Factors that alter body fat, body mass, and fat-free mass in pediatric obesity

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Authors' objectives
To quantify the effects of exercise treatment programmes on changes in body mass, fat-free mass (FFM) and body fat in obese children and adolescents.

Searching
Current Contents, MEDLINE, Dissertation Abstracts International, Psychological Abstracts, and SPORTDiscus were searched from 1960 to 2001. The search terms included 'children', 'exercise', 'obesity', 'physical activity' and 'weight loss' (the authors' own sample of their search terms). In addition, the bibliographies of retrieved studies and review articles were handsearched and cross-referenced. An expert in exercise and pediatric obesity also reviewed the reference list for thoroughness and completeness. The studies were limited to publications in the English language.

Study selection
Study designs of evaluations included in the review
No explicit criteria relating to study design were stated. Randomised controlled trials (RCTs), controlled trials and studies with no control group were included. The studies had to have at least six participants per group.

Specific interventions included in the review
Exercise training programme (e.g. walking, jogging, cycle ergometry, high repetition resistance exercise, and combinations there of) of a duration of at least 3 weeks.

Participants included in the review
Apparently 'healthy' children (i.e. free from endocrine diseases and disorders) aged from 5 to 17 years were eligible for inclusion. The authors did not specifically state that the children had to be clinically obese, but it was implicit in the study objectives and outcomes assessed. Age ranges rather than specific ages were often reported, and gender was not always distinguished in the studies. Most of the children were Caucasian; although Hispanic and African-American children were also included, there were too few in these ethnic groups to allow a meaningful analysis.

Outcomes assessed in the review
Changes in body mass, percentage body fat, and FFM were assessed.

How were decisions on the relevance of primary studies made?
The authors do not state how the papers were selected for the review, or how many of the reviewers performed the selection.

Assessment of study quality
The authors do not state that they assessed validity.

Data extraction
The two authors independently extracted all the data, then met and reviewed each item for accuracy and consistency. Any disagreements were resolved by consensus.

The following data were extracted:

exercise programme characteristics, i.e. length frequency, intensity, duration, mode and compliance, where compliance was defined as the number of exercise sessions attended;
study characteristics, i.e. author(s), year, the definition used to establish obesity, study design, comparison groups (e.g. exercise plus diet versus exercise plus behaviour intervention) and the number of participants;

participant characteristics, i.e. age, weight, gender, health status, race and fitness status (e.g. maximum oxygen uptake);

body composition measurement characteristics, e.g. dual-energy X-ray absorptiometry versus bioelectric impedance analysis versus skinfold; and

primary outcomes, i.e. changes in body mass, percentage body fat, and FFM.

The research findings from each study were transformed into a common effect size (ES) for the primary variables of interest (body mass, percentage body fat, and FFM). The standard ES formula was applied for studies with a control group, while for those without a control group, the pre- to post-training changes in body mass, FFM and percentage body fat were used.

**Methods of synthesis**

*How were the studies combined?*

A random-effects model was used to pool the ES data on changes in body composition if heterogeneity was present. A pooled variance weighted for sample size was calculated, which was corrected for bias by bootstrap resampling (a non-parametric method used for non-normally distributed data). For studies that generated more than one ES, due to the presence of more than one treatment group, the ESs were treated as independent data points but were also combined to determine the impact of ESs on the overall results. Publication bias was examined using the Kendal tau-rank correlation test, which correlated the observed outcomes (i.e. changes in the ES of body mass, FFM and percentage body fat) with sample size.

*How were differences between studies investigated?*

A subgroup analysis was performed to examine between-group differences. The subgroups were analysed according to: intensity; exercise duration; length of training; frequency; mode; method of assessing body composition; participant characteristics such as gender and fitness status; research design; and type of intervention programme. Heterogeneity of the ESs was investigated by identifying the outliers beyond the tenth and ninetieth percentiles. The authors then examined each study represented by an outlier, and if a methodological flaw or physiological reason explained the variability, the study was excluded. Any differences of opinion were resolved through discussion and consensus. The ESs were averaged across studies to determine the treatment effects and were further stratified according to the coded characteristics of interest. Analysis of variance-like procedures for meta-analysis were used to determine whether significant differences in body mass, FFM and percent body fat existed for exercise prescription components. Linear regression was used to indicate the magnitude and direction of relationships among variables, and stepwise regression was used to find which combination of factors best accounted for changes in body weight and composition after training.

A subgroup analysis of the primary outcomes partitioned by research design (RCT, controlled trial, no control group) was performed to determine the impact of design on components of the exercise prescription. A Tukey post hoc test was used to determine which mean values were statistically different in the presence of significant F-ratios. An alpha level of P less than or equal to 0.05 was established a priori to establish the presence of significant differences.

**Results of the review**

A total of 30 studies were included: 7 RCTs, 6 controlled trials and 17 studies with no control groups. The tabulated data yielded a total of 1,058 participants, whereas the authors reported their findings on the basis of a total of 945 participants.

No publication bias was found for ES changes in body mass (p=0.71), FFM (p=0.24) or percentage body fat (p=0.09). Across all designs, intervention strategies and categories, the fixed-effect modelling based on pre- to post differences yielded significant decreases in percentage body fat (mean: 0.70 ± 0.35, 95% confidence interval, CI: 0.21, 1.1), FFM (mean: 0.50 ± 0.38, 95% CI: 0.03, 0.57), body mass (mean: 0.34 ± 0.18, 95% CI: 0.01, 0.46), and body mass index (mean: 0.76 ± 0.55, 95% CI: 0.24, 1.7).
The subgroup analyses found significant differences in outcomes according to the type of intervention group (p<0.04 and p<0.05), body composition assessment methods (p<0.006), exercise intensity (p<0.01), duration (p<0.03), and mode of exercise (p<0.02).

The stepwise linear regression suggested that initial body fat levels (or body mass), the type of treatment intervention, exercise intensity, and exercise mode accounted for most of the variance associated with changes in body composition after training.

**Authors’ conclusions**
Exercise is efficacious for reducing selected body composition variables in children and adolescents. The most favourable alterations in body composition occurred with low-intensity exercise of long duration; aerobic exercise combined with high repetition resistance training; and exercise programmes combined with a behavioural modification component.

**CRD commentary**
The review question was clearly stated. The literature search seemed reasonably comprehensive, with efforts made to identify unpublished sources, although the searches were restricted to English language journals only.

The authors did not provide any information as to whether any validity assessments were carried out, which would seem to be particularly important as a range of different study designs were included. However, the fact that some studies were excluded from the analysis if a methodological flaw or physiological reason was apparent (in relation to explaining variability amongst studies) suggests that some kind of validity assessment was undertaken.

The range of statistical tests employed seems to be appropriate and tests for heterogeneity and publication bias were conducted. The authors reported that they performed a subgroup analysis according to study design, but they failed to report the results of this. There were some inconsistencies in the reported findings. For example, the total number of participants was 1,058 in the tabulated data but 945 in the ‘Results’ section, with no explanation provided for this difference; details provided in the abstract were less accurate than those in the ‘Results’ section (e.g. for the type of intervention group), and there was a typographical error in the 95% CIs reported for body mass index (CI reported as 4.24, 1.7, instead of 0.24, 1.7).

The authors’ conclusions seem valid in the light of the data presented. However, it should be remembered that their main findings are based on a combination of different study designs, and on pre-test post-test changes.

**Implications of the review for practice and research**
Practice: The authors state that exercise is an effective adjunctive treatment in the treatment of childhood and adolescent obesity. Low-intensity exercise of long duration and aerobic exercise with high repetition resistance training have the most favourable influence.

Research: The authors state that there is a need to carry out studies with more standardised methods for defining and measuring obesity. New directions in the research of paediatric obesity, which include molecular and behavioural genetics, should be used in synergistic ways with organ-systems physiology and exercise biochemistry.

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