Single versus multiple sets of resistance exercise: a meta-regression

Krieger JW

CRD summary
The author concluded that two-to-three sets per resistance exercise were associated with 46% greater strength gains than one set, in both trained and untrained participants. Due to limitations in the reporting of the review methods, and complex analyses of studies with small sample sizes, the author’s conclusions may not be entirely reliable.

Authors' objectives
To compare the effects of single versus multiple sets of exercise on dynamic strength, using hierarchical random-effects meta-regression.

Searching
PubMed, SPORTDiscus, and CINAHL were searched for studies published in English between 1960 and December 2007. Some search terms were reported and the reference lists of retrieved studies and reviews were handsearched.

Study selection
Studies of resistance exercise programmes that lasted at least four weeks were eligible if they compared the effects of single versus multiple sets of exercise, in apparently healthy adults, whilst all other variables were the same. Programmes had to involve training on at least one exercise for at least one major muscle group. Studies had to report pre- and post-training measures of dynamic one-repetition maximum strength, the number of sets per exercise, and exercise frequency, and provide sufficient data to allow effect sizes to be calculated.

In most studies, the participant ages ranged from 19 to 44 years, with two studies including older participants, and both males and females were included. Some participants were trained, others were not; some programmes were supervised, others were not. Programmes lasted between five and 25 weeks, with between one and three sessions per week. The number of sets of exercise ranged from one to four, and most studies were of one or three. Studies used a range of exercises including: bench, chest, leg, and shoulder presses; and biceps and leg curls.

The author did not state how papers were selected for the review.

Assessment of study quality
Validity was scored on two published 10-point scales, one described by Bagenhammar and Hansson and the other by Durall, Hermsen, and Demuth. These scores were added together to form an overall score.

The author did not state how many reviewers assessed validity.

Data extraction
Pre- and post-training mean one-repetition maximums, plus standard deviations, were extracted. Effect sizes were calculated for each exercise in each treatment group, as the difference in means divided by the pre-training standard deviation. Control-group effect sizes were assumed to be zero in all studies. The overall effect size was the mean of all the effect sizes across treatment groups in all studies. The methods used to calculate the variance for each effect size were reported.

The author did not state how many reviewers performed the data extraction.

Methods of synthesis
A hierarchical random-effects linear mixed model was used to pool the data, this allowed for variation between types of exercise within a study, between treatment groups, and between studies. Observations were weighted by the inverse of the variance. The full model included the following variables: quality; age; sex; resistance exercise experience; training

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programme duration; level of supervision; targeted body area; multiple sets of exercise (yes or no); multiple exercises per target muscles; and exercise frequency. Variables were removed one at a time until the best-fitting model was achieved.

Two additional models were created using two interaction terms: multiple sets of exercise and training experience; and multiple sets and training duration. The dose-response effect was examined using a model that included the number of sets performed per exercise, instead of the multiple sets variable. A Hochberg correction was used to adjust for post-hoc multiple comparisons.

The possibility of publication bias was assessed using methods described by Macaskill, Walter, and Irwig. Sensitivity analyses were performed by removing each study in turn to investigate the effect on the result for the multiple sets variable.

**Results of the review**

Fourteen studies were included (440 participants), with 30 treatment groups and total of 92 effect sizes. The number of participants per treatment ranged from eight to 29. Quality scores ranged from nine to 15 out of 20.

In the full model, multiple sets of exercise were associated with a significantly larger effect size than single sets (difference 0.26, 95% CI 0.15 to 0.37). None of the covariates assessed in the model were found to be statistically significant. The results from the reduced model were similar; the mean effect size was 0.54 for single sets and 0.80 for multiple sets. Sensitivity analyses removing one study at a time led to similar results.

The dose-response model showed that two to three sets per exercise were associated with a significantly larger effect size than one set (difference 0.25, 95% CI 0.14 to 0.37). There was no significant difference between: one set and four-to-six sets per exercise; nor between two-to-three and four-to-six sets per exercise. There were no interactions between set volume and other predictors.

There was no evidence of publication bias.

**Authors' conclusions**

Multiple sets per exercise were associated with significantly greater strength gains, than a single set per exercise, during a resistance exercise programme. Two-to-three sets per resistance exercise were associated with 46% greater strength gains, than one set, in both trained and untrained participants.

**CRD commentary**

The review question was clearly stated and the inclusion criteria were appropriately defined for participants, intervention, and outcomes. Several relevant sources were searched, but no attempts were made to minimise publication or language bias. The methods used to select studies, assess their validity, and extract data were not described and so it is not known whether efforts were made to reduce reviewer errors and bias. Study validity was assessed, but the criteria were not reported and only an aggregate score was presented, which makes it difficult to judge the quality and hence the reliability of the evidence. Random-effects regression modelling was used to compare multiple and single sets of exercise after adjusting for other variables, including multiple effect sizes in each study. The number of variables in the model was large compared with the number of studies in the review and so the estimates may not be reliable. Adjusting for clustering within a study is not the same as analysing the treatment effect (ratio or difference between treatment and control groups) and does not maintain randomisation in the same way, but the author acknowledged that not all studies had a control group.

Due to limitations in the reporting of the review methods, and complex analyses of studies with small sample sizes, the author's conclusions may not be entirely reliable.

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

**Practice:** The author did not state any implications for practice.
Research: The author stated that future research on resistance exercise programmes should focus on dose-response relationships.

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This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.