

Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials

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ABSTRACT

Objective To review the published literature on the effectiveness of interventions to promote physical activity in children and adolescents.

Design Systematic review.

Data sources Literature search using PubMed, SCOPUS, Psychlit, Ovid Medline, Sportdiscus, and Embase up to December 2006.

Review methods Two independent reviewers assessed studies against the following inclusion criteria: controlled trial, comparison of intervention to promote physical activity with no intervention control condition, participants younger than 18 years, and reported statistical analyses of a physical activity outcome measure. Levels of evidence, accounting for methodological quality, were assessed for three types of intervention, five settings, and three target populations.

Results The literature search identified 57 studies: 33 aimed at children and 24 at adolescents. Twenty four studies were of high methodological quality, including 13 studies in children. Interventions that were found to be effective achieved increases ranging from an additional 2.6 minutes of physical education related physical activity to 283 minutes per week of overall physical activity. Among children, limited evidence for an effect was found for interventions targeting children from low socioeconomic populations, and environmental interventions. Strong evidence was found that school based interventions with involvement of the family or community and multicomponent interventions can increase physical activity in adolescents.

Conclusion Some evidence was found for potentially effective strategies to increase children's levels of physical activity. For adolescents, multicomponent interventions and interventions that included both school and family or community involvement have the potential to make important differences to levels of physical activity and should be promoted. A lack of high quality evaluations hampers conclusions concerning effectiveness, especially among children.

INTRODUCTION

Physical activity among young people is believed to be insufficient,¹⁻³ yet it is unclear how successful efforts have been to increase activity levels. Recent reviews have

mostly dealt with obesity prevention⁴⁻⁷ or were mostly narrative.⁸⁻¹⁰ We systematically reviewed the evidence on promotion of physical activity in children and adolescents.

METHODS

We carried out an electronic literature search of published trials on interventions to promote physical activity in young people (see bmj.com). Inclusion criteria were children and adolescents (≤ 18 years), interventions in which one of the main components was aimed at promoting physical activity through behaviour change in any setting, inclusion of a non-physical activity intervention for the control group, and reported analyses of an outcome measure related to physical activity.

We assessed methodological quality using a 10 item scale (see bmj.com). EMFvS and AMMcM independently assessed whether each study's score on an item was "positive," "negative," or "not, or insufficiently, described." Quality was high when randomised controlled trials scored six or more or controlled trials scored five or more.

Data extracted included study design, baseline data, randomisation procedure, descriptions of intervention and control conditions, length of follow-up, and physical activity measures (see bmj.com). Data were also extracted on the specifics of the intervention, sample size, and overall effectiveness of the study for the main outcome measure.

Studies used a range of methods to assess effectiveness and reported a variety of different outcome measures. To avoid problems with such heterogeneity we used scores to indicate study effectiveness (see www.mrc-epid.cam.ac.uk/Publications/Supplementary_Material/VanSluijsBMJ2007/).

To summarise effectiveness, we used a rating system of levels of evidence based on study design, quality, and size: strong, moderate, limited, inconclusive, or no evidence for effect (see www.mrc-epid.cam.ac.uk/Publications/Supplementary_Material/VanSluijsBMJ2007/). If at least two thirds of the studies had significant results in the same direction then we considered the overall results to be consistent. In a stratified analysis we assessed levels of evidence for studies according to setting, target population, and type of intervention (educational,

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environmental or policy based, or a combination, “multi-component”).

RESULTS

Overall, 3045 references were retrieved from the database search. Fifty seven studies of interventions to promote physical activity in children ($n=33$)^{w1-w47} and adolescents ($n=24$)^{w48-w77} were included (see bmj.com). The characteristics of the studies are on bmj.com.

Overall 24 studies (42%) exhibited high methodological quality (see www.mrc-epid.cam.ac.uk/Publications/Supplementary_Material/VanSluijsBMJ2007/), of which 15 (25.3%) had a large sample size. Most studies applied intention to treat analyses and measured groups at similar times, but only 10 (18%) had a follow-up of six months or longer. Insufficient information was provided to score the adequacy of the randomisation procedure for 34 studies (60%), and 33 studies (58%) lacked information on allocation concealment at outcome assessment.

Eighteen studies in children were carried out in the United States, seven in the United Kingdom, and eight elsewhere. Most (82%) evaluated school based interventions; 14 included a community or family component. Around half the interventions were educational whereas a third used an educational and environmental intervention. Just over half the studies relied on child or parent reports as the main measure of physical activity (see http://www.mrc-epid.cam.ac.uk/Publications/Supplementary_Material/VanSluijsBMJ2007/). Twelve studies used an objective measure whereas three used observation methods. Only five of these assessed overall physical activity; the remainder mostly assessed activity during physical education or playtime. Nineteen studies assessed physical activity overall, eight measured school based physical activity, and six assessed out of school physical activity.

Eighteen studies in adolescents were carried out in the United States and six elsewhere. Almost all evaluated school based interventions, six of which included a family or community component. Five studies included follow-up of six months or more (see http://www.mrc-epid.cam.ac.uk/Publications/Supplementary_Material/VanSluijsBMJ2007/). Physical activity was mostly focused on non-school related activities and measured by self report or recall. Four studies used an objective measure, assessing total physical activity, and one used direct observation to assess physical education related physical activity.

Evidence of effect on physical activity

Thirty eight studies (14 in children, 13 in adolescents) reported a positive intervention effect (67%), achieving significance in 27 (47%) (see www.mrc-epid.cam.ac.uk/Publications/Supplementary_Material/VanSluijsBMJ2007/). Significant results ranged from an increase of 2.6 minutes during physical education classes to a 42% increase in participation in regular physical activity and an increase of 83 minutes weekly in moderate to vigorous physical activity. The table summarises the stratified levels of evidence for the effectiveness of the interventions.

Intervention types in children

Nineteen studies evaluated education only interventions, including one large ^{w11} and four small high quality randomised controlled trials,^{w15-w17 w23} two large high quality controlled trials,^{w3 w4} and seven low quality randomised controlled trials.^{w1 w2 w8 w10 w19-w21} Four reported a significant intervention effect. No overall evidence of an effect of education only interventions was identified. Four studies evaluated changes in the school environment, including two low quality trials.^{w24 w26} Both reported a significant effect, providing limited evidence of an effect of environmental interventions.

Ten studies evaluated multicomponent interventions, including three large high quality randomised controlled trials.^{w29 w39 w44} Only one of these trials reported a significant positive effect, equating to inconclusive evidence of effectiveness.

Intervention types in adolescents

Seventeen studies evaluated education only interventions in adolescents, including four large high quality randomised controlled trials.^{w48 w58 w60 w63} No evidence of an effect was found, with only one of these trials reporting significant positive results. One study, a low quality randomised controlled trial,^{w67} evaluated the effect of an environmental intervention, providing inconclusive evidence of an effect.

Six studies evaluated multicomponent interventions, all in schools. Three were large high quality randomised controlled trials.^{w69 w72 w76} All showed significant positive results, providing strong evidence of an effect of multicomponent interventions.

Summary of levels of evidence for effect of interventions to promote physical activity in children and in adolescents, stratified by setting, characteristics of intervention, and target group

Variables	Children (33 studies)		Adolescents (24 studies)	
	No of studies	Level of evidence	No of studies	Level of evidence
Intervention type:				
Educational	19	No	17	No
Environmental or policy	4	Limited	1	Inconclusive
Multicomponent	10	Inconclusive	6	Strong
Setting:				
School	13	Inconclusive	14	Inconclusive
School plus community or family	14	Inconclusive	6	Strong
Family	4	No	1	Inconclusive
Community	2	No	1	Inconclusive
Primary care	0	No	2	Inconclusive
Target group:				
One sex only	5	No	9	Inconclusive
Ethnic minority populations	10	No	0	No
Low SES populations	3	Limited	2	Inconclusive

Categories are exclusive for setting and intervention type but not for target group. SES=socioeconomic status.

Settings in studies of children

Twenty seven studies evaluated school based interventions. Thirteen of these were restricted to schools, including five randomised controlled trials, one of high quality^{w39} and four of lower quality.^{w8 w21 w24 w26} Three of these trials reported significant positive intervention effects, resulting in inconclusive evidence of an effect of school only interventions. The other 14 school based interventions included family or community components. One of two large high quality randomised controlled trials^{w29 w44} showed a significant positive intervention effect, suggesting inconclusive evidence of an effect.

Four studies evaluated family based interventions, including three small high quality randomised controlled trials.^{w16 w17 w23} Only one reported a significant effect, favouring the control group. One large high quality randomised controlled trial^{w11} and one small high quality randomised controlled trial^{w15} evaluated the effect of a community based intervention; neither reported a positive intervention effect. Therefore no evidence of an effect of either family based or community based interventions among children was found.

Settings in studies of adolescents

Fourteen of the 20 studies that evaluated school based interventions were restricted to schools, including two large high quality randomised controlled trials,^{w58 w60} one of which reported a significant intervention effect.^{w58} This represents inconclusive evidence of an effect. Six studies evaluated school based interventions including family or community involvement, three of which were large high quality randomised controlled trials.^{w69 w72 w76} Two of these trials showed significant positive results suggesting strong evidence of an effect of such interventions.

The only study evaluating a family based intervention, a high quality randomised controlled trial,^{w63} did not report a positive effect, as did the high quality randomised controlled trial^{w48} evaluating a community based intervention. One of the two low quality randomised controlled trials evaluating primary care based interventions^{w49 w57} showed a significant positive effect. Consequently evidence of an effect of either family based, community based, or primary care based interventions in adolescents is inconclusive.

Target populations

Five studies evaluated interventions targeted at girls: one large and two small high quality randomised controlled trials^{w11 w15 w16} and two low quality randomised controlled trials.^{w8 w19} Four reported positive effects; only one was significant. Ten studies evaluated interventions aimed at ethnic minority groups, including four small high quality and four low quality randomised controlled trials.^{w2 w10 w15-w17 w19 w23 w33} Only one low quality trial reported a significant positive effect. Therefore no overall evidence of an effect for interventions targeting girls or ethnic minority groups was found. Three controlled trials (two of high quality^{w3 w28}), assessed the effect of interventions targeting children

from low socioeconomic backgrounds. All reported a significant positive effect, resulting in a classification of limited evidence of an effect.

Eight studies evaluated interventions aimed at adolescent girls and one aimed at boys. Three were large high quality randomised controlled trials,^{w48 w69 w72} of which one showed significant positive results. In two small high quality studies—one randomised controlled trial^{w50} and one controlled trial^{w54}—interventions were aimed at low socioeconomic groups, with only one reporting a significant intervention effect. Consequently evidence of an effect of interventions targeting adolescents of one sex or from low socioeconomic groups is inconclusive.

DISCUSSION

Our systematic review of interventions aimed at promoting physical activity in children and adolescents found that in children there is limited evidence of an effect of interventions targeting low socioeconomic populations and environmental interventions and inconclusive evidence of an effect for multicomponent interventions and the two types of school based interventions. In general, interventions achieved important changes, such as a 13% increase in play time spent in moderate to vigorous physical activity. No evidence of effectiveness was observed in six of the intervention categories. This review raises questions about the usefulness of targeting interventions at children from ethnic minority populations or carrying out family based or community based interventions, as most of the studies identified did not report positive results. In addition, in children no evidence of an effect was found for educational interventions and the interventions targeting females, despite more than 67% of studies evaluating these interventions reporting positive effects. Most of these were low quality studies and did not always achieve significance.

Overall there was more evidence for an effect of interventions among adolescents than among children. However, more studies in adolescents were of high quality and included a large sample size (33% v 21%). Adolescents are also known to be less active than children^{11 12} so may exhibit greater potential for change. Effects ranged from increases of three minutes during physical education to a 50% increase in the number of participants being regularly active. Strong evidence was found for the effectiveness of school based interventions including family or community involvement and multicomponent interventions. No evidence of an effect was observed for educational interventions although an overall positive trend was observed. This trend is, however, mainly due to the results of studies with lower methodological quality and should be interpreted with caution. This review also shows inconclusive evidence of an effect in adolescents in other categories.

Intervention approaches

Almost a third of the studies in children were targeted at minority ethnic groups, although the evidence on the association between ethnicity and physical activity in children is fairly inconsistent.^{13 14} In contrast an

WHAT IS ALREADY KNOWN ON THIS TOPIC

Children and adolescents are believed to have low levels of physical activity, which is associated with obesity and other health problems
It is unclear what strategies might be effective to promote physical activity

WHAT THIS STUDY ADDS

Multicomponent interventions and interventions including school and family or community involvement may make important differences in physical activity levels in adolescents
For children some evidence of effect was shown for environmental interventions and those targeted at children from low socioeconomic backgrounds

association has often been reported in adolescents, with levels of physical activity tending to be lower in non-white ethnic groups,¹³⁻¹⁵⁻¹⁷ yet no interventions targeting adolescents from minority ethnic groups were identified. Low socioeconomic status has been identified as a possible determinant of physical inactivity.¹⁸⁻²¹ Recently, trials of interventions targeting socially disadvantaged people provided some evidence of the potential of this strategy. A higher level of activity in males compared with females is consistently observed throughout childhood and adolescence and evidence also suggests that both sexes tend to become less active with increasing age.¹¹⁻¹³ This review raises doubts about whether specifically targeting the sexes separately is an effective approach, although a positive trend was observed among children. Moreover, most of the studies investigating differential response by sex did not find one.

Parental factors and the home environment are believed to influence physical activity,²²⁻²³ yet few interventions were aimed at the home and those that have been carried out did not show significant positive results. An increasing number of school based interventions do, however, include some parental involvement. Evidence of effectiveness of these interventions in adolescents was strong, although in children the evidence is still inconclusive.

The conclusion of strong evidence of effect of multicomponent interventions in adolescents and the limited evidence of effect of environmental interventions in children is in keeping with the ecological approach to behaviour change.²⁴⁻²⁷ The environmental or policy element of multicomponent interventions mostly consisted of alterations to the physical education programme, such as additional classes. Observations of physical activity during classes mostly showed some increases, but few effects were observed in overall activity. This raises the question of whether children might compensate during the rest of the day. It is therefore important to use objective measures to assess the overall effect of the intervention on total activity levels.

Young children's activity is typically intermittent¹² whereas that of adolescents is more structured. Although traditional cognitive approaches, potentially combined with environmental approaches, may increase activity among adolescents and older children (≥ 10 years), more structural environmental or policy changes might be needed to change younger children's behaviour.²⁸ This is supported by the evidence of an effect of

environmental interventions, which tended to be evaluated in children in lower primary school grades (grades 1-4). Few studies included preschool children.

Implementation of interventions

Factors that may have limited effectiveness are the levels of exposure to the intervention and adherence. For example, Pate et al³⁷ described that only 5% of participants attended at least half of the sessions offered. Most papers, however, did not describe attendance, implementation, or quality assurance of the intervention, making it impossible to assess the impact of these factors on findings.

Most of the included studies were from the United States, raising questions about the generalisability of these results to other countries.

Methodological quality

Various limitations were identified. Information was lacking on the randomisation procedure and blinding at outcome assessment, limiting the interpretation of methodological quality. Brief descriptions of interventions hampered stratification of the studies and analyses. Overall, limitations across the studies included short follow-up, inadequate adjustment for potential confounders, and failure to adjust for clustering when randomisation was carried out at group level. Another limitation was the lack of precision of the outcome measures. For example, 18 of the studies in children used self reported or parent reported measures, just over half of which were not reported to be validated. Studies using observation or objective measures of physical activity were, however, more likely to report significant positive results than studies with a self reported measure.

Conclusion

It seems that a multilevel approach to promoting physical activity, combining school based interventions with family or community involvement and educational interventions with policy and environmental changes, is likely to be effective among adolescents. For children, limited evidence of an effect was found for environmental interventions and interventions targeting those from low socioeconomic groups.

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Objectively monitored patching regimens for treatment of amblyopia: randomised trial

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ABSTRACT

Objectives To compare visual outcome in response to two prescribed rates of occlusion (six hours a day and 12 hours a day).

Design Unmasked randomised trial.

Setting Research clinics in two London hospitals.

Participants 97 children with a confirmed diagnosis of amblyopia associated with strabismus, anisometropia, or both.

Interventions 18 week period of wearing glasses (refractive adaptation) followed by occlusion prescribed ("patching") for six or 12 hours a day.

Main outcome measures Visual acuity measured by logMAR letter recognition; objectively monitored rate of occlusion (hours a day).

Results The mean age of children at study entry was 5.6 (SD 1.5) years. Ninety were eligible for occlusion but 10 dropped out in this phase, leaving 80 children who were randomised to a prescribed dose rate of six (n=40) or 12 (n=40) hours a day. The mean change in visual acuity of the amblyopic eye was not significantly different (P=0.64) between the two groups (0.26 (95% confidence interval 0.21 to 0.31) log units in six hour group; 0.24 (0.19 to 0.29) log units in 12 hour group). The mean dose rates

(hours a day) actually received, however, were also not significantly different (4.2 (3.7 to 4.7) in six hour group v 6.2 (5.1 to 7.3) in 12 hour group; P=0.06). The visual outcome was similar for those children who received three to six hours a day or more than six to 12 hours a day, but significantly better than that in children who received less than three hours a day. Children aged under 4 required significantly less occlusion than older children. Visual outcome was not influenced by type of amblyopia. **Conclusions** Substantial (six hours a day) and maximal (12 hours a day) prescribed occlusion results in similar visual outcome. On average, the occlusion dose received in the maximal group was only 50% more than in the substantial group and in both groups was much less than that prescribed. Younger children required the least occlusion. **Trials registration** Clinical Trials NCT00274664.

INTRODUCTION

The developing visual system is highly sensitive to visual experience.^{1,2} Interruption by any obstacle, such as blurred vision or strabismus before about 7 years, results in a reduction of visual capacity known as amblyopia.^{1,3} About 90% of work in the children's eye services is related to amblyopia,⁴ and the condition carries an