Effect of resistance training on resting blood pressure: a meta-analysis of randomized controlled trials
Cornelissen VA, Fagard RH

CRD summary
This review evaluated the effects of resistance training on resting blood-pressure in healthy adults. The authors concluded that resistance training could be included in interventions to prevent and treat hypertension, but further research was required. The limited search, lack of a validity assessment and poor reporting of review methods make it difficult to assess the reliability of the authors' conclusions.

Authors' objectives
To evaluate the effects of resistance training on resting blood pressure in healthy sedentary adults.

Searching
MEDLINE was searched from inception to December 2003 using the reported search terms. The reference lists of published articles and reviews were screened. Only studies that were published in full in peer-reviewed journals were eligible for inclusion.

Study selection
Study designs of evaluations included in the review
Parallel-group and cross-over randomised controlled trials (RCTs) were eligible for inclusion. The duration of the included studies ranged from 6 to 26 weeks (mean 16.4 weeks).

Specific interventions included in the review
Studies that evaluated training programmes comprised solely of resistance exercises without any aerobic endurance exercises and which lasted at least 4 weeks were eligible for inclusion. In the review, resistance training was defined as programmes that used strength, weight, static and/or isometric training to increase muscular strength, power and/or endurance. The majority of the included studies used dynamic training (including both circuit training and conventional training programmes of isolated exercises); one study used static resistance training (definitions were reported). The average frequency of training was three times per week and exercise intensity ranged from 30 to 90% of the maximum weight that could be lifted in one repetition. Most exercise regimes used arms, trunks and legs.

Participants included in the review
Studies of normotensive or hypertensive adults (aged 18 or older) without other obvious concomitant diseases were eligible for inclusion. In the included studies, the majority of the participants were male (61%) and the median age was 69 years (means ranged from 20 to 72 years). Most studies were in normotensive participants; 3 studies were in patients with hypertension (defined as systolic blood pressure 140 mmHg or greater and/or diastolic blood pressure 90 mmHg or greater). Some participants were taking antihypertensive medication.

Outcomes assessed in the review
Studies that reported systolic blood pressure and/or diastolic blood pressure for all treatment groups were eligible for inclusion. The secondary review outcomes were maximal oxygen uptake, heart rate, percentage body fat and weight.

How were decisions on the relevance of primary studies made?
The authors did not state how the papers were selected for the review, or how many reviewers performed the selection.

Assessment of study quality
The authors did not state that they assessed validity.

Data extraction
The data were extracted using a standardised protocol, but the authors did not state how many reviewers performed the
data extraction. For each study, the blood pressure at baseline and follow-up was extracted for each treatment group and the net change in blood pressure, with 95% confidence interval (CI), was calculated. Exercise intensity was also extracted or calculated for each intervention. For studies with more than two treatment groups, treatment effects were calculated separately for each intervention compared with control.

**Methods of synthesis**

How were the studies combined?
Summary statistics were presented for the baseline characteristics of the participants. The overall weighted net changes in systolic and diastolic blood pressure, along with 95% CIs, were calculated using a fixed-effect model. Individual studies were weighted using two different methods: the inverse of the total variance for change in blood pressure and the number of participants for each treatment group available for analysis. The potential for publication bias was assessed using a funnel plot and tested using Kendall's tau statistic.

How were differences between studies investigated?
Statistical heterogeneity of net changes in resting systolic and diastolic blood pressure was assessed using the Q statistic. The influence of each study on the results was assessed by repeating the analysis after omitting each study in turn. A subgroup analysis was used to assess the influence of hypertensive status of the participants, study duration, type and intensity of the training programmes, and sample size on the results. A fixed-effect model was used for the subgroup analyses; the studies were weighted by the reciprocal of the total variance of the change in blood pressure and statistical significance was tested by analysis of variance.

**Results of the review**

Nine parallel-group RCTs (with 12 study groups) were included in the review (n=341 in studies, n=290 included in analyses).

The mean drop-out rate was 15% (range: 0 to 37).

The funnel plots for systolic blood pressure and diastolic blood pressure were slightly asymmetrical with smaller changes in net blood pressure in larger studies, but Kendall's tau statistics were not significant (p=0.27 and p=0.73, respectively).

There was no statistically significant heterogeneity for the meta-analysis of either systolic blood pressure or diastolic blood pressure.

When weighting was applied using the inverse of the variance, resistance training was associated with a significant decrease in systolic blood pressure (-6.0 mmHg, 95% CI: -10.4, -1.6, p<0.01) and diastolic blood pressure (-4.7 mmHg, 95% CI: -8.1, -1.4, p<0.01) compared with control. When weighting was applied using the sample size, resistance training was associated with a significant decrease in diastolic blood pressure compared with control (-3.5 mmHg, 95% CI: -6.1, -0.9, p<0.01), but there was no significant difference between treatments in systolic blood pressure (-3.2 mmHg, 95% CI: -7.1, 0.7, p=0.10).

In the subgroup analyses, only duration of follow-up appeared to be significantly associated with changes in blood pressure. Studies with longer follow-up (>15 weeks) showed smaller changes in systolic blood pressure (p<0.01) and diastolic blood pressure (p<0.05) than studies lasting less than 15 weeks.

The results for the other outcomes were reported in the paper.

**Authors' conclusions**

Moderate intensity resistance training could be included in interventions to prevent and treat hypertension, but further research was required.

**CRD commentary**

The review addressed a clear question that was defined in terms of the participants, intervention, outcomes and study design. Limiting the search strategy to one electronic database and reference lists meant that relevant studies might have been missed. No attempt was made to obtain unpublished data and tests suggested that the possibility of publication bias
could not be excluded. It was unclear whether any language limitations had been applied, thus the potential for language bias could not be assessed. The methods used to select studies and extract the data were not described, so it is not known whether any efforts were made to reduce reviewer errors and bias. Only RCTs were included but the quality of the included studies was not assessed; this made it difficult to determine the reliability of the evidence presented.

Adequate information on the participants and resistance interventions was provided, but there was no information on the control interventions. The studies appeared to have been appropriately pooled using meta-analysis, statistical heterogeneity was assessed, and subgroup analysis was used to examine the influence of various relevant factors. The limited search, lack of reporting of review methods and lack of a validity assessment make it difficult to assess the reliability of the authors' conclusions.

Implications of the review for practice and research

Practice: The authors stated that moderate intensity resistance training (preferably combined with aerobic endurance training) may be incorporated into non-pharmacological interventions for the prevention and treatment of hypertension provided appropriate precautions were taken.

Research: The authors stated that there was a need for further RCTs to evaluate the effects of purely static training on resting blood pressure and to compare this with the effects of dynamic resistance training. Research on the effects of resistance training in hypertensive patients was also required.

Bibliographic details

PubMedID
15662209

Original Paper URL

Additional Data URL
http://hyper.ahajournals.org/content/58/5/950.abstract

Other publications of related interest

Indexing Status
Subject indexing assigned by NLM

MeSH
Adult; Aged; Blood Pressure /physiology; Exercise Therapy; Female; Follow-Up Studies; Humans; Hypertension /physiopathology /prevention & control /therapy; Male; Middle Aged; Randomized Controlled Trials as Topic; Rest; Retrospective Studies; Teaching; Treatment Outcome; Vascular Resistance /physiology

AccessionNumber
12006005073

Date bibliographic record published
30/06/2007

Date abstract record published
30/06/2007
Record Status
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.