Optimising upper-limb exercise in patients with COPD: another step towards personalised pulmonary rehabilitation?

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Upper-limb interval training may be a promising new modality in pulmonary rehabilitation
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Many challenges in daily life for people with chronic obstructive pulmonary disease (COPD) involve the use of their upper limbs. These include tasks such as dressing, bathing, shopping and various household activities. It has been shown that there is a significant negative correlation between upper-limb performance in people with COPD and limitations in activities of daily living [1]. Therefore, exercise training programmes during pulmonary rehabilitation ideally should include upper-limb training [2]. Typical exercise modalities for upper-limb training are aerobic modalities (*e.g.* arm cycling) or resistance training (*e.g.* using multigym stations, elastic tubes or free weights).

Upper-limb resistance training has been shown to improve upper-limb muscle strength in people with COPD [3]. However, the evidence for the benefits of upper-limb exercise training in people with COPD on patient-reported outcomes is still low-to-moderate quality [4, 5]. A Cochrane systematic review concluded that some form of upper-limb exercise training (compared with no upper-limb exercise or sham intervention) improves dyspnoea [6]. The limited number of trials (with small sample sizes ranging from 12 to 43 participants) showed a small but significant improvement of 0.37 points on the dyspnoea domain of the Chronic Respiratory Disease Questionnaire. However, no significant improvements in health-related quality of life have been found after upper-limb exercise training.

Therefore, the search for optimal exercise modalities in COPD rehabilitation continues, and a recent physiological cross-over study has revealed a promising avenue: upper-limb interval exercise (INT-EX). In this issue of *ERJ Open Research*, the study by Paneroni *et al.* [7], conducted by a team of dedicated researchers, aimed to compare for the first time the effects of INT-EX and continuous upper-limb exercise (CONT-EX) in people with COPD. One of the key findings of the study is the significantly longer exercise tolerance (7.2 *versus* 5.3 min) observed in the majority (77%) of patients during INT-EX compared to CONT-EX.

What makes INT-EX particularly noteworthy is its effect on physiological responses at isotime, where work is equivalent between INT-EX and CONT-EX. Patients performing INT-EX had lower dynamic hyperinflation (−43%), oxygen uptake (−6%), minute ventilation (−6%) and symptoms (Borg dyspnoea and effort both −3 points). These results highlight the potential of upper-limb interval training to mitigate the physiological burden on people with COPD, offering a more comfortable and sustainable workout regimen. Compared to lower-limb endurance training, the interval training approach for the upper limbs may result in smaller physiological differences, particularly in dynamic hyperinflation (figure 1). This may be due to the lower quantity of activated muscle mass.

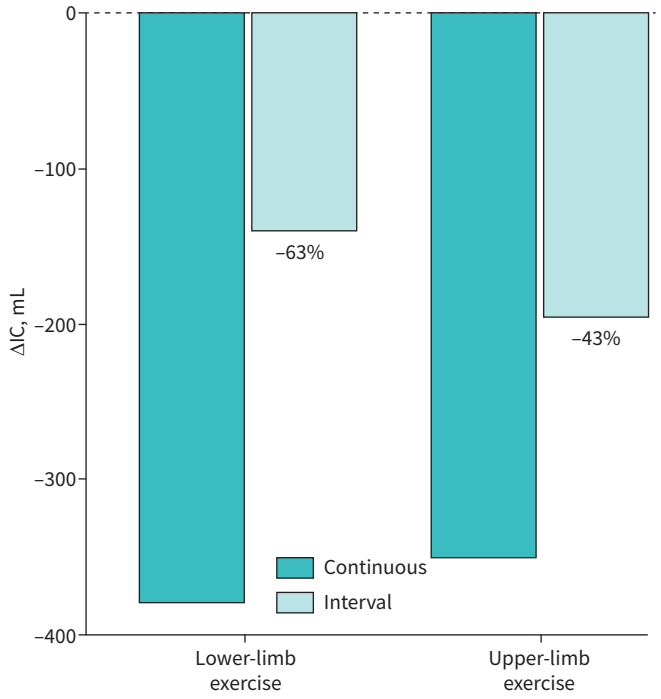

FIGURE 1 Dynamic hyperinflation at isotime of lower- or upper-limb endurance exercise following a continuous or interval training modality. Data from the studies by Louvaris *et al.* [8] for lower-limb exercise (mean±SD forced expiratory volume in 1 s (FEV_1) 58±17% of predicted, residual volume (RV) 158±33% of predicted; n=12) and Paneroni *et al.* [7] for upper-limb exercise (FEV_1 54±15% of predicted, RV 157±33% of predicted; n=26). ΔIC: change in inspiratory capacity.

Although the focus of this study is highly commendable, it does not explicitly tackle a crucial question: is arm cycling exercise a vital modality for people with COPD, and does the choice between interval and continuous approaches significantly influence the activities of daily living (ADL) for this population? Although the present study highlights the advantages of interval training, there is a notable gap in addressing ADL activities, and establishing connections between them and exercise performance during arm cycling exercises. To provide a more comprehensive understanding, it would be beneficial to explore the impact of arm cycling on ADL and how the choice of training approach may affect the daily lives of people coping with COPD. Moreover, the research conducted by the same group has previously indicated that the extent of arm elevation plays a crucial role in determining endurance and cardiopulmonary adaptations among people with COPD engaging in upper-limb exercise [9]. Specifically, the study found that a higher arm elevation of 120° posed greater challenges than a lower arm elevation of 80°. In light of these results, there arises a question regarding whether activities performed at higher arm elevations yield more benefits for people with COPD compared to arm cycling.

Thus, considering these findings, the efficacy and significance of incorporating arm cycling exercises into the regimen of people with COPD warrant further investigation. Although interval training offers the advantages of extended exercise durations and heightened workloads, it remains essential to explore and understand the potential implications of these results to ascertain the relevance of arm cycling for people with COPD. Future randomised, controlled trials (with adequately powered sample sizes) should compare the differences between upper-limb endurance training, upper-limb resistance training, and combined upper-limb endurance and resistance training on patient-relevant outcomes such as dyspnoea, health-related quality of life and upper limb ADL performance. This is necessary to clarify the relevance of upper-limb exercise training, specifically arm cycling, in people with COPD.

However, the study by Paneroni *et al.* [7] not only provided the physiological rationale for upper-limb interval training, the authors also looked at patient characteristics. They showed that patients with longer INT-EX had lower comorbidity scores and better-preserved lung function compared to their CONT-EX counterparts. This suggests that interval exercise may be particularly beneficial for people with specific clinical profiles, paving the way for a more personalised approach to pulmonary rehabilitation.

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