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Innovative Exercise for Extrapulmonary Benefits in Chronic Obstructive Pulmonary Disease

Feasibility, Physiological Responses and Methodology

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Academic dissertation

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Abstract

Background
Chronic obstructive pulmonary disease (COPD) is a leading global health burden and a major cause of morbidity and mortality. Beyond airflow limitation and respiratory symptoms, COPD is associated with multiple extrapulmonary manifestations including cognitive impairment, decreased cardiovascular fitness and muscle dysfunction. These systemic effects contribute to lower physical capacity and increased mortality, independent of lung function. To treat extrapulmonary manifestations among individuals with COPD, exercise training has an important role. However, traditional exercise methods are often difficult for individuals with COPD to tolerate, given their ventilatory limitations and muscle dysfunction, resulting in sub-optimal treatment effects. Short-duration watt-controlled supramaximal high-intensity interval training (HIIT) consisting of 10 × 6 second intervals is promising for individuals with COPD, as it enables high external intensities while allowing for ventilatory relief. Yet, evaluation of its feasibility, physiological response, prescription and long-term effectiveness is lacking. Furthermore, reporting quality in aerobic exercise trials in COPD may be incomplete, hindering reproducibility and the translation of research findings into clinical practice. The overarching aim of this thesis therefore was to advance the development of effective exercise strategies for COPD by evaluating the feasibility, physiological responses, and methodological aspects of supramaximal HIIT, and by assessing the reporting quality of aerobic exercise interventions in the COPD literature.

Methods
This thesis comprises four papers based on two clinical trials and one systematic review. In a randomised cross-over trial, Paper I examined the feasibility and acute physiological responses to supramaximal HIIT, compared to moderate-intensity continuous training (MICT), in 16 individuals with COPD and 16 matched healthy controls (HCs). Paper II, using data from the same trial, evaluated the feasibility and applicability of the modified Borg Cycle Strength Test (mBCST) for prescribing supramaximal workloads. Paper III presents the study protocol of an ongoing, international multicentre randomised controlled trial (RCT), the COPD-HIIT RCT. The trial compares supramaximal HIIT and MICT over 3 months in individuals with COPD and HC, with continued training for 24 months in the COPD group. Paper IV was a systematic review assessing the reporting quality and application of exercise training principles in RCTs that included aerobic training in individuals with COPD.

Results
Paper I demonstrated that supramaximal HIIT was feasible and enabled participants with COPD to achieve higher external intensities (245 ± 88 *vs.* 71 ± 22 W) compared to MICT, with reduced ventilatory demand. Both exercise modalities increased plasma brain-derived neurotrophic factor by an average of 59%. Paper II deemed the mBCST feasible and applicable for prescription of supramaximal intensities in COPD. The COPD-HIIT RCT, presented in Paper III, have enrolled 133 participants of which 82 are individuals with COPD. The participants with COPD constitute a representative cohort with a varied disease severity. Compared to matched healthy controls, they exhibit reduced cognitive function, cardiorespiratory fitness and quadriceps function at baseline. Paper IV included 298 trials, in which the quality of reporting was generally poor. This was demonstrated by a mean of 5.4 ± 3.0 reported items (out of a maximum of 19) on the Consensus on Exercise Reporting Template.

Conclusions
This thesis supports the feasibility of short-duration, watt-controlled supramaximal HIIT for individuals with COPD, allowing higher exercise intensities with lower ventilatory demand than MICT. The mBCST appears feasible and applicable for prescribing supramaximal workloads, while further research is warranted for its clinical implementation. Preliminary data from the ongoing COPD-HIIT RCT indicates good adherence to supramaximal HIIT and representative recruitment. Finally, the systematic review revealed suboptimal reporting of aerobic exercise interventions in COPD research, emphasizing the need for improved reporting to strengthen reproducibility and clinical translation.

Keywords: Chronic obstructive pulmonary disease, COPD, high-intensity interval-training, exercise, aerobic exercise, feasibility

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