscles dysfunction, hypoxemia, and deconditioning. These effects have important clinical consequences, as they contribute to the limitation of patients' exercise capacity and the decline of health status (3).

Exercise training is currently recognized as a fundamental component of pulmonary rehabilitation. Several studies have been published describing the effects of aerobic, strength and combined aerobic and strength exercises (7).

Aerobic training improves exercise performance and decrease perception of dyspnea in patients with COPD by improving muscular work rate, muscular oxidative capacity with increased oxidative enzymes and mitochondrial concentration, but seems to have little effect on muscle atrophy and weakness (4).

Strength training has been shown to improve not only muscle strength, but also overall endurance and perceived dyspnea, however there was no significant improvements in VO_{2max} or 6-minute walk test distances (1,3).

According to Ortega et al. (7), combined exercise training (strength + aerobic) it is probably a better strategy to treat COPD patients because we can obtain the improvements achieved by the other two strategies alone.

PURPOSE

The aim of this study was to assess differences in Cardiorespiratory fitness after a combined exercise program in COPD patients

RESULTS

- After training there were significant differences (p<.001), on CRF with an increase of VO_{2peak} (15.38±5.0 vs 25.7±5.4 mL.kg⁻¹.min⁻¹), and VCO_{2peak} (0.88±0.36 vs 1.19±0.45 L.min⁻¹), associated with decreased VE_{peak} (45.1±6.6 vs 37.8±5.4 L.min⁻¹), which reflects a ventilatory efficiency demonstrated by an improvement of VE/VO_{2peak} (36.7±15.1 vs 29.2±6.6) and Vt (1.52±0.35 L.min⁻¹ vs 1.82±0.41 L.min⁻¹) (Table 1).
- Increased distance in 6 minute walk test in the work peak was associated with desensitization of dyspnea
- For strength variables, significant differences were observed, for all muscular groups trained and all measurements (Figure 1).

Figure 1- Muscular strength

