Lifestyle interventions to reduce raised blood pressure: a systematic review of randomized controlled trials

CRD summary
This review evaluated the effect of lifestyle interventions on blood-pressure (BP). The authors concluded that people with elevated BP should follow a weight reducing diet, take regular exercise and restrict alcohol and salt intake, but there is no evidence to support the use of supplements. There were limitations with the review and the results should be treated with some caution.

Authors' objectives
To assess the effects of lifestyle interventions on blood-pressure (BP).

Searching
MEDLINE, EMBASE and the Cochrane CENTRAL Register were searched from 1998 to May 2003. Bibliographies of relevant systematic reviews and guidelines for publications predating 1998 were also searched. Only studies in the English language were eligible for inclusion.

Study selection
Study designs of evaluations included in the review
Randomised controlled trials (RCTs) of at least 8 weeks' duration were eligible for inclusion. Only parallel trials of behavioural interventions were eligible, but crossover trials for studies of oral supplements or salt restriction were also included.

Specific interventions included in the review
The intervention of interest was a lifestyle intervention, compared with placebo, sham therapy, usual care or no treatment. Studies in which the participants received hypertensive medication that varied throughout the length of the study were excluded. Trials that assessed unusual interventions that were not replicated in other studies, and those with missing data not available from the authors, were also excluded.

The included studies assessed diet, exercise, relaxation, advice on alcohol restriction, advice on sodium restriction, combined interventions, calcium supplements, potassium supplements and fish oil supplements. Summaries of treatment regimens and supplement doses were provided. Where reported, the treatment time ranged from 4 to 78 weeks and the follow-up from 8 to 260 weeks.

Participants included in the review
Studies of adults with raised BP (average baseline systolic BP 140 mmHg or above and/or diastolic BP 85 mmHg or above) were eligible for inclusion. Studies of pregnant women and of people with secondary hypertension or renal disease were excluded. Where reported, the mean age of the participants ranged from 24 to 67 years, 0 to 100% were men, and 0 to 100% were white. The baseline systolic BP ranged from 130 to 171 mmHg and the diastolic BP from 84 to 148 mmHg.

Outcomes assessed in the review
The outcomes of interest were changes in systolic and diastolic BP. Tolerability of the intervention was also reported.

How were decisions on the relevance of primary studies made?
One reviewer selected studies for inclusion, with a second reviewer checking the selection. Any differences were resolved by discussion.
Assessment of study quality
The quality of the studies was assessed using aspects such as the adequacy of randomisation, allocation concealment, blinding and losses to follow-up. Crossover trials were also assessed on basis of their inclusion of a washout period and an assessment of any evidence for carry-over effects.

Two reviewers independently extracted data on quality. Any differences were resolved by discussion with a third reviewer.

Data extraction
Two reviewers extracted the data independently. Any differences were resolved by discussion with a third reviewer. Authors were contacted for missing data. For studies with several treatment and/or control arms, the data were aggregated into single treatment and control arms. For crossover studies, appropriate data were aggregated for different time periods under the assumption of no interaction. Where necessary, the mean within-person correlation was imputed. An inter-cluster coefficient of 0.10 was assumed for cluster RCTs. Data on differences in the rate of withdrawal between the treatment and control arms were extracted to assess tolerability and losses to follow-up. The data were extracted on an intention-to-treat basis, where possible.

Methods of synthesis
How were the studies combined?
Separate meta-analyses were performed for each lifestyle intervention. A random-effects model was used to estimate the pooled mean difference (MD), along with 95% confidence intervals (CIs), in systolic and diastolic BP, and pooled risk difference (RD) for tolerability. Data from parallel and crossover studies were combined where there was no heterogeneity. Funnel plots were used to assess publication bias.

How were differences between studies investigated?
Heterogeneity was assessed using the I-squared statistic. The effect of trial size on treatment effect was also investigated. Sensitivity analyses were performed, excluding trials that reported extremely large reductions in BP and those of less than 6 months' duration. Subgroup analyses explored findings from previous systematic reviews.

Results of the review
A total of 105 RCTs (6,805 participants) were included. Of these:

14 (1,450 participants) assessed diet; 21 (1,518 participants) assessed exercise;
23 (1,391 participants) assessed relaxation;
4 (496 participants) assessed alcohol restriction; 7 (520 participants) assessed sodium restriction;
6 (413 participants) assessed combined interventions;
13 (485 participants) assessed calcium supplements;
12 (545 participants) assessed magnesium supplements;
5 (425 participants) assessed potassium supplements; and
8 (393 participants) assessed fish oil supplements.

Randomisation was adequate in 19% of the studies, allocation concealment in 8%, and blinding of the outcome assessors in 27%. Fifty per cent of crossover trials reported a washout period, whilst 31% reported no carry-over effects. The overall loss to follow-up was 10%.

Systolic BP.
There was a significant decrease in systolic BP with diet (MD -6.0, 95% CI: -8.6, -3.4; 14 studies), exercise (MD -6.1, 95% CI: -10.1, -2.1; 14 studies), relaxation (MD -4.0, 95% CI: -6.4, -1.6; 23 studies), alcohol restriction (MD -3.8, 95% CI: -6.1, -1.4; 4 studies), sodium restriction (MD -4.7, 95% CI: -7.2, -2.2; 7 studies), combined interventions (MD -5.5, 95% CI: -8.8, -2.3; 6 studies), calcium supplements (MD -2.5, 95% CI: -4.4, -0.6; 13 studies) and fish oil supplements (MD -2.3, 95% CI: -4.3, -0.2; 8 studies). There was no significant reduction with magnesium supplements (12 studies) or potassium supplements (5 studies).

Diastolic BP.

There was a significant decrease in diastolic BP with diet (MD -4.8, 95% CI: -6.9, -2.7; 14 studies), exercise (MD -3.0, 95% CI: -4.9, -1.1; 14 studies), relaxation (MD -3.1, 95% CI: -4.7, -1.5; 23 studies), alcohol restriction (MD -3.2, 95% CI: -5.0, -1.4; 4 studies), sodium restriction (MD -2.5, 95% CI: -3.3, -1.8; 7 studies), combined interventions (MD -4.5, 95% CI: -6.9, -2.0; 6 studies), magnesium supplements (MD -2.2, 95% CI: -3.4, -0.9; 12 studies) and fish oil supplements (MD -2.2, 95% CI: -4.0, -0.4; 8 studies). There was no significant reduction with calcium supplements (13 studies) or potassium supplements (5 studies).

The results of the sensitivity analyses were presented. The rates of withdrawal were not significantly different between the treatment and control groups for any intervention. The funnel plots showed little evidence of publication bias.

**Authors' conclusions**

People with elevated BP should follow a weight reducing diet, take regular exercise, and restrict alcohol and salt intake. The available evidence does not support the use of relaxation therapies, or calcium, magnesium or potassium supplements to reduce BP.

**CRD commentary**

The inclusion criteria were clearly stated. Several relevant databases were searched in order to update a previous review (see Other Publications of Related Interest). However, the search was limited to publications in English and, therefore, it is possible that some studies were missed. Methods were used to reduce the potential for error and bias during the review process, and the quality of the included studies was assessed.

The studies were appropriately grouped according to the type of intervention and heterogeneity was assessed. Statistically significant heterogeneity was present between studies for most interventions, therefore the pooling of data might not have been appropriate. Considering the data were pooled, appropriate sensitivity analyses were conducted. Many of the studies were short term; the results were less convincing for the meta-analysis of only longer term studies, with positive effects only from diet and combined interventions. There was little information on the interventions or the baseline characteristics of the participants (e.g. body weight, physical fitness), which could affect the generalisability of the results. In view of these comments, the authors' conclusion should be treated with some caution.

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

Practice: The authors stated that overweight patients with high BP should be encouraged to lose weight through diet and exercise. Where appropriate, patients should also be encouraged to reduce alcohol and salt intake.

Research: The authors stated that trials of lifestyle interventions need to be longer, larger and of better quality. In particular, trials to assess the effects of relaxation and potassium supplements in hypertensive patients are required. Future trials should include older people.

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Other publications of related interest

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