Effects of exercise training and inspiratory muscle training in spinal cord injury: a systematic review
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CRD summary
This review concluded there was insufficient evidence to strongly support exercise training and inspiratory muscle training use for improved respiratory function in people with spinal cord injury. The reliability of the authors' conclusions is unclear given the potential for publication bias, reviewer error and bias, and a number of limitations in the evidence (small sample sizes and poor study designs).

Authors' objectives
To assess the effectiveness of exercise training and inspiratory muscle training on respiratory function in patients with spinal cord injury.

Searching
MEDLINE, CINAHL, EMBASE, and PsycINFO (all from 1980 to 2006) were searched for publications in English language only. Search terms were reported. The reference lists of retrieved articles were screened for additional studies.

Study selection
The inclusion criteria for study designs were not explicitly stated. Only studies of exercise and inspiratory muscle training protocols on respiratory function were considered. Studies of acute responses to exercise or competitive athletics, and those with no measurable outcome associated with the intervention, were excluded. Only participants with spinal cord injury were considered. Studies where less than half of participants had spinal cord injury were also excluded.

The characteristics of study participants (level of spinal injury and time since injury) and training protocols (frequency, intensity and duration) were varied. The mean age ranged from 28.5 to 36 years, and the majority were men. The included training modalities were varied: wheelchair or arm-crank aerobics; ventilatory and upper extremity muscle exercise; target, non-target, resistive or threshold inspiratory muscle training). The included studies considered varied measures of respiratory function: expiratory capacity, ventilatory muscle strength and endurance, lung volumes and dyspnoea. Studies of exercise training mainly included participants with lower-level paraplegia, while those of inspiratory muscle training included both paraplegia and tetraplegia (mainly with cervical injuries).

The authors did not state how many reviewers performed study selection or how any disagreements was resolved.

Assessment of study quality
The quality of randomised controlled trials (RCTs) was assessed using the Physiotherapy Evidence Database (PEDro) score (assigning a score between 0 to 10). The Downs and Black tool (assigning a score between 0 to 28) was used for non-RCTs, with the higher end of each scale representing higher quality.

Two reviewers independently assessed study quality. Disagreements were resolved by discussion or a third reviewer.

Data extraction
Data were extracted in order to assess improvements/changes in respiratory outcomes including: respiratory strength and endurance; resting and exercising respiratory functions; lung function; and lung capacity.

The authors did not state how the data were extracted for the review, or how many reviewers performed the data extraction.
Methods of synthesis
Studies were combined in a narrative synthesis. Study differences were summarised using tables and discussed in the text.

Results of the review
Thirteen studies were included (n=143 participants): three randomised controlled trials (RCTs, n=43 participants), two cohort studies (n=33 participants), one pre-post study (n=9 participants), five case-series (n=47 participants), and two case reports (n=11 participants). Sample sizes were small and varied, ranging from one to 24. PEDro quality scores ranged from 4 to 6 (out of 10) while Downs and Black scores ranged from 7 to 19 (out of 28).

Exercise training: Exercise training was associated with improvement in respiratory strength and endurance, and in resting and exercising respiratory function (one cohort study and three case-series studies). There was no improvement in respiratory function following training in one case-series study. No negative effects of exercise training were reported.

Inspiratory muscle training: Inspiratory muscle training was associated with improvements in measures of inspiratory muscle and lung function in both control and training groups (two RCTs) and in total lung capacity (one RCT). Inspiratory muscle training was associated with improvement in endurance measures (with no change in lung volumes or measures of respiratory capacity, one cohort study) and respiratory muscle strength (one case series and one pre-post study). Inspiratory muscle training was associated with a non-significant improvement in respiratory muscle strength in two case reports.

Authors’ conclusions
Data were not sufficiently robust to support the use of exercise training or inspiratory muscle training as a means to improve respiratory function in people with spinal cord injury. There was some weak evidence of the efficacy of both regimens.

CRD commentary
The review question was clearly defined with respect to participants and interventions. Lack of a clear definition of outcome measures and eligible study designs resulted in heterogeneous data, which appeared to have hindered the synthesis of study results. Although four relevant databases were searched, some studies may have been missed, as only papers published in English were considered and no apparent efforts were made to search for unpublished papers. Thus, the potential for language and publication biases cannot be ruled out. It is not clear whether study selection and data extraction were carried out in duplicate. Thus, the possibility of reviewer error and bias in the review process cannot be ruled out. Study quality was assessed independently by two reviewers using relevant criteria. The narrative synthesis of studies appeared to be justified given the apparent differences between studies. Relevant details of an additional study used in the synthesis, on the efficacy of training, were not reported. The authors’ conclusions seemed appropriate given the presented evidence. The reliability of the conclusions is unclear given a number of weaknesses in the review process and limitations of the evidence (small sample sizes and poor study designs).

Implications of the review for practice and research
Practice: The authors did not state any implications for practice.

Research: The authors stated that additional well designed RCTs are needed to determine the effect of exercise training on pulmonary function, and to compare the effectiveness of inspiratory muscle training to alternative rehabilitation interventions. Future inspiratory muscle training RCTs should use optimal training techniques and include outcomes of muscle strength and endurance, and quality and function of life. Further large cross-sectional and longitudinal studies are needed to fully characterize pulmonary function (for example, interactions with age) in spinal cord injury.

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