Exercise, lipids, and lipoproteins in older adults: a meta-analysis
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CRD summary
This review evaluated the effects of aerobic exercise on lipids and lipoproteins in older adults. The authors concluded that aerobic exercise improves high-density lipoprotein cholesterol (HDL-C) and the ratio of total cholesterol to HDL-C. The robustness of the authors’ conclusions may be undermined by limitations in the data.

Authors' objectives
To evaluate the effects of aerobic exercise on lipids and lipoproteins in adults aged 50 years and older.

Searching
MEDLINE, EMBASE, SPORTDiscus, Current Contents and Dissertation Abstracts International were searched using the reported key terms. In addition, reference lists in retrieved articles were checked, key journals were handsearched, and experts were contacted. Studies reported in English in journals, dissertations and masters theses between 1955 and January 2003 were eligible for inclusion.

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 that compared prescribed aerobic exercise for at least 8 weeks with a non-exercise control were eligible for inclusion. Most of the included studies reported no changes in diet or the taking of medication that could affect lipids and lipoproteins. Most studies generally adhered to the American College of Sports Medicine recommendations using supervised, both supervised and unsupervised, or unsupervised exercise sessions. Where reported, the mean duration of the interventions was 35 weeks (range: 8 to 156), the mean frequency was 3.5 times per week (range: 2 to 6) and the mean duration of each session was 42.4 minutes (range: 17 to 75). The mean compliance with the intervention was 81.8% (range: 5 to 100).

Participants included in the review
Studies of adults aged 50 years or older were eligible for inclusion. In the included studies, the ratio of males to females was 48% to 52%. Where reported, the mean age of the participants was approximately 63 years, the mean baseline body mass index (BMI) was 27 kg/m2, and the mean baseline levels of lipids were within the normal range.

Outcomes assessed in the review
Studies that assessed one or more of the following variables in the apparently fasting state were eligible for inclusion: total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), and the ratio of TC to HDL-C (TC:HDL-C ratio). The secondary outcomes were body weight, BMI, percentage body fat and maximal oxygen consumption (VO2 max). The included studies assessed lipids after a 10- to 14-hour fast (mean 12.2) and after refraining from exercise for between 12 and 144 hours (mean 45.9).

How were decisions on the relevance of primary studies made?
The authors did not state how the studies were selected for the review, or how many reviewers performed the selection. [A: Two reviewers selected studies for inclusion. Any disagreements were resolved by consensus with the aid of a third reviewer if required.]

Assessment of study quality
Validity was assessed and scored using the Jadad scale to assess randomisation, blinding and withdrawals. The
maximum possible score was 5 points. The review also reported losses to follow-up. The authors did not state how the validity assessment was performed. [A: Two reviewers assessed validity and resolved any disagreements by consensus.]

Data extraction
Two reviewers independently extracted and coded the data. For each study, the mean difference and standard deviation (SD) were extracted for each outcome of interest.

Methods of synthesis
How were the studies combined?
A pooled weighted mean difference (WMD) with 95% confidence intervals (CIs) was calculated using a random-effects model for each outcome; the studies were weighted by the inverse of the variance. Publication bias was assessed using a rank-based, data-augmentation, trim-and-fill procedure.

How were differences between studies investigated?
Statistical heterogeneity was assessed using the Q and I-squared statistics. The influence of each study was assessed by repeating the analysis after omitting each study in turn. Subgroup analyses were conducted to examine the effect on lipids and lipoproteins of study source, country, gender, health status, and supervised or unsupervised exercise. The authors stated that it was not possible to assess the influence of cigarette smoking, alcohol consumption, antihyperlipidaemic medication, diet and baseline physical activity of the participants. Meta-regression was used to examine the relationship between changes in lipids and lipoproteins and study quality, year of publication, percentage drop-out, baseline lipid and lipoproteins levels, age, height, baseline body weight, changes in body weight, BMI, percentage body fat, VO2 max, number of hours fasted, number of hours over which exercise is avoided before lipid assessment, characteristics of exercise training (length, frequency, intensity, duration and total minutes) and compliance.

Results of the review
Twenty-two RCTs (n=1,427) reporting 28 outcomes were included.

The quality scores ranged from 1 to 4 (median 2). Losses to follow-up ranged from 5.0 to 45% (mean 18.3) in the exercise groups and from 0 to 64% (mean 14.9) in the control groups. Only two studies used an intention-to-treat analysis.

Compared with control, aerobic exercise significantly improved TC (WMD -3.3, 95% CI: -6.5, -0.02; p=0.05), HDL-C (WMD 2.5, 95% CI: 0.7, 4.4; p=0.01), LDL-C (WMD -3.9, 95% CI: -7.7, -0.08; p=0.05) and TC:HDL-C ratio (WMD -0.8, 95% CI: -1.2, -0.4; p<0.001), but not TG (WMD -7.0, 95% CI: -14.0, 0.1; p=0.06).

There was no evidence of publication bias for TC, HDL-C or TC:HDL-C ratio.

Only the improvements in HDL-C and TC:HDL-C ratio remained statistically significant after the removal of each study in turn (p<0.05 for both).

Reductions in TC were associated with greater decreases in body weight and BMI. Increases in HDL-C were associated with greater increases in VO2 max and older age.

Aerobic exercise was associated with small, statistically significant decreases in BMI (p<0.001) and percentage body fat (p=0.004), but not body weight (p=0.07). Aerobic exercise was associated with a large statistically significant increase in VO2 max (p<0.001).

The results of other subgroup analyses, meta-regression and post-hoc analyses were also reported.

Authors' conclusions
Aerobic exercise increases HDL-C and reduces the TC:HDL-C ratio in older adults.

**CRD commentary**
The review addressed a clear question that was defined in terms of the participants, intervention, outcomes and study design. Several relevant sources were searched and attempts were made to minimise publication bias. Since eligibility was limited to studies reported in English, the authors might have missed some relevant studies. However, publication bias was assessed and no evidence of it was found for most of the assessed outcomes. Methods were used to minimise reviewer errors and bias in the selection of studies, assessment of validity and extraction of data. Validity was assessed using established criteria but, other than drop-outs, the results for individual validity items were not reported; this makes it difficult for the reader to independently judge the study validity.

The characteristics of the participants and interventions were adequately summarised. The analysis appears to have been restricted to those with pre- and post lipid assessment, which may mean that results from the individual studies have been overestimated and not reliable. Statistical heterogeneity was assessed, studies were pooled using meta-analysis, and the influence of many relevant factors on lipids and lipoproteins was examined and the results discussed; the multiplicity of factors considered might have increased the risks of detecting significant results by chance. The methods used to analyse the results were appropriate given the available data. However, limitations in the data may undermine the authors' general conclusion.

**Implications of the review for practice and research**
Practice: The authors stated that it seems reasonable to suggest that aerobic exercise conducted according to the American College of Sports Medicine guidelines for at least 35 weeks could improve HDL-C and reduce the TC:HDL-C ratio in older adults. These guidelines recommend an exercise intensity of 55 to 90%; in patients who are unfit at baseline, an intensity level of 55 to 64% is recommended.

Research: The authors stated that future research in this field should report intention-to-treat and per-protocol analyses; examine the effects of aerobic exercise in studies limited to patients with elevated lipids and lipoprotein; and include patients who smoke and/or consume alcohol. In addition, studies could examine the interaction, if any, between aerobic exercise and antihyperlipidaemic medications and the effects of aerobic exercise on lipids and lipoproteins in older adults.

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