Effects of aerobic exercise on lipids and lipoproteins in adults with type 2 diabetes: a meta-analysis of randomized-controlled trials

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CRD summary
This well-conducted review cautiously concluded that overall aerobic exercise appears to lower low-density lipoprotein cholesterol in adults with type 2 diabetes, but this needs to be confirmed by further randomised controlled trials. The authors' conclusions appear reliable given the quantity and quality of the evidence available.

Authors' objectives
To examine randomised controlled trials (RCTs) in adults with type 2 diabetes, for evidence of the effects of 8 weeks or more of aerobic exercise on lipids and lipoproteins.

Searching
MEDLINE, EMBASE, SPORTDiscus, Current Contents and Dissertation Abstracts International were searched for articles published in English between 1 January 1955 and 1 October 2006; the search terms were reported. The reference lists of relevant trials and reviews were checked, and selected journals (no details reported) handsearched. Content experts were asked to review the final list of retrieved trials.

Study selection
RCTs comparing prescribed aerobic exercise, for at least 3 days per week for 8 weeks or longer, with a non-exercise control in adults (aged at least 18 years) were eligible for inclusion. Interventions were not allowed to comprise a diet intervention, and all participants had to be classified as having type 2 diabetes. Studies that were limited to progressive resistance training (weight training) were excluded from the review, as were those interventions combining progressive resistance training and aerobic exercise. The included studies assessed 10 to 26 weeks (3 to 7 sessions per week) of various types and combinations of aerobic exercise, including cycling, walking, swimming, rowing, jogging and skiing. Where stated, the mean age of the included participants ranged from 45 to 61 years. The majority of trials were conducted in mixed populations of men and women, though two were conducted in single sex populations (one in men and one in women). One trial was conducted in a sedentary population and another in an overweight/obese sedentary population. Two trials included postmenopausal women. The majority of trials were conducted in individuals who had had type 2 diabetes for over a year and who were instructed to maintain their normal diet. No information was provided about race, although three studies were carried out in the USA and one in each of the following countries: Netherlands, Israel, Finland and France. Various types of diabetes treatment were received prior to study enrolment, and four of the studies reported that participants were not physically active before the trial began. Eligible studies had to report lipid and lipoprotein data: total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), the ratio of TC to HDL-C (TC/HDL-C) and triglycerides (TG). The secondary outcomes included glycosylated haemoglobin, glucose, insulin, body weight, percentage fat, body mass index and fitness (defined as changes in maximum oxygen consumption).

Two authors reviewed each study for inclusion and any disagreements were resolved through consensus.

Assessment of study quality
Study quality was assessed by the authors using the Jadad scale (randomisation, blinding and withdrawals), with each study receiving a score of between 0 and 5 points.

Data extraction
Changes in lipid and lipoprotein levels from baseline to follow-up were extracted in both milligrams per decilitre (mg/dL) and millimoles (mmol). Net changes in the primary outcomes were calculated as the difference (exercise minus control) of the changes (final minus initial) in the mean values from each study. Continuous data were reported as means with standard deviations for descriptive data or as means with 95% confidence intervals (CIs) for primary and secondary outcome data.
Both authors independently extracted the study data using a coding form. Any discrepancies were resolved by consensus.

**Methods of synthesis**

The studies were grouped according to outcome and pooled weight mean differences (WMDs) calculated using a random-effects analysis, with weights equal to the inverse of the variance for net changes in all lipid and lipoprotein outcomes. Statistical heterogeneity was assessed using the $Q$ statistic (with statistical significance set at $p \leq 0.10$) and the $I^2$ statistic. Meta-regression was planned to examine potential sources of heterogeneity: the country of origin; the inclusion of overweight or obese participants; the presence of reductions in weight during the exercise intervention; initial lipid levels; study quality; participant age; and length, frequency, duration and intensity of training, as well as the total minutes of training (length x frequency x duration). However, most analyses were not possible because of a lack of data. The effects of each individual study on the overall effect sizes were also examined. Publication bias was assessed using regression analysis to detect funnel plot asymmetry (statistical significance set at $p \leq 0.05$).

**Results of the review**

Ten RCTs met the inclusion criteria, but the authors were only able to obtain and include in their analysis, seven of these ($n=220$, comprising 112 exercise and 108 controls).

The median Jadad score was 1 out of 5 (individual study scores were not reported).

Changes favouring a benefit from exercise in comparison with control were reported for TC, HDL-C, LDL-C, TC/HDL-C and TG, but were only statistically significant for changes in LDL-C (WMD -6.4 mg/dL, 95% CI: -11.8, -1.1 and WMD -0.17 mmol, 95% CI: -0.31, -0.03; 4 RCTs). Statistically significant heterogeneity was reported for the analyses of HDL-C and TC/HDL. No statistically significant publication bias was detected. The removal of each individual study in turn from the analysis did not result in any major changes to the overall results. No significant associations were observed with any of the variables examined by meta-regression, with the exception of a greater reduction in TC associated with studies conducted in the USA, compared with other countries (correlation, $r=0.89$, 95% CI: 0.37, 0.98).

**Authors’ conclusions**

Overall, aerobic exercise appears to lower LDL-C in adults with type 2 diabetes, but this needs confirmation in further RCTs.

**CRD commentary**

This review answered a clear review question using reliable methods to reduce the risk of reviewer error and bias. Publication bias, statistical heterogeneity and study quality were assessed, although the quality of the individual studies was not reported. The analyses appear appropriate and the authors’ cautious conclusions appear to reliably reflect the quality and quantity of the evidence presented.

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

**Practice:** The authors stated that ‘although aerobic exercise should almost always be recommended because of the numerous other benefits that can be derived from it, it seems that people with type 2 diabetes may need to be treated aggressively with lipid-improving drugs and a rigorous diet’.

**Research:** The authors stated that further RCTs are required to confirm their findings and to determine the efficacy and effectiveness of aerobic exercise interventions, particularly the magnitude of benefit associated with combining exercise with newer and more effective medications. Future studies should report the important participant characteristics, which were found to be under reported in this review, and to include quantitative data for body weight and changes in fitness. The number of hours that participants refrained from exercising before the assessment of lipids and lipoproteins, and their compliance with the exercise intervention, should also be reported.

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