Exercise Training in Pulmonary Rehabilitation

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KEYWORDS

• Exercise • Rehabilitation • Pulmonary • Lungs • Intervention • Physical activity

KEY POINTS

- Exercise training remains a cornerstone of pulmonary rehabilitation (PR) in patients with chronic respiratory disease.
- The choice of type of exercise training depends on the physiologic requirements and goals of the individual patient as well as the available equipment at the PR center.
- Current evidence suggests that, ground walking exercise training, Nordic walking exercise training, resistance training, water-based exercise training, tai chi, and nonlinear periodized exercise are all feasible and effective in (subgroups) of patients with chronic obstructive pulmonary disease.

Pulmonary rehabilitation (PR) is defined as a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies that include, but are not limited to, exercise training, education, and behavior change. PR programs are designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence to health-enhancing behaviors.[1] Therefore, exercise training is a core component of PR in patients with chronic respiratory disease.[1–6] This article provides an overview of various types of exercise training, including endurance exercise training, interval exercise training, ground walking exercise training, Nordic walking exercise training, resistance training, water-based (or aquatic) exercise training, tai chi, and nonlinear periodized exercise training (NLPE) (**Fig. 1**).

ENDURANCE EXERCISE TRAINING

Endurance training can be defined as an activity in which large muscle groups are used continuously.[7] In the past, PR has focused primarily on aerobic endurance training (such as walking, cycling, stair climbing[8]), a training frequency of 3 to 4 days per week, with an initial work-phase duration of 10 to 15 minutes, progressively increasing up to 30 to 40 minutes.[9,10] Between 6 and 8 weeks of endurance exercise training is thought to be the minimum time frame needed to achieve substantial effects.[11,12] However, longer PR programs generally lead to more favorable results.[11]

The main aim of endurance training in patients with chronic obstructive pulmonary disease (COPD) is to improve aerobic capacity and augment the ability to perform daily activities.[10] Previous studies have shown that endurance exercise training also has beneficial effects on peripheral muscle force, functional exercise capacity, peak work rate, and health-related quality of life.[13–16] Increased exercise capacity following PR can be attributed, in part, to centrally mediated improvements, such as reduced ventilatory requirement for a given task and increased peak aerobic capacity.[8] There is also evidence that endurance exercise

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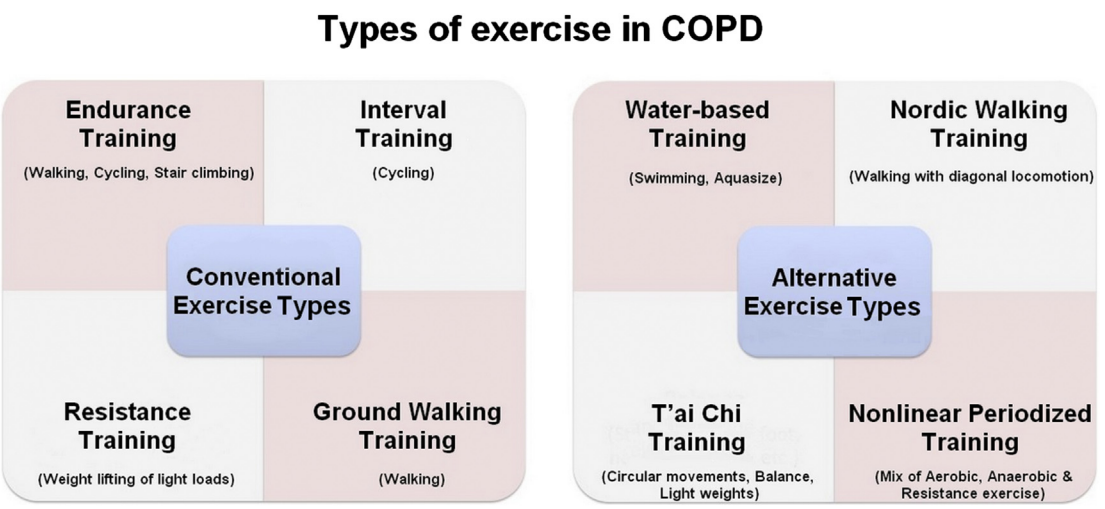

Fig. 1. Types of exercise in chronic obstructive pulmonary disease (COPD).

training elicits improvements in aerobic function and structure of the lower-limb muscles. The latter include increased muscle fiber capillarization, increased mitochondrial density, increased oxidative capacity of muscle fibers, and a delayed onset of the anaerobic metabolism.[8,17] Endurance exercise training also seems to improve arterial stiffness in patients with COPD,[18] but these results need to be verified in larger studies. Aortic pulse wave velocity did not change following a state-of-the-art PR program in patients with COPD, including endurance exercise training, interval exercise training, and strengthening exercises.[19] A lower BODE index (a composite COPD rating, including measures of body mass index, airway obstruction, dyspnea, and 6-minute walk distance) has also been observed after endurance exercise training.[20] Because higher (worse) BODE scores predict mortality in COPD,[21] this type of exercise intervention may improve mortality.[22] However, this finding has never been confirmed prospectively.

Endurance training, under the supervision of a health care professional such as a physiotherapist or exercise physiologist, is highly recommended for patients with COPD who are able to perform continuous training of at least moderate intensity.[23] In PR exercise training, the target training intensity is usually monitored by work rate and perceived exertion.

Exercise training at 60% to 90% of peak work rate is usually defined as high-intensity exercise,[5] and is thought to be superior to lower intensity training in achieving physiologic improvements in aerobic exercise capacity.[11,24–27] An intensity greater than 60% of the peak work rate can usually be sustained for short periods only, ranging from 4 to 10 minutes in patients with moderate to severe COPD. Less than 20% of patients may be able to sustain this continuous high-intensity exercise throughout the PR program.[28] Although higher intensity of training generally leads to greater increases in exercise capacity, this is not always the case.[4,29] Low-intensity to moderate-intensity continuous training (50% to 60% of peak work rate or a score of 5 to 6 points on the modified Borg scale) can also lead to gains in exercise endurance, even in patients with advanced disease.[8,30]

INTERVAL EXERCISE TRAINING

Interval training can be defined as repeated short periods of exercise alternated with rest. The duration of the work interval and the recovery interval can vary greatly and depend on the duration of the work phase.[31,32] In healthy individuals the metabolic changes, including cardiorespiratory responses and low muscle lactate concentrations, during interval exercise are similar to those of continuous moderate exercise.[33]

Emerging research indicates that interval training is an attractive alternative to continuous training, especially in those patients with COPD who develop severe dyspnea during exercise[34–36]; these patients are often unable to sustain continuous exercise intensities sufficiently long enough to obtain physiologic training adaptations.[23,37] The intermittent recovery periods during interval training facilitate a decrease in end-expiratory lung volume and prevent high lactate accumulation, which results in lower ventilation and less dyspnea.[37–43]

Compared with continuous high-intensity training, interval training results in fewer unintended