A systematic review of the effects of nuts on blood lipid profiles in humans
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CRD summary
This review assessed the effects of eating nuts on blood lipid (cholesterol) levels. The authors concluded that the consumption of 50 to 100 g of nuts five times per week as part of a heart-healthy diet may significantly decrease cholesterol levels. Despite some limitations of the review, the conclusions are likely to be reliable.

Authors' objectives
To evaluate the effects of nut consumption on blood lipid levels.

Searching
MEDLINE (from inception to August 2004) and Web of Science (1994 to August 2004) were searched; the search terms were given. Authors of relevant papers were contacted and reference lists were checked. The authors did not state whether any language restrictions were applied.

Study selection
Study designs of evaluations included in the review
Inclusion criteria for the studies were not given. However, trials with missing or incomplete data were excluded.

Specific interventions included in the review
Studies that evaluated the effects of nut consumption were eligible for inclusion. Studies where the independent effect of nuts was not available were excluded. The included studies assessed the effects of almonds, hazelnuts, peanuts, pecans, pistachio nuts and walnuts. Where stated, the mean daily intake of nuts ranged from 25 to 113 g. In some studies high and low doses of nuts were compared. The control groups received normal diet, American Heart Association Step I and Step II diet, low-fat diet, high-fat diet, low-fat high-complex carbohydrate diet, Mediterranean diet, Japanese diet, olive oil-based diet, average American diet, muffins-control or ‘control’. Where stated, the percentage total fat from the control diets ranged from 17 to 37%, while that from the nut diets ranged from 20 to 45%. The duration of the intervention lasted from 3 weeks to 6 months, with the majority lasting 4 to 6 weeks.

Participants included in the review
Studies of humans were eligible for inclusion. The studies included healthy people, those with normal cholesterol levels, and those with hypercholesterolaemia, hyperlipidaemia or diabetes.

Outcomes assessed in the review
The outcomes of interest were changes in blood lipid levels, total cholesterol (TC), low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol and triacylglycerols.

How were decisions on the relevance of primary studies made?
Two reviewers independently assessed studies for inclusion in the review.

Assessment of study quality
A scoring system was used to assess quality. This was based on study characteristics such as whether the study was controlled, randomisation, justification of the sample size, compliance, single-blinded, and comparability of the baseline characteristics. The highest quality score attainable was 1 and the lowest was 3. Studies scoring 3 were not discussed in the data synthesis. Two reviewers independently assessed the quality of the studies. Any disagreements were resolved with a third reviewer or by discussion.
Data extraction
Two reviewers independently abstracted the data on to pre-designed and pre-piloted standardised forms. Any disagreements were resolved with a third reviewer or by discussion. Changes in lipid levels were calculated as the percentage difference in changes from baseline between the treatment and control groups.

Methods of synthesis
How were the studies combined?
Studies that scored 1 or 2 on the quality rating scale were discussed, grouped by type of nut. Studies that scored 3 were not discussed.

How were differences between studies investigated?
Differences between the studies were described in the text and tables.

Results of the review
Twenty-three studies (577 participants) were included in the review: 2 parallel randomised controlled trials (RCTs; 64 participants), 15 crossover RCTs (381 participants), 1 parallel controlled trial (25 participants), 2 crossover controlled trials (34 participants) and 3 uncontrolled trials (73 participants).

Almonds: in 3 of the 4 highly rated studies, 50 to 100 g of almonds per day reduced TC and LDL in people with normal and raised cholesterol, compared with the control, muffins-control or Step I diet: the TC reduction was 4 to 16% and the LDL reduction was 7 to 19%. Diets with less than 50 g of almonds per day had no effect on LDL. There was no significant difference in lipids with almonds in comparison with an olive oil-based diet. There was no effect on triacylglycerols.

Macadamia nuts: in one highly rated study, macadamia nuts statistically significantly reduced TC (5%), LDL (5%), triacylglycerols (9%) and HDL (4%) in comparison with the average American diet. However, a second trial found no difference in lipid reductions for macadamia nuts compared with a low-fat high-complex carbohydrate diet.

Peanuts: in one highly rated study, peanuts statistically significantly reduced TC (7%) and LDL (9%) in comparison with a low-fat diet; in a second trial, TC was reduced by 11% and LDL by 14% compared with the average American diet and TC reduced by 2% compared with a Step II diet. Peanuts had no effect on lipids in comparison with an olive oil-based diet.

Pecans (72 g per day): one highly rated study showed pecans statistically significantly lowered lipids compared with a Step I diet (TC 7%, LDL 10%, triacylglycerols 11%); HDL was increased by 6%.

Walnuts (7 highly rated studies): in 4 studies (40 to 84 g per day) there was a statistically significant decrease in TC (4 to 12%) and LDL (6 to 16%) compared with Step I, Mediterranean and Japanese diets. Three studies of walnuts (41 to 78 g per day) showed no significant changes in comparison with low-fat, Mediterranean or Step 1 diets. In most studies HDL was not significantly affected.

No studies scoring 1 or 2 for quality assessed the effects of hazelnuts or pistachio nuts.

Authors’ conclusions
The consumption of 50 to 100 g of nuts at least five times per week as part of a heart-healthy diet with total fat content of 35% of energy (especially almonds, peanuts, pecan nuts or walnuts) may significantly lower TC and LDL cholesterol. The evidence for macadamia nuts is less convincing.

CRD commentary
The inclusion criteria for this review were only partly stated, particularly in relation to study design. Only two relevant databases were searched, and some efforts were made to identify unpublished studies. No mention was made about whether language restrictions were applied. It is possible that other relevant studies were missed. The study selection,
data extraction and quality assessment processes were carried out in duplicate, which helps reduce the potential for reviewer error or bias. Studies were quality assessed using appropriate criteria, and only studies that attained a score of 1 or 2 were synthesised. Given that studies were scored on whether they were controlled and randomised as part of the quality assessment, it might have been more appropriate to restrict the inclusion criteria to RCTs.

The authors chose not to statistically combine the results as the differences between the studies were considered too great. They therefore appropriately discussed the results within the text. The results were presented as the percentage difference in changes from baseline between the control and treatment groups, but there was no mention of actual levels of changes in blood lipids. It is therefore not possible to say how clinically significant the changes in cholesterol were. In addition, as the authors discussed, the included studies were all small and underpowered. The authors’ conclusions should be interpreted in the light of these comments.

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

**Practice:** The authors stated that it is appropriate to recommend that people with normal or raised lipid levels consume 50 to 100 g of a variety of nuts at least five times a week.

**Research:** The authors stated that quality feeding studies should be carried out with larger sample sizes and longer durations. In particular, there should be studies on mixed nuts and on nuts not already evaluated.

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