Dynamic resistance exercise and resting blood pressure in adults: a meta-analysis
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Authors' objectives
To determine the effects of dynamic resistance exercise on the resting systolic and diastolic blood-pressure in adults.

Searching
MEDLINE was searched from January 1966 to December 1995. Handsearches and cross-referencing approaches were also conducted. The only foreign language studies considered were those found when searching MEDLINE.

Study selection
Study designs of evaluations included in the review
Published randomised and non-randomised controlled trials of the effect of dynamic resistance training on resting systolic and diastolic blood-pressure of adults were included.

Specific interventions included in the review
Interventions in which dynamic resistance exercise was the only mode of training were included. The characteristics of the training programme were as follows: the duration ranged from 6 to 26 weeks; most participants trained 3 days per week; and the number of exercises during each session ranged from 2 to 14. Studies had to include a non-exercise control group.

Participants included in the review
Adults aged at least 18 years. The physical characteristics of the participants were as follows:

the mean age in each study ranged from 20 to 72 years (exercise group: mean 40 years, standard deviation (SD) 17; control group: mean 41 years, SD=17);

the initial mean body weight ranged from 74 to 89 kg (exercise group: mean 82 kg, SD=5; control group: mean 80 kg, SD=9);

the initial mean percentage body fat ranged from 19 to 30% (exercise group: mean 25%, SD=4; control group: mean 26%, SD=4);

the initial mean body mass index ranged from 25 to 29 kg/m2 (exercise group: mean 27 kg/m2, SD=2; control group: mean 27 kg/m2, SD=2);

the initial mean resting heart rate ranged from 57 to 79 beats/minute (exercise group: mean 70 beats/minute, SD=7; control group: mean 70 beats/minute, SD=8);

the initial resting systolic blood-pressure ranged from 113 to 146 mmHg (exercise group: mean 132.71 mmHg, SD=11.27; control group: 131.84 mmHg, SD=10.22); and

the mean resting diastolic blood-pressure ranged from 69 to 96 mmHg (exercise group: mean 82.28 mmHg, SD=10.62; control group: mean 83.11 mmHg, SD=9.12).

Outcomes assessed in the review
The difference in blood-pressure from pre- to post-training was calculated for the exercise and control groups for each study. The treatment effect per study was then calculated as the difference between these values.

How were decisions on the relevance of primary studies made?
All studies meeting the inclusion criteria were coded. The decision on whether to include the paper was made by
examining the methods and results separately under coded conditions.

Assessment of study quality
The author does not state that they assessed validity.

Data extraction
A coding sheet was developed and used to extract the following categories of data: study characteristics; physical characteristics of the participants; blood-pressure assessment characteristics; training programme characteristics; and blood-pressure results. Details of the data extracted within each category were provided in the paper.

Methods of synthesis
How were the studies combined?
The mean difference between the treatment groups, in terms of the systolic and diastolic blood-pressure for all studies, was calculated. The bootstrap technique was used to estimate the reliability of this estimated mean change. Weighting was not used since no relationship was found between the number of participants in the study and the change in systolic or diastolic blood-pressure.

How were differences between studies investigated?
Independent t-tests or Mann Whitney rank sum tests were used to assess the differences between blood-pressure changes according to the following variables: study design (random versus non-random); position of participant during blood-pressure recording (sitting versus supine); and blood-pressure category (hypertensive versus normal).

A correlation analysis was used to examine the relationship between treatment effect and the following variables:

- study characteristics, i.e. the number of participants, the percentage of men, and the percentage compliance;
- initial and final physical characteristics, such as age, body mass index, percentage fat, lean body mass, maximum oxygen consumption, and resting heart rate;
- blood-pressure protocols, i.e. the number of measures and the rest period before assessment of the blood-pressure;
- training programme characteristics, e.g. length, frequency, duration, number of sets, rest between sets, number of exercises, and percentage adherence; and
- initial resting blood-pressure.

Results of the review
Four randomised (132 participants) and 5 non-randomised trials (127 participants) were included.

Compliance ranged from 48 to 100%. The length of time between the last exercise session and blood-pressure measurements was reported in only one study. Information on the time of day and Korotkoff sound used for blood-pressure recording, and the characteristics of the training programme, were not available for all studies.

For analysis across all designs and categories, the reductions in resting blood-pressures were: systolic, -4.55 mmHg (SD=5.69; 95% confidence interval, CI: -0.18, -8.93); diastolic, -3.72 mmHg (SD=3.46; 95% CI: -1.06, -6.38). The results for the bootstrap technique were: systolic, -4.55 mmHg (SD=1.75; 95% CI: -1.56, -8.56); diastolic, -3.79 mmHg (SD=1.12; 95% CI: -1.89, -6.33).

The subgroup analysis did not show that the following variables had any significant effect on the results: study design; position of participant during blood-pressure measurement; hypertensive or normotensive status; and gender of participant.
The correlation analysis did not show any significant relationships between either systolic or diastolic changes and the following: study characteristics; initial and final physical characteristics; blood-pressure protocols; training programme characteristics; and initial resting blood-pressure.

Authors’ conclusions
There is a suggestion that dynamic resistance exercise reduces resting systolic and diastolic blood-pressures in adults. However, it is premature to form strong conclusions regarding the effects of dynamic resistance exercise on resting blood-pressure. There is a need for additional well-designed studies on this topic before a recommendation can be made regarding the efficacy of dynamic resistance exercise as a non-pharmacological therapy for reducing resting blood-pressure in adults, especially hypertensive adults.

CRD commentary
The confounding effect of certain variables on the outcomes was assessed. The author acknowledged limitations resulting from the paucity of available studies and the heterogeneity of the treatment effects in the individual studies. These two factors warrant extreme caution in the interpretation of the results, especially in relation to the subgroup analysis. The tentative conclusion was appropriate given the paucity of evidence.

Full details of the search strategy were not supplied and unpublished data were not sought. The validity of the included studies was not assessed. The statistically non significant differences found in the treatment effect among subgroups may be the result of small numbers rather than the lack of a confounding effect. The number of hypertensive participants was not stated.

Implications of the review for practice and research
The author suggests that future studies include hypertensive patients, and report complete descriptions of blood-pressure measurement techniques and training programme characteristics.

Bibliographic details

PubMedID
9134905

Original Paper URL
http://jap.physiology.org/content/82/5/1559

Indexing Status
Subject indexing assigned by NLM

MeSH
Adolescent; Adult; Aged; Blood Pressure /physiology; Cardiovascular Physiological Phenomena; Exercise /physiology; Humans; Middle Aged; Weight Lifting /physiology

AccessionNumber
11997003438

Date bibliographic record published
30/04/1999

Date abstract record published
30/04/1999
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.