CRD summary
This review concluded that resistance training was associated with a clinically and statistically significant effect on respiratory function such as forced vital capacity. These conclusions may not be reliable, given the moderate to high degree of statistical heterogeneity in most pooled outcomes, the possibility of missing relevant studies and limitations in the review methods.

Authors’ objectives
To assess the effects of resistance training on respiratory function measures in patients with chronic obstructive pulmonary disease (COPD).

Searching
MEDLINE was searched from 1980 to December 2009. Search terms were reported. Reference lists of relevant publications were screened.

Study selection
Randomised controlled trials (RCTs) that compared resistance training versus an exercise or non-exercise control group in patients with COPD (according to the recognised diagnostic criteria) were eligible for inclusion. Only trials evaluating progressive resistance training with a training period of at least four weeks were eligible. Trials evaluating acute single bouts of resistance training were excluded, as were those using mere recommendations as interventions without further detail. Studies in which the resistance training was not either directly supervised or well documented were excluded. Studies in which a pulmonary co-intervention in the intervention group was not applied to the control group were also excluded. The primary outcome was forced expiratory volume in 1s measured in litre (L) or percent predicted. Secondary outcomes included forced vital capacity in 1s and maximal minute ventilation (L/min).

The included studies evaluated either progressive resistance training only or combination of resistance training plus aerobic endurance training. The control arms of included studies were non-exercise control, aerobic endurance training, resistance training plus aerobic endurance training. The duration of interventions ranged from 4 to 12 weeks in most studies, with one study lasting six months. All patients met the recognised diagnostic criteria for COPD. The mean age of patients was 63.9 years, ranging from 51 to 74 years across studies. Approximately 65% of included patients were male. Most interventions involved two or three training sessions per week; resistance training occurred on non-consecutive days. The intensity of resistance training varied across the studies.

The authors did not state how many reviewers assessed studies for inclusion.

Assessment of study quality
The quality of studies was assessed using the Jadad scale, a five-point scale evaluating randomisation, blinding, and withdrawal/drop-out. The authors did not state how many reviewers performed quality assessment.

Data extraction
Data were extracted on mean and standard deviation to enable the calculation of mean differences (MDs) with 95% confidence intervals (CIs). The authors did not state how many reviewers performed data extraction.

Methods of synthesis
A random-effects meta-analysis model was used to calculate weighted mean differences (WMDs) with 95% CIs. Statistical heterogeneity was assessed using the Q and I² statistics. Publication bias was assessed using a funnel plot.

Results of the review
Fourteen RCTs were included in the review (n=503 patients). The sample size of studies ranged from 12 to 70. All
trials had adequate randomisation (details not reported). Blinding was not possible for investigators and patients, but no trials reported blinding of outcome assessors. Dropouts in the intervention groups ranged from zero to five patients in most trials.

Compared with controls, resistance training was not associated with a significant increase in forced expiratory volume in 1 s measured in litre (WMD 0.08 L, 95% CI −0.03 to 0.19; seven RCTs) and percent predicted (WMD 2.71%, 95% CI −1.86% to 7.27%; number of pooled RCTs not reported).

Compared with controls, resistance training was associated with a significant improvement in forced vital capacity (FVC) in 1 s (WMD 0.37 L, 95% CI 0.26 to 0.49; four RCTs). There was no significant difference in maximum minute ventilation between the two groups (WMD 3.77, 95% CI -0.51 to 8.04; seven RCTs).

Statistical heterogeneity was observed in the outcomes of forced expiratory volume in 1 s measured in litre ($I^2=44.6\%$), percent predicted ($I^2=68.1\%$) and maximum minute ventilation ($I^2=72.3\%$).

There was no evidence of publication bias. Results on the dose–response relationship between intensity, duration and frequency of resistance training and assessed outcomes were also reported.

Authors’ conclusions
Resistance training was associated with a clinically and statistically significant effect on respiratory function such as forced vital capacity.

CRD commentary
The review question was clear and was supported by appropriate inclusion criteria. Only one relevant database was searched, so some relevant studies may have missed. No specific attempts were made to find unpublished studies, thereby introducing the potential for publication bias. It was unclear whether language restriction was applied in the search, which made it difficult to assess the risk of language bias. It was also unclear whether steps were made to minimise reviewer biases and errors during the review process. Appropriate criteria were used to assess study quality, although the Jadad scale does not take into account allocation concealment. Statistical heterogeneity was assessed and appropriate methods were used to pool the results. The authors’ conclusions may not be reliable, given the moderate to high degree of statistical heterogeneity in most pooled outcomes, the possibility of missing relevant studies and limitations in the review methods.

Implications of the review for practice and research
Practice: The authors stated that given the significant effect of resistance training on respiratory function such as forced vital capacity, resistance training is recommended for the management of COPD.

Research: The authors stated that further studies assessing the pulmonary functions of COPD patients over longer time-periods are required. Future studies should have post-intervention follow-up of at least 6 months, in order to assess whether resistance training prescriptions should be maintained as part of a pulmonary rehabilitation programme and whether the improved pulmonary function can be maintained over longer follow-up.

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