Antecedent exercise in the treatment of disruptive behavior: a meta-analytic review
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Authors' objectives
To evaluate antecedent exercise (AE) as a means of treating disruptive behaviours.

Searching
PsycLIT, Sociofile, MEDLINE, NurseLit, PsycBOOKS and ERIC were searched on CD-ROM (search dates unclear) using the following search terms and cross-references: ‘exercise’, ‘physical activity’, ‘running’, ‘jogging’ with ‘behavior’, ‘conduct’ and ‘hyperactivity’. The National Technical Information Service (NTIS, 1989) was also searched. An ancestry analysis was conducted on each report located. Dissertation Abstracts International database, and convention programmes from the Association for Behavior Analysis (1989 to 1992) and the Association for the Advancement of Behavior Therapy (1989 to 1992), were checked for additional material. No language restrictions were reported.

Study selection
Study designs of evaluations included in the review
Group studies (including controlled studies) and single-case studies were included in the review.

Specific interventions included in the review
AE defined as the application of some increased level of physical exertion noncontingently with the intent of decreasing later disruptive behaviour, i.e. not following a behaviour as punishment. Sport was not classed as exercise as it implies participation but not necessarily physical exertion. Interventions reported in the review included running, walking, swimming, and various gym or exercise classes. No treatment was included as another comparison intervention.

Participants included in the review
Individuals with disruptive behaviour problems, defined as any observable response on the part of the individual that the therapist or experimenter was trying to reduce, e.g. aggression, self-injury, talking out loud in class. Internalising behaviours such as anxiety and depression were not classed as disruptive behavioural problems. Participants included male and female youths, children, elderly men and other individuals suffering from mental retardation, emotional disturbances, hyperactivity, and other emotional and behavioural problems. Some of the participants were from institutions and rehabilitation centres.

Outcomes assessed in the review
A wide variety of subjective measures of undesired behaviour were used such as attention span, impulse control, length of quiet time, incidence of maladaptive behaviours, hyperactivity, speaking out etc. Self-reported hostility was not included.

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 report a method for assessing validity, although methodological quality is mentioned in the sensitivity analysis (attention-placebo controls, blindness, dependent variable reliability assessments, treatment integrity checks and social validity assessments). No further data is presented.

Data extraction
The authors do not state how data were extracted for the review, or how many of the reviewers performed the data extraction. Tables reported in the review included the following types of data: bibliographic details, participant details,
intervention and control details, outcome measures, results, whether there was a delay between the intervention and the outcome assessment, and whether the study was published or not.

Methods of synthesis
How were the studies combined?
Effect sizes were calculated for each individual study and expressed such that more positive numbers indicated beneficial (disruptive behaviour reduction) effects, whilst negative numbers indicated negative (disruptive behaviour increase) ones. Where there were 2 or more 'dose' levels of treatment offered, the most intense treatment condition was compared to the no-treatment or attention placebo control. For group studies, effect sizes were expressed as Cohen's d-values (calculated by the difference between the mean treatment and mean control divided by pooled within-group standard deviation), which were then converted to Hedges and Olkin's d-values (see Other Publications of Related Interest no.1). Effect sizes for single-case studies were calculated using the multiple regression approach of Allison and Gorman (see Other Publications of Related Interest no.2). The resultant r-values were then converted into d-values. Where there were multiple dependent variables and/or multiple participants, separate effect sizes were calculated for each variable and participant. Within-participant effect sizes were averaged over all variables, yielding a single effect size for each participant; within-study effect sizes were averaged over all participants (weighting by the number of data points per participant) yielding a single effect size per study.

Where there was sufficient homogeneity, effect sizes were combined and both weighted and unweighted mean effect sizes calculated. Publication bias was assessed using the method described by Rosenthal (see Other Publications of Related Interest no.3) and by using the fail-safe N. Sensitivity analyses were carried out to determine the effects of the study design, type of control group, developmental disability status, duration of exercise, type of measurement, number of sessions, total weeks of treatment and the general methodological quality.

How were differences between studies investigated?
Heterogeneity was assessed using the Q statistic.

Results of the review
Forty-two studies were included: 16 group studies (13 controlled) and 26 single-case studies, of which 22 were published and 20 were not.

Group studies (n=16).

Twelve studies showed positive results and 4 produced negative effects. The weighted mean effect size was d=0.33, standard error 0.08 (unweighted mean effect size was d=0.54, standard error not stated). There was evidence of heterogeneity (Q=74.26, d.f.=15, p<0.00001), and studies using direct behavioural observation, hyperactive participants, or non-aerobic exercise were found to have greater effects, whilst those of higher quality had weaker effects.

A negative correlation (-0.64) between effect size and sample size indicated the possibility of publication bias, whereas the Z value (0.04, p=0.968) suggested there were no significant differences between the actual sample of published and unpublished studies. The fail-safe N was 169 (alpha=0.05) suggesting that 169 unpublished studies showing no effect would be required to overturn the review findings with regards to group studies.

Single-case studies (n=26).

Twenty-two studies produced positive results, 1 produced no effect and 3 produced negative effects. The mean effect size weighted by number of participants was d=1.989, standard error 0.411; the mean effect size weighted by number of data points per study was d=2.372, standard error 0.519 (unweighted mean effect size d=2.103, standard error 0.530). No formal tests of heterogeneity were performed as the distribution of effect size indices was not known with certainty; there were no statistically-significant effects from any of the factors investigated.

No significant correlation was observed between effect size and sample size. When the unweighted mean effect sizes were compared between published and unpublished studies, unpublished studies had significantly larger effect sizes.
Authors' conclusions
Reviewed information suggested that AE is socially acceptable, can be implemented with treatment integrity, and has a benign side-effect profile. Current data strongly support the efficacy of antecedent exercise as a treatment for disruptive behaviour. The extent to which antecedent exercise is functionally based remains open to question due to a lack of understanding regarding the mechanism of action. Further research is needed to elucidate mechanisms of action and practical aspects of implementing AE in clinical settings.

CRD commentary
This review is based on a wide search of the literature including both published and unpublished studies. The authors clearly define the main terms they use to describe the intervention, but since the inclusion criteria for participants and outcome measures are very wide, a broad range of heterogeneous studies is included. Little detail is provided of the methodologies used and the number of individuals involved in assessing the relevance of studies and extracting data. In addition, although the authors mention using the methodological quality of studies in the sensitivity analyses, it would appear that studies were not formally assessed for validity and no data was presented. The design of the group studies is not clearly stated, but many appear to be controlled studies.

Study effect sizes were pooled and heterogeneity was assessed statistically for group but not single-case studies. A significant level of heterogeneity was identified for the group studies: all of the studies showed great variation in the participants, interventions and outcome measures used. Pooling data in this situation is not advisable. Publication bias was highlighted as a potential problem for single-case studies, although the authors stated that this should not significantly affect the review findings. The evidence from single-case studies is of poorer quality than that from group studies and the authors may have been better limiting the review to only controlled studies. Given the level of heterogeneity between studies and the other aforementioned problems, the findings of the review should be interpreted with caution.

Implications of the review for practice and research
Practice: The authors state that 'there is clear evidence that antecedent exercise is effective in reducing a variety of disruptive behaviours across a variety of populations'.

Research: The authors state 'a major emphasis of future research should be on elucidating the mechanisms of action for antecedent exercise and examining whether these mechanisms are comparable across diverse populations'. Other areas for further research include 'the practical aspects of achieving faithful implementation of antecedent exercise in clinical settings', 'the affective properties of antecedent exercise', 'the issue of aversiveness and individual differences' and 'the relationship between vigour of physical exertion and the magnitude of effects'. The authors also state that future studies should include the following elements: 'an adequate number of observations, regular reliability checks on the dependent variable, regular treatment integrity checks on the independent variable, appropriate control groups or conditions incorporating attention placebos, assessment of the social validity of treatment outcomes and whenever possible blinding of as many persons as possible'.

Bibliographic details

Other publications of related interest

**Indexing Status**
Subject indexing assigned by CRD

**MeSH**
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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.