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Should patients with Chronic Obstructive Pulmonary Disease be prescribed a resistance-training programme?

Short running title: Should patients with COPD be prescribed a resistance-training programme?

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Abstract

The purpose of this editorial/leader is to highlight the importance of encouraging patients with chronic obstructive pulmonary disease (COPD) to participate in a programme of resistance training (RT). COPD is a respiratory condition, which not only affects the pulmonary system but it also has systemic effects on the peripheral skeletal muscles. The systemic effects alter the structure and function of the peripheral skeletal muscles, which leads to muscle weakness, loss of muscle mass and poor health related quality of life (HRQoL). In the past aerobic training has been recommended to counteract the deleterious effects of COPD. However, evidence suggests that RT, which exerts or resists an external force (weight machines and free weights) will improve muscular strength, lean leg mass and HRQoL in COPD patients.

Keywords: Resistance training, chronic obstructive pulmonary disease, skeletal muscle dysfunction, muscle mass, health related quality of life

Introduction

Chronic Obstructive Pulmonary Disease (COPD) has long been recognised to affect the pulmonary system. However, a growing body of evidence is now emerging, which indicates that skeletal muscle dysfunction (SMD) is becoming a key feature of COPD.[1] SMD is related to the loss of muscle mass and strength, which are significant predictors of poor health related quality of life (HRQoL), mortality and subsequent increased healthcare costs in COPD patients.[2-4] SMD usually affects the muscles of ambulation by altering their structure and biochemical function.[1] Tissue biopsies taken from the quadriceps muscles have shown a greater predominance towards fatigable Type IIb muscle fibres and a reduction in Type I muscle fibres, along with lower oxidative enzyme concentrations, mitochondria and lower muscle fibre to capillary ratios. [1, 7-9] The shift in Type IIb muscle fibres along with lower oxidative enzyme concentrations cause early lactic acid production at lower exercise levels due to anaerobic metabolism.[10]

Despite the greater predominance of Type IIb muscle fibres, there also appears to be a deficit in muscle strength in COPD patients. An observational study has demonstrated that respiratory disease patients have on average a 19% overall lower muscle strength score on 4 resistance exercises (knee extensions, leg curls, chest press and seated row) when compared to healthy subjects.[11]

Traditionally most exercise training programmes have focused on aerobic training (AT) to counteract the deleterious effects of COPD. However, AT has little effect on improving muscle mass or strength. To improve the latter, exercises in the form of resistance training (RT), which resists or exerts an external force (weight machines or free weights) is required to increase muscle mass and strength. Therefore it would be prudent to recommend RT to patients who suffer from COPD.

What does the evidence suggest?

There have been two systematic reviews to help increase knowledge in this area. The first review by O'Shea *et al*[12] identified nine clinical trials that examined the effect of upper and lower limb RT on a total of 236 patients. The training protocol differed among the nine trials but generally RT was performed using free weights or resistance machines. The subjects were prescribed a series of 2-4 sets of exercises at a repetition range of 6-12, and intensity was set at 50-85% of their 1-repetition maximum. The frequency of each training protocol ranged from 2-3 sessions per week for 6-26 weeks. General outcomes of the trials were strength, respiratory function, exercise capacity (cycling endurance), walking endurance (timed walk test or shuttle walk test) and psychological factors (Short Form-36 Health Status Questionnaire and St George Respiratory Questionnaire). The pooled results of the studies showed that RT provoked significant improvements in both upper body and knee extensor strength when compared to no treatment or AT (upper body strength [n=136] effect size 0.70, 95% CI 0.28 to 1.11 and knee extensor strength [n=202] 0.90, 95% CI 0.42 to 1.38). The findings on respiratory function, psychological factors, exercise capacity and walking endurance were similar with RT and no treatment or with AT.

Puhan *et al*[13] included 11 trials in their review, 4 trials compared RT to AT and 7 trials compared AT to AT plus RT. The RT protocols used and outcomes measured in this review were similar to O'shea's *et al* [12] review. The outcome measures included HRQoL (chronic respiratory questionnaire), functional and maximal exercise capacity. However, the findings in this review differed somewhat to O'Shea *et al* [12] analysis. Puhan *et al* [13] demonstrated that RT produced larger improvements than AT for all the Chronic Respiratory Questionnaire (CRQ) domains (dyspnoea, fatigue, emotional function and mastery) with significant differences occurring in the emotional function domain and for the CRQ total score (-0.38, 95% CI –0.01 to –0.74 and –0.27, 95% CI –0.02 to 0.52 respectively). However, the evidence for whether RT improves functional and maximal exercise capacity was unclear. One trial found a larger improvement in functional exercise capacity with RT when compared to AT (70m, 95% CI –19 to 159), whereas three trials found a greater improvement with AT. However, the weighted mean difference for the three trials did not reach significance (15 m, 95% CI –14 to 44). Furthermore, one trial showed AT led to larger improvements in maximum exercise capacity, whereas another trial showed similar improvements between AT and RT (mean difference between AT and RT of 6 Watt, 95% CI –2.2 to 14.2 and mean difference – 1 Watt, 95% CI –11.5 to 9.5).

In the trials comparing AT with AT plus RT the results showed that a combination of training increased muscular strength. However, the gains in strength did not translate into additional benefits in terms of HRQoL, functional capacity and maximal exercise capacity. These findings along with O'Shea *et al*[12] findings might have been limited by different exercise training protocols, sample sizes and disease related factors.

In relation to muscle mass, three trials have demonstrated that RT increases lean leg mass and mid-thigh girth.[14-16] Two trials showed that lower limb RT lead to modest improvements in lean leg mass (3% and 4%) compared to no treatment.[14,15] Furthermore, one trial demonstrated that AT plus RT increased mid-thigh girth by 8% compared to AT alone.[16]

Conclusion

Evidence supports the use of RT as a means of improving muscular strength, lean leg mass and HRQoL in COPD patients.[12-15] However, the evidence for whether RT improves functional and maximal exercise capacity was inconclusive.[12,13] In addition, strength gains through combined AT plus RT have not translated into additional benefits in terms of HRQoL, functional and maximal exercise capacity.[13] Although, a combination of AT plus RT has been shown to increase mid-thigh girth.[16]

With reference to prescribing a RT programme, the analysis's carried out by O'shea *et al* [12] and Puhan *et al* [13] used RT protocols similar to the guidelines for healthy young adults (table 1).[17] However, the number of RT exercises, intensity, number of repetitions and sets varied amongst the trials. Further research is needed to determine the effects of different RT variables on muscular strength, HRQoL and lean leg mass in COPD patients.

Table 1 Comparison between resistance training study protocols in COPD patients and resistance training guidelines for healthy adults

Programme variables	COPD patients	Healthy Adults
Exercise mode	Resistance machines and free weights	Resistance machines and free weights
No. of exercises	4 to 8 resistance exercises covering the upper body and leg muscles	8 to 10 resistance exercises covering the major muscle groups; chest, upper back, shoulders, legs, arms, lower legs, lower back and abdomen
Intensity	50-85% of 1-repetition maximum	60-70% of 1-repetition maximum
Duration	2-4 sets of 6 to12 repetitions	Single set of 8-12 repetitions
Frequency	2-3 sessions per week	2-3 sessions per week

What is already known on this topic?

A key feature of COPD is SMD, which changes the structure and biochemical function of the peripheral skeletal muscle fibres. These changes lead to poor muscle mass and strength, which impacts on HRQL in COPD patients

What this editorial adds?

RT increases upper body and leg strength, which improves leg mass and HRQL in patients with COPD

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Non-declared

Competing interests
Non-declared

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Notes