Effects of resistance training on metabolic fitness in children and adolescents: a systematic review

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CRD summary
This review concluded that there is insufficient good-quality evidence to determine either the effectiveness of resistance training for improving metabolic fitness in children and adolescents, or the best type of resistance training to prescribe. Although the search was somewhat limited and the review methods were not fully reported, the review was overall well-conducted and these conclusions appear reliable.

Authors' objectives
To assess the effects of resistance training (RT) and circuit weight training (CWT) on metabolic fitness in children and adolescents.

Searching
MEDLINE, SPORTDiscus, CINAHL, AMED and EBM Reviews (comprising ACP Journal Club, Evidence-Based Medicine, the Cochrane Controlled Trials Register, the Cochrane Database of Systematic Reviews and DARE) were searched to 2006; the search strategy was reported. The references of retrieved articles and of relevant review papers and position statements were handsearched. The search was limited to articles published in English.

Study selection
Studies of children or adolescents aged under 18 years were eligible. Studies were required to administer RT in at least one study arm, using machines and/or free weights, either alone or in conjunction with other treatment, and to report data relating to both metabolic outcomes (e.g. lipoproteins, insulin, glucose) and adiposity outcomes (e.g. body mass index, BMI).

Where reported, the participants in the included studies were recruited from schools, sports teams, or hospital or medical clinics. Their ages ranged from 6 to 19 years. Most of the studies targeted participants who were obese or overweight. The programmes varied widely, with some including additional components, as did the number of repetitions and number of sets prescribed. Overall, the intensity was apparently low to moderate, though one study included moderate- and one included high-intensity RT. The duration of the programme was in most cases 6 to 10 weeks (range: 6 weeks to 5 months). Where reported, exercise was supervised, apart from home-based components. The interventions in the control group varied. Only one study used an alternative exercise programme (physical education classes). The controls in some studies received the same dietary/nutritional and behaviour modification programme as the treatment group, while others had no treatment or were on a waiting list. The review included randomised controlled trials (RCTs), non-RCTs and uncontrolled trials (UCTs). One crossover RCT had an adjunctive cross-sectional control group.

The authors did not state how the papers were selected for the review, or how many reviewers performed the selection.

Assessment of study quality
The following aspects of study validity were assessed: randomisation, allocation concealment, blinding, clarity of eligibility criteria, assessment of baseline comparability, detailed description of the intervention, reporting of adverse events, rates of loss to follow-up and attendance, intensity of intervention, management of missing data, description of statistical methods, identification of primary and secondary outcomes, use of validated and reliable assessment instruments, use of power calculation, identical treatment in both groups (apart from intervention), and the reporting of measures of variance.

The authors did not state how the validity assessment was performed.
Data extraction
Study data were tabulated. In most cases the data comprised pre- and post-intervention measurements for each study group, with p-values and standard deviations where available.

The authors did not state how the data were extracted for the review, or how many reviewers performed the data extraction.

Methods of synthesis
The studies were combined in tables and in a narrative, grouped by study outcome. Heterogeneity between the studies was discussed in the text.

Results of the review
Twelve studies (n=425) were included: 5 parallel-group RCTs (n=252), one crossover RCT (n=19), 4 non-RCTs (n=89) and 2 UCTs, both pre-test post-test studies (n=65).

Adiposity outcomes.
Body mass and BMI (12 studies, n=425): no controlled studies reported favourable changes in body mass or BMI associated with RT.

Body composition: the outcomes reported were whole body fat (4 RCTs, 1 crossover RCT, 1 UCT), central body fat (3 RCTs, 1 crossover RCT, 1 non-RCT) and whole body lean mass (4 RCTs, 2 UCTs). The crossover RCT (n=19) found a significant decrease in abdominal fat mass after progressive RT, as measured by dual-energy X-ray absorptiometry (8.0 versus 8.6, p<0.05), and one RCT (n=22) found a significant increase in lean body mass in the treatment (CWT) group, as measured by dual-energy X-ray absorptiometry. Otherwise, none of the controlled studies found any statistically significant benefit from RT compared with controls.

Metabolic outcomes.
Lipids: the outcomes reported were total cholesterol (4 RCTs, 3 non-RCTs, 1 UCT, 1 crossover RCT), high-density lipoprotein (HDL; 4 RCTs, 3 non-RCTs, 1 UCT, 1 crossover RCT), low-density lipoprotein (LDL)/HDL ratio (2 RCTs), triglyceride/HDL ratio (1 RCT), triglycerides (4 RCTs, 1 non-RCT, 1 crossover RCT, 1 UCT), LDL (3 RCTs, 3 non-RCTs, 1 UCT, 1 crossover RCT). One RCT reported significant reductions in total cholesterol associated with RT (p<0.05) and another found a significant improvement in LDL/HDL ratio associated with CWT plus diet, compared with diet alone (p<0.05). Otherwise, none of the controlled studies found a significant benefit associated with the intervention compared with controls.

Insulin and glucose (3 RCTs, 1 crossover RCT, 2 non-RCTs, 1 UCT): none of the studies showed a statistically significant change in insulin levels or insulin sensitivity associated with the intervention compared with controls.

Authors' conclusions
There is insufficient good-quality evidence to determine the effectiveness of RT for improving metabolic fitness in children and adolescents, or the best type of RT to prescribe.

CRD commentary
The review objectives and inclusion criteria were clear and a large number of relevant sources were searched, though the restriction to articles published in English means that the review may be subject to language and publication bias. The risk of publication bias was not assessed. Detailed information about the primary studies was provided and relevant criteria were used to assess study validity. However, it is not clear whether steps were taken to reduce the risk of error and bias in the study selection, validity assessment and data extraction processes, such as having more than one reviewer make decisions independently. The narrative synthesis highlighted the better quality evidence and appropriately addressed heterogeneity in the study findings. Although the search was limited in some respects and the review methods were not fully reported, the review was overall well-conducted and the authors’ conclusions appear reliable.
Implications of the review for practice and research
Practice: The authors did not state any implications for practice.

Research: The authors stated that research is needed to determine best practice for prescribing RT aimed at addressing obesity in children and adolescents. Future studies should be RCTs, conducted in a variety of countries, of single modality exercise with standardised outcomes and attention to maturation and age as potential confounders. Outcomes should include lipids, insulin and glucose levels, insulin sensitivity and inflammatory markers.

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Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.