Aerobic exercise and lipids and lipoproteins in women: a meta-analysis of randomized controlled trials
Kelley G A, Kelley K S, Tran Z V

CRD summary
This review assessed the effects of aerobic exercise on lipids and lipoproteins in women. The authors concluded that aerobic exercise effectively increased high-density lipoprotein cholesterol and decreased total cholesterol, low-density lipoprotein cholesterol and triglycerides. The conclusions reflect the data presented. However, given the large number of analyses performed and the poor-quality of the included trials, the validity of the conclusions is uncertain.

Authors' objectives
To assess the effects of aerobic exercise on lipids and lipoproteins in women.

Searching
MEDLINE, EMBASE, Current Contents and Dissertation Abstracts International were searched for studies published in the English language between January 1955 and January 2003; the search terms were reported. The reference lists of review articles and original studies were screened and selected journals were handsearched.

Study selection
Study designs of evaluations included in the review
Randomised controlled trials (RCTs) were eligible for inclusion.

Specific interventions included in the review
Studies of chronic aerobic exercise for a minimum of 8 weeks were eligible for inclusion. Exercise interventions varied amongst the included studies, with the majority focusing on walking. Aerobic exercise was compared with a control group, details of which were not provided.

Participants included in the review
Studies of women aged at least 18 years were eligible for inclusion. Most of the study samples consisted of sedentary women.

Outcomes assessed in the review
Studies assessing lipids and lipoproteins in the fastening state were eligible for inclusion, i.e. total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C) and triglycerides (TG). The secondary outcomes included in the review were body weight, body mass index (BMI), percentage body fat and maximum oxygen consumption (VO2 max). Most of the included studies assessed lipids the morning after a 12-hour fast.

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
Validity was assessed using the Jadad scale, which rates randomisation, blinding and attrition to give an overall score of between 0 (lowest quality) and 5 (highest quality). The authors did not state how many reviewers performed the validity assessment.

Data extraction
Two reviewers independently extracted the data into a pre-designed form. Any disagreements were resolved by consensus or a third reviewer. Percentage change in outcome was calculated by subtracting the percentage change in the exercise group from the percentage change in the control group. Variances were also calculated.

**Methods of synthesis**

**How were the studies combined?**
The studies were pooled in a random-effects meta-analysis and weighted by the inverse of the variance. Publication bias was assessed using the procedure of Egger et al.

**How were differences between studies investigated?**
Heterogeneity was investigated using the Q statistic and the I-squared statistic.

Subgroup analyses were performed to assess the potential influence of the following factors on the results: study source; menopausal status; drugs that might affect lipids and lipoproteins; race or ethnicity; cigarette smoking; diabetes; overweight or obesity; position of lipid assessment; and training modality.

Clinical heterogeneity was assessed using a meta-regression. The variables investigated included: initial lipid level; age; height; baseline and treatment effect changes in body weight; BMI; percentage body fat; VO2 max; number of hours fasted prior to lipid and lipoprotein assessment; number of hours that exercise was avoided prior to lipid and lipoprotein assessment; and various features of and compliance with the training protocol.

Analyses were repeated by deleting some groups of participants, namely those taking hormone replacement therapy, those in which changes in diet had occurred, and one study where all the patients were hyperlipidaemic.

Due to the large number of subgroup analyses, a p-value of less than or equal to 0.01 was used to indicate statistical significance.

**Results of the review**

Forty-one studies were included (1,715 pooled participants: 1,022 in the exercise group and 693 in the control group).

The scores for study quality ranged from 1 to 5 (median score 1).

A statistically significant reduction in TC of approximately 2% was observed in participants in the aerobic exercise group (mean -4.3, 95% confidence interval, CI: -6.9, -1.7, p<0.001). There was no evidence of publication bias (p=0.37).

A statistically significant increase in HDL-C of approximately 3% was observed in participants in the exercise group (mean 1.8, 95% CI: 0.1, 3.5, p<0.001). There was no evidence of publication bias (p=0.25).

A statistically significant reduction in LDL-C of approximately 3% was observed in participants in the exercise group (mean -4.4, 95% CI: -6.5, -2.2, p<0.001). There was no evidence of publication bias (p=0.46).

A statistically significant decrease in TG of approximately 5% was observed in participants in the exercise group. There was no evidence of publication bias (p=0.31).

There were no statistically significant or clinically relevant differences in TC, HDL-C, LDL-C or TG between premenopausal and postmenopausal women, and those studies in which all participants were not taking any type of medication that could affect lipids and lipoproteins.

In terms of secondary outcomes, a 2% decrease in both body weight and BMI was found in the exercise group, in addition to a 4% decrease in body fat. There was also a statistically significant increase of approximately 13% for VO2max in this group.
Authors' conclusions
Aerobic exercise is efficacious for increasing HDL-C and decreasing TC, LDL-C and TG in women.

CRD commentary
The inclusion criteria were clear and specific for the intervention, participants, outcomes and study design. The search was adequate and there was no reported publication bias. However, the study was restricted to English language papers, which might have introduced language bias. With the exception of the data extraction, it was unclear whether other stages of the review were carried out in duplicate; this increases the potential for reviewer error and bias. The authors' conclusions follow from the data presented. However, the large number of analyses performed increases the chance of spurious findings, although the authors attempted to compensate for this by employing narrower criteria for determining statistical significance. In addition, the quality of the trials was poor, which may also compromise the validity of the conclusions.

Implications of the review for practice and research
Practice: The authors did not state any implications for practice.

Research: Further trials that focus on women with elevated levels of lipids and lipoproteins and are restricted to women with cardiovascular disease are required. The timing of the menstrual cycle is also important to note when measuring lipids and lipoproteins in women. It is essential that future studies report any concomitant medication that may affect lipids and lipoproteins, such as oral contraceptives and oestrogen replacement therapy. The reporting of intention-to-treat and per-protocol analyses would be useful.

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