Effect of combined aerobic and resistance training versus aerobic training alone in individuals with coronary artery disease: a meta-analysis

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CRD summary
The review found that combined aerobic and resistance training was more effective than aerobic training in the cardiac rehabilitation of patients with coronary artery disease. Limitations of the review methodology, and the low quality of the included trials, mean that the reliability of the authors' conclusions is uncertain.

Authors' objectives
To compare the efficacy and safety of aerobic training alone versus combined aerobic and resistance training in the cardiac rehabilitation of patients with coronary artery disease.

Searching
Cochrane Central Register of Controlled Trials, EMBASE, MEDLINE, SPORT DISCUS and CINAHL were searched from inception to October 2009. Search terms were reported. Manual searches of the reference lists of identified studies were conducted. Only studies published in English were eligible for inclusion.

Study selection
Randomised controlled trials (RCTs) that compared combined aerobic and resistance training with aerobic training in men and women with coronary artery disease were eligible for inclusion. Trials of patients with heart failure only were excluded. Eligible trials had to report at least one of the following outcomes: body composition measured by dual energy X-ray absorptiometry (DEXA), cardiovascular fitness, ventilatory anaerobic threshold, muscular strength, and/or health-related quality of life.

In the included trials, most of the participants were men, with a mean age (where reported) that ranged from 47 to 71 years; most had suffered a recent coronary event. Most trials excluded patients with compromised left ventricular function. The mean body mass index at baseline ranged from 26 to 29.8kg/m² and mean total per cent body fat ranged from 29.6 to 34.9% (where reported). The mean duration of the exercise interventions ranged from four to 29 weeks, at a frequency of two to six times a week. Most trials attempted to equalise the total activity exposure/dose between treatment groups. Brief details of each intervention were given in the review.

Two reviewers checked the eligibility of the studies; disagreements were resolved by consensus.

Assessment of study quality
Two reviewers independently assessed study quality, using the PEDro and Jadad scales; disagreements were resolved by consensus. Both scales determined adequacy of random allocation, blinding and assessment of withdrawals and drop-outs. The PEDro scale also assessed allocation concealment, similarity of groups at baseline, measures of at least one key outcome from more than 85% of the subjects initially allocated to groups, intention-to-treat analysis, between-group analysis, and point estimates and variability.

Data extraction
Data were extracted to allow the calculation of mean differences between groups. When the standard deviation of the mean difference for each group was not available, it was estimated from the p value for the difference in means or by imputing from the standard deviations observed in other studies of similar methodology. In two trials, in which varying intensities of resistance training were used, the multiple arms were combined into a single arm.

One reviewer performed the data extraction.

Methods of synthesis
The results were pooled using random-effects meta-analysis to estimate weighted mean difference (WMD) or standardised mean difference (SMD) with 95% confidence intervals (CI). Heterogeneity was investigated using $I^2$. 
Sensitivity analysis was performed to examine the effect of blinding of outcome assessors on the review results.

Quality of life was synthesised qualitatively due to the small number of trials and variety of instruments used.

Results of the review

Twelve RCTs (reported in 13 publications; 504 participants) were included in the review. Trial quality ranged from 2 to 3 out of 5 points on the Jadad score, and 4 to 8 out of 10 on the PEDro score. Most trials did not describe or have adequate allocation concealment or blinded outcome assessors. None of the trials were excluded from the main analyses on the basis of the quality assessment. There was no difference in the significance of the treatment effects when low quality trials (scoring below 5 on the PEDro scale) were removed from any analysis.

Cardiovascular fitness: Combined aerobic and resistance training had a beneficial effect on peak exercise capacity in three trials (SMD 0.88, 95% CI 0.45 to 1.31; I²=0%) and a beneficial effect on peak oxygen uptake in nine trials, although this did not reach conventional levels of statistical significance (WMD 0.41mL/kg/min, 95% CI -0.05 to 0.88; I²=30%), compared with aerobic training. There was no evidence of statistical heterogeneity for either outcome. Subgroup analyses for peak oxygen uptake found no effect for sample size, trial duration, intensity of weight prescribed, or inclusion of a period of aerobic prior to the introduction of resistance training.

Ventilatory anaerobic threshold (three trials): Combined training had a beneficial effect on oxygen uptake occurring at the ventilatory anaerobic threshold (WMD 1.42ml/kg/min, 95% CI 1.63 to 4.47) compared with aerobic training. Despite the confidence interval suggesting otherwise, the authors stated that this effect was not significant. The authors also stated that there was significant heterogeneity (I² not reported).

Body composition (three trials): Combined training had a beneficial effect on fat-free mass (WMD 0.88kg, 95% CI 0.39 to 1.36), per cent body fat (WMD -2.3%, 95% CI -3.59 to -1.02) and trunk fat (SMD -0.56, 95% CI -0.96 to -0.15) when compared with aerobic training. None of these analyses showed any heterogeneity (I²=0%).

Muscular strength: Combined training had a beneficial effect on lower body strength in seven trials (SMD 0.77, 95%CI 0.49 to 1.04; I²=0%) compared with aerobic training. Upper body strength was reported in nine trials; significant heterogeneity was found, so the authors reported a post-hoc analysis eight trials (excluding one trial on women only) and found a a beneficial effect of combined training (SMD 1.07, 95% CI 0.76 to 1.38).

Health-related quality of life (three trials): Combined training and aerobic-only training had beneficial effects on various quality of life domains.

Adverse events: Most trials reported no adverse events. The mean proportion of patients who discontinued the trials were 14.2% for aerobic training and 11.5% for combined training.

Authors’ conclusions

Combined training was more effective than aerobic training in improving body composition, strength, and some indicators of cardiovascular fitness, and did not compromise trial completion or safety when compared with aerobic training.

CRD commentary

The study addressed a clear question; inclusion criteria were clear and appropriate. Since the search was limited to trials that were published in English, the results may have been affected by language or publication bias. Although efforts were made to minimise bias and errors at some stages of the review process, data extraction was performed by one reviewer, so this may have been subject to errors or bias.

Two appropriate quality assessment tools were applied to the included trials; adequate results were reported. Trials were generally of low quality. Trial details were presented. In general, the chosen method of synthesis appeared to be appropriate. The justification to exclude one trial of women in the post-hoc analysis appeared arbitrary. Although the relatively few women included in the review was consistent with the small numbers entering cardiac rehabilitation, the review aim was not focused on differences by gender. Therefore, some of the review findings may not be generalisable to all patients.
Limitations of the review methodology, and the low quality of the included trials, mean that the reliability of the authors' conclusions is uncertain.

**Implications of the review for practice and research**

**Practice:** The authors stated that the review results favoured the addition of resistance training to aerobic training as the standard exercise programme for cardiac rehabilitation.

**Research:** The authors stated that more studies with strong methodological design and large sample size were required to further evaluate the added benefit of combined versus aerobic training.

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