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Effects of interval-load versus constant-load training on the BODE index in COPD patients

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Summary
The BODE index is frequently used to assess functional capacity in patients with COPD. The aim of this study was to investigate the effectiveness of interval-load training (ILT) to improve the BODE index in comparison to the commonly implemented constant-load training (CLT).

Forty-two patients with COPD [FEV_1: (mean ± SEM) 42 ± 3% predicted] were randomly allocated to either ILT ($n = 21$) or CLT ($n = 21$). The training program consisted of cycling exercise 3 days/week for 10 weeks. Patients assigned to ILT exercised at a mean intensity of 126 ± 4% of baseline peak work rate (Wpeak) with 30-s work periods alternated with 30-s rest periods for 45 min per day, whereas patients allocated to CLT exercised at a mean intensity of 76 ± 5% of baseline Wpeak for 30 min per day. The BODE index and its components: body mass index, FEV_1, MMRC dyspnea score and the 6-min walk test (6-MWT) as well as cycling Wpeak were assessed before and after both exercise training regimes.

Both ILT and CLT significantly ($p < 0.001$) decreased the BODE index (from 4.8 ± 0.5 to 4.0 ± 0.5 units and from 4.4 ± 0.5 to 3.8 ± 0.5 units, respectively). In addition, both ILT and CLT significantly decreased the MMRC dyspnea score by 0.4 ± 0.1 units and increased the 6-MWT (by 52 ± 16 and 44 ± 12 m, respectively) as well as cycling Wpeak (by 14 ± 2 and 10 ± 2 W, respectively). The magnitude of these changes was not significantly different between ILT and CLT. Consequently, ILT is equally effective to CLT in terms of improving the BODE index in patients with COPD and as such it may constitute an alternative rehabilitative modality in COPD.
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Introduction

Pulmonary rehabilitation is a multidisciplinary process of care for patients with Chronic Obstructive Pulmonary Disease (COPD) that is tailored and designed to optimize physical and social performance and autonomy.[1] Exercise training is widely accepted as the cornerstone for enhancing the functional ability and the quality of life in patients with COPD.[2,3]

The BODE index is a simple multidimensional grading index which incorporates measurement of the body mass index (BMI), the forced expiratory volume in one second (FEV_1), the Modified Medical Research Council dyspnea scale (MMRC) and the 6-min walk test (6-MWT). The BODE index is usually used to assess functional capacity and prognosis of mortality in patients with COPD.[4,5] In particular, two of the outcomes of the BODE index, the 6-MWT and the MMRC dyspnea scale are routinely used in patients with COPD to assess changes in functional capacity following implementation of pulmonary rehabilitation and also the severity of perceived respiratory disability of daily activities, respectively.[6–8]

The majority of rehabilitation programs typically implement constant-load training for 30–40 min, three to five times per week.[9] The intensity of training is recommended to be higher than 60% of peak workload (Wpeak) in order to obtain physiological adaptations.[10–13] However, patients with severe airflow limitation cannot tolerate such prolonged periods of constant-load training at high intensity levels.[12] In these patients, interval-load training, consisting of repeated periods of maximal or high intensity exercise alternating with short intervals of rest or low intensity exercise levels, constitutes a good alternative training strategy to constant-load training.[14–16]

In healthy subjects interval-load training leads to a training effect that is similar to that of constant-load training but with lower blood lactate concentration during the actual training sessions.[17,18] Similarly, in patients with moderate to severe COPD, interval-load training consisting of maximal exercise intensity for 30-s alternating with 30-s rest periods, has been shown to be equally effective to constant-load training sustained at 65–80% of Wpeak in terms of enhancing cycle ergometry exercise tolerance and peak oxygen consumption.[14] Importantly, interval-load training is associated with lower levels of dyspnea and leg discomfort during the training sessions.[14,19] However, to the best of our knowledge no trials have been conducted to investigate whether interval-load training is equally effective to constant-load training in terms of increasing functional capacity in patients with COPD as this is assessed by the BODE index and its components.

Therefore, the aim of this study was to compare the effect of interval-load training to constant-load training in terms of improving the BODE index and its components in patients with COPD. Based on the findings of previous studies[19,20] showing similar effects of the two training modalities on the magnitude of adaptations in peripheral muscle fiber cross-sectional area, oxidative capacity and capillarity and also on the degrees of improvement in exercise tolerance and peak oxygen consumption, it was hypothesized that the improvement in the BODE index and its components would not differ between interval- and constant-load training.

Methods

Study design

Forty-two COPD patients with GOLD stages II, III and IV[21] admitted to a comprehensive pulmonary rehabilitation program. Inclusion criteria required patients to be younger than 75 years old with a $FEV_1 \leq 80\%$ predicted without significantly reversibility ($<12\%$ change of initial FEV_1 values after bronchodilator), clinical stable with no significant co-existing disease that affects the patients ability to undertake exercise training. The study was approved by the institution's Ethics Committee. The aim of the study was fully explained to the patients and a written informed consent was obtained from all participants.

Before and after a 10-week period of pulmonary rehabilitation patients were asked to record their perceived breathlessness on the MMRC scale. In addition, each patient undertook a 6-MWT, an incremental cycle ergometry test to assess Wpeak and pulmonary function assessment tests. Immediately, after the baseline assessment patients were randomly assigned into two different training modalities: interval-load training (ILT) and constant-load training (CLT). Based on the findings of our previous studies[14,19,20] randomization was stratified according to the patients' baseline lung function (FEV_1% predicted lower or higher than 50) and cycling exercise Wpeak (higher or lower than 50 W).

Pulmonary function assessment

Spirometry for the determination of FEV_1 and FVC was performed with the patient in the sitting position using a Spirometer (Master Jaeger, Germany) according to recommended techniques.[22] Maximal voluntary ventilation (MVV) was estimated indirectly by multiplying FEV_1 by 40.[23]

Arterial tensions of O_2 (PaO_2) and CO_2 ($PaCO_2$), and pH were measured from 2 mL blood samples using a blood gas electrode system combined with a co-oximeter (ABL625, radiometer, Copenhagen, Denmark) within 10 min of collection.

Incremental exercise tests

An incremental exercise protocol on a cycle ergometer was performed by each patient in order to assess Wpeak. The work rate increments were determined according to the equations reported by Wasserman et al.[23] The protocol of the incremental exercise test was as follows: after 3-min of rest and 3-min of unloaded pedaling, the work rate was increased by 5–10 W every 1-min to the limit of tolerance. During each test cardiac frequency (f_c) was recorded by an ECG (Marquette Max, HELLIGE GMBH, Germany) and percentage O_2 saturation (%SpO_2) by a portable pulse oximeter (Nonin 8600 Nonin medical, Plymouth, USA). Also the modified Borg scale[24] was used to rate the magnitude of perceived dyspnea and leg discomfort every 2-min throughout the test and at the cessation of exercise.

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