Electrical stimulation and peripheral muscle function in COPD: a systematic review
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CRD summary
The authors concluded that there was weak evidence of the effectiveness of electrical stimulation to improve lower limb muscle function in chronic obstructive pulmonary disease patients. These conclusions should be interpreted with caution as they were based on a small number of very small studies and there was a possibility that relevant studies have been missed.

Authors' objectives
To determine the effect of electrical stimulation on muscle function, muscle size, fibre characteristics and exercise performance in patients with chronic obstructive pulmonary disease (COPD).

Searching
Cochrane Central Register of Controlled Trials (CENTRAL), PubMed, CINAHL, EMBASE, Web of Science, SPORTDiscuss and PEDro were searched from inception (no exact end date specified). Search terms were reported. Reference lists from relevant articles were screened. The review was restricted to studies published as full-text articles in English.

Study selection
Randomised controlled trials (RCTs) that evaluated a specific and well-defined component of electrical stimulation applied to the lower extremities in patients with COPD and that reported data on muscle function, muscle size, muscle fibre characteristics or exercise performance were eligible for inclusion.

Most studies included patients with severe or very severe COPD; one study included patients with moderate COPD. Mean body mass index (BMI) was in the normal range in most studies; one study included patients with low body mass index. Patients were ambulatory in all studies except one. Studies compared electrical stimulation to a sham group or as an adjunct to standard exercise or rehabilitation treatment. One study used a cross-over design and compared electrical stimulation to control/standard treatment. Electrical stimulation was applied to the quadriceps muscle in all studies; some also examined the effect of electrical stimulation on hamstrings and calf muscle or glutei. Pulse duration ranged from 200μs to 400μs. Stimulation frequency ranged from 8Hz to 50Hz. Intensities ranged from 10mA to 120mA and were progressively increased throughout the study. The number of electrical stimulation sessions ranged from three to five per week. Intervention duration ranged from four to six weeks.

The results of the searches were screened by one reviewer. The authors did not state how full-text articles were assessed for inclusion.

Assessment of study quality
Two reviewers independently assessed study quality using the PEDro scale, which included: eligibility criteria; random allocation; concealed allocation; follow-up; baseline comparability; blinding (of participants, therapists and assessors); intention to treat; between-group analysis; and point measures and measures of variability. A summary quality score was calculated by rating each item (except eligibility criteria) as 1 if fulfilled. Disagreements were resolved through discussion with a third reviewer.

Data extraction
Two reviewers independently extracted data as pre- and post-intervention scores. The mean change score (post-intervention scores minus pre-intervention scores) together with standard deviations (SD) were calculated. Effect sizes were estimated by dividing the difference between mean changes scores in experimental and control groups by the pooled standard deviation.

Methods of synthesis
Summary mean differences were estimated using the inverse-variance random-effects model. Forest plots were used to display results. Heterogeneity was assessed using the $X^2$ and $I^2$ statistics. Where data were unsuitable for meta-analysis, a narrative description was provided based on the size of the effect size.

**Results of the review**

Five RCTs were included (n=91). Quality scores ranged from 5 to 8 out of 10. All studies scored points for random allocation, baseline comparability, between-group analyses and reporting of point estimates and variability. Concealed allocation and blinding of therapists were each adequate in single studies. Assessors and participants were blinded in two studies. Intention-to-treat analysis was performed in two studies. Follow-up was adequate in three studies.

Four of the five RCTs reported improvements of the electrical stimulation in outcomes related to muscle function. There was a significant improvement in peak torque (mean difference 9.64 Newton metre, 95% CI 1.23 to 18.05; three RCTs) and walking distance (mean difference 47.6m, 95% CI 9.1 to 86.0m; three RCTs). There was no evidence of heterogeneity for either meta-analyses ($I^2=0\%$). Other outcomes were assessed in one or two studies.

None of the studies reported any adverse effects specific to electrical stimulation.

**Authors' conclusions**

There was weak evidence of the effectiveness of electrical stimulation to improve lower limb muscle function in COPD patients.

**CRD commentary**

The review addressed a focused question supported by clearly defined inclusion criteria. The literature search was extensive for published studies, but the end date of the searches was not clearly reported and so it was difficult to determine whether the review was up to date. Restriction of the review to full-text published studies in English raised the possibility of language and publication biases. It appeared that at least two studies were excluded based on language, which could have had a significant impact on the results given the small number of included studies. Appropriate steps were taken to minimise bias and errors for quality assessment and data extraction; no such steps were taken during study selection. Study quality was formally assessed using appropriate criteria and the results of the quality assessment were reported clearly. Relevant study details were summarised in the text and tables, which aided interpretation of results. The methods used to combine studies were appropriate. The authors’ conclusions were supported by the data, but should be interpreted with caution as they are based on a small number of very small studies and there was a possibility that relevant studies were missed.

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

**Practice:** The authors did not state any implications for practice.

**Research:** The authors stated that further studies with larger sample sizes were needed to determine the optimal parameters for electrical stimulation protocols and selection criteria for responders and non-responders.

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