Physical activity and children

Review 6:

INTERVENTION REVIEW: ADOLESCENT GIRLS

NICE Public Health Collaborating Centre – Physical Activity
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CONTENTS

Executive Summary

Introduction

This is the sixth review providing background evidence for the development of public health guidance for promoting physical activity in children and adolescents. The descriptive epidemiology review (Review One) made a clear link between physical activity and health outcomes in young people. There is evidence suggesting that levels of physical activity among children are insufficient and this is particularly so in adolescent girls. There is a clear need to promote physical activity within this age and gender group.

Objectives

This review addressed the question: **what interventions are effective in increasing levels of physical activity/core physical skills in adolescent girls aged 11-18 years?**

Methods

Literature searches were conducted using the terms and databases listed below. References were downloaded into a Reference Manager database (see Figure 1 for data). Search terms followed the same order (1) physical activity terms, (2) child terms and (3) location terms. All searches were performed from January 1990 to the most recently published version of the database (usually August 2007). Databases searched were: Cochrane Database of Systematic Reviews (CDSR), Database of Abstracts of Reviews of Effectiveness (DARE), Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, PsycINFO, CINAHL, HMIC, SPORTDiscus, ASSIA, SIGLE, Current Contents, ERIC, TRANSPORT, Environline, EPPI Centre Databases, NRR.

After the initial screening (see Figure 1), 250 titles and abstracts were assessed for relevance against the following inclusion criteria:

- Is the paper an **intervention study**?
- Is the age group studied **aged 11-18 years**?
- Is the study population **female**? [1]

[1] The study could include boys and girls, but was required to provide separate results for girls.

- Is an outcome reported on **physical activity behaviour** or **core physical skills?**

In total 153 titles were assessed to be potentially relevant and the full papers retrieved. In addition, studies were excluded if:

- They had a main focus on treating obesity
- They were from less economically developed countries or they were studies about ethnic groups that do not have large populations in England (labelled inappropriate population in Figure 2)
- The intervention involved primarily school physical education lessons
- The study involved a change to the built or natural environment (and thus had been covered in NICE guidance on the environment and physical activity) or was clearly more appropriate for one of the other reviews in this series (e.g., active travel).

Twelve studies were accepted for full data extraction (Baxter et al., 1997; Haerens et al., 2006; Marks et al., 2006; Metzker, 1999; Moon et al., 1999; Murphy, Dhuinn, Browne, & ORathaille, 2006; Patrick et al., 2006; J. J. Prochaska & Sallis, 2004; Robbins, Gretebeck, Kazanis, & Pender, 2006; Schofield, Mummery, & Schofield, 2005; Simon et al., 2004; Winett et al., 1999) (see Evidence Tables) and 141 were rejected (see Appendix B). See Figure 2 for flow diagram of the study selection procedure. Only intervention study designs were included (see Tables 1 & 3), but all intervention designs were eligible.

Results

Designs included randomised controlled trials (n=1), cluster randomised controlled trials (n=5), controlled non-randomised trials (n=4), and a randomised non-controlled trial (n=1) (see Table 1). Studies varied in scale from 57 to 2991 participants. The studies were conducted in one or in a combination of settings, including schools, the home, primary health care, or in unspecified settings. Of the two outcomes under investigation (physical activity and core physical skills/physical literacy), studies were only located for physical activity. Studies were conducted in the USA (n=6), the UK (n=2), other European (non-UK) countries (n=3), and Australia (n=1).

Eight interventions studied girls aged 11-13y, with four studying adolescents 14y or older. The measurement of physical activity involved objective assessment only (n=1), validated self-reported assessment only (n=4), self-reported assessment of

unknown validity (n=5), and a combination of objective and validated self-report measures (n=2). Time from baseline to follow-up measurement varied from being immediately at the conclusion of the intervention to 2 years. Of the 12 studies, six investigated girls only, three of which targeted less active girls, and six investigations included boys and girls.

The 12 studies were classified into intervention locations and types, with some studies appearing in more than one category. The categories are: school-based (single-behaviour) interventions (n=5); school-based (multiple behaviour) interventions (n=5); primary health care intervention (n=1); mediated interventions[2] (n=6); counselling interventions (n=3); educational interventions (n=5).

Evidence statements

1. School-based (single-behaviour) interventions: Evidence statement

There is evidence from three cluster randomised controlled trails, one each in Australia [+], France [+], and Ireland [+], and one controlled non-randomised trial in the USA [-], that school-based interventions, outside of physical education lessons, targeting the single behaviour of physical activity, can lead to moderate-to-large increases in physical activity in adolescent girls for up to 6 months. One randomised controlled trail [++] and one cluster randomised controlled trail [+], both from the USA, failed to show an effect. Characteristics of successful interventions were not consistent across studies, although three of the four successful trials targeted girls only. Successful interventions included self-monitoring techniques, stage-matched counselling, teacher-led extra-curricula physical activity, and multi-level programming targeting psychological, social and environmental correlates.

The evidence is drawn from non-UK studies and therefore the applicability to the UK is limited.

[2] Mediated approaches are those delivered via some form of intermediary such as computer or printed materials.

2. School-based (multiple behaviour) interventions: Evidence statement

There is evidence from one randomised controlled trial in the USA [++]; one cluster randomised controlled trial in Belgium [+]; and two controlled non-randomised trials in the UK [both -], that school-based interventions, outside of physical education lessons, targeting multiple health behaviours, including physical activity, do not lead to increases in physical activity in adolescent girls. Characteristics of these interventions included targeting younger boys and girls (<14 y), and those with a range of activity levels with strategies that included education, mediated approaches, and broad-based education and policy initiatives.

Only one study reported a beneficial effect. This was a controlled non-randomised trial in the USA [-]. Characteristics of this study included educational material delivered via the internet to older girls only.

The evidence is drawn from UK and non-UK studies and therefore the applicability to the UK is moderate.

3. Primary health care intervention: Evidence statement

There is evidence from one randomised controlled trial in the USA [++] that a primary health care intervention designed to increase physical activity in adolescent girls which included targeting physical activity and nutrition through computer-mediated and counselling approaches with younger adolescent boys and girls was not successful.

The evidence is drawn from a non-UK study and therefore the applicability to the UK is limited.

4. Mediated interventions: Evidence statement

There is evidence from two randomised controlled trials in the USA (both [++]) and two cluster randomised controlled trials, one in the USA [+] and one in Belgium [+]; that interventions delivered via a medium such as computer, phone or printed materials do not lead to increases in physical activity in adolescent girls.

However, there is evidence from one cluster randomised controlled trial in the USA [+] and one randomised non-controlled trial in the USA [-] that mediated interventions can lead to increases in physical activity in adolescent girls. A characteristic of these interventions is that they included younger girls (aged < 15 y).

The evidence is drawn from non-UK studies and therefore the applicability to the UK is limited.

5. Counselling interventions: Evidence statement

There is evidence from a randomised controlled trail in the USA [++] and a cluster randomised controlled trail in the USA [+], that counselling interventions do not lead to changes in physical activity in adolescent girls. A characteristic of these interventions is that they included younger girls (<15 y).

There is evidence from one controlled non-randomised trial in the USA [-], that a counselling intervention can lead to an increase in physical activity in adolescent girls. A characteristic of this intervention is that it is was short (8 weeks) and included older girls (>14 y) only.

The evidence is drawn from non-UK studies and therefore the applicability to the UK is limited.

6. Educational interventions: Evidence statement

There is evidence from one controlled non-randomised trial in the USA [-], and two cluster randomised controlled trials, one in Ireland [+] and one in France [+], that educational interventions can increase levels of physical activity in adolescent girls for up to 6 months. These interventions took place in schools but other characteristics were non-consistent across interventions.

There is evidence from two controlled non-randomised trials in the UK [both -] that educational interventions do not lead to increases in physical activity in adolescent girls. These interventions took place in schools, targeted physical activity alongside other health behaviours in younger girls (<15 y), and assessed physical activity with a self-report instrument on unknown validity.

The evidence is drawn from UK and non-UK studies and therefore the applicability to the UK is moderate.

Included studies

Baxter, A. P., Milner, P. C., Hawkins, S., Leaf, M., Simpson, C., Wilson, K. V., et al. (1997). The impact of heart health promotion on coronary heart disease lifestyle risk factors in schoolchildren: Lessons learnt from a community-based project. *Public Health, 111*, 231-237.

Haerens, L., Deforche, B., Maes, L., Cardon, G., Stevens, V., & De Bourdeaudhuij, I. (2006). Evaluation of a 2-year physical activity and healthy eating intervention in middle school children. *Health Education Research, 21*(6), 911-921.

Marks, J. T., Campbell, M. K., Ward, D. S., Ribisl, K. M., Wildemuth, B. M., & Symons, M. J. (2006). A comparison of web and print media for physical activity promotion among adolescent girls. *Journal of Adolescent Health, 39*, 96-104.

Metzker, A. L. (1999). *The effects of a transtheoretical model physical activity intervention program on the physical activity behavior of female adolescents.* Unpublished doctoral thesis, University of Northern Colorado, Greeley, Colorado, USA.

Moon, A. M., Mullee, M. A., Rogers, L., Thompson, R. L., Speller, V., & Roderick, P. (1999). Helping schools to become health-promoting environments: An evaluation of the Wessex Healthy Schools Award. *Health Promotion International, 14*(2), 111-122.

Murphy, N. M., Dhuinn, M. N., Browne, P. A., & ORathaille, M. M. (2006). Physical activity for bone health in inactive teenage girls: Is a supervised, teacher-led program or self-led program best? *Journal of Adolescent Health, 39*, 508-514.

Patrick, K., Calfas, K. J., Norman, G. J., Zabinski, M. F., Sallis, J. F., Rupp, J., et al. (2006). Randomized controlled trial of a primary care and home-based intervention for physical activity and nutrition behaviors. *Archives of Paediatric & Adolescent Medicine, 160*, 128-136.

Prochaska, J. J., & Sallis, J. F. (2004). A randomized controlled trial of single versus multiple health behavior change: Promoting physical activity and nutrition among adolescents. *Health Psychology, 23*(3), 314-318.

Robbins, L., Gretebeck, K. A., Kazanis, A., & Pender, N. J. (2006). Girls on the Move program to increase physical activity participation. *Nursing Research, 55*(3), 206-216.

Schofield, L., Mummery, K. W., & Schofield, G. (2005). Effects of a controlled pedometer intervention trial for low-active adolescent girls. *Medicine and Science in Sports and Exercise, 37*(8), 1414-1420.

Simon, C., Wagner, A., DiVita, C., Rauscher, E., Klein-Platat, C., Arveiler, D., et al. (2004). Intervention centred on adolescent's physical activity and sedentary behaviour (ICAPS): Concept and 6-month results. *International Journal of Obesity, 28*, S96-S103.

Winett, R. A., Roodman, A. A., Winett, S. G., Bajzek, W., Rovniak, L. S., & Whiteley, J. A. (1999). The effects of the *Eat4Life* internet-based health behavior program on the nutrition and activity practices of high school girls. *Journal of Gender, Culture, and Health, 4*(3), 239-254.

1. Introduction

This is the sixth review in a series commissioned to provide background evidence for the development of public health guidance for promoting physical activity in children and adolescents. The descriptive epidemiology review (Review One) made a clear link between physical activity and health outcomes in young people. There is evidence suggesting that levels of physical activity among children are insufficient and this is particularly so in adolescent girls. There is a clear need to promote physical activity within this age and gender group.

This report examines the evidence for the effectiveness of interventions to promote physical activity in adolescent girls, aged 11-18 years.

1.1. Background to this review

This review is best seen in the context of the 'behavioural epidemiology' framework (Sallis & Owen, 1999). This framework proposes five phases in the research process concerning physical activity and health (see Figure 1).

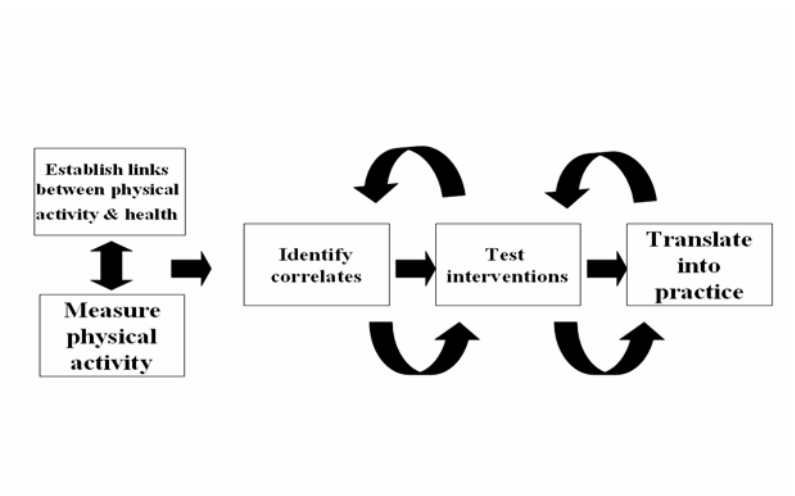


Figure 1: Behavioural epidemiological framework showing the five phases of the research process concerning physical activity and health.

According to this framework, it is first necessary to assess whether there are links between physical activity and health in young people, and this was the purpose of

Review One [3]. In addition, it is important to have the ability to measure the behaviour in question – physical activity. However, measurement of physical activity is challenging, especially in children. Measurement error plagues this field because without accurate measures of physical activity it will always be difficult to demonstrate strong associations with other variables, if they exist. Moreover, researchers will struggle to show intervention effects due to lack of measurement sensitivity. Typically, studies have utilised self-report tools and these are have varying levels of validity and reliability. They may be problematic with some children because physical activity for this age group is likely to be sporadic and they may find it difficult to accurately recall or quantify some types of activity (Welk, Corbin, & Dale, 2000).

Recent studies have used 'objective' measures of physical activity, such as accelerometers (Riddoch et al., 2007). These are likely to give more accurate estimates of volume of activity, but lack the ability to specify the type of activity, which may be important to answer some research questions. There is also debate about the best way to analyse such data, and this variability may lead to differing conclusions regarding the amount of physical activity thought to be undertaken by young people.

In the behavioural epidemiological framework, it is proposed that before interventions are planned and conducted there is a need to know what might be the key determinants, or correlates, of a behaviour, in this case physical activity. These correlates are then used to define target groups (e.g., adolescent girls) or become targets for change (e.g., increasing parental support for physical activity). Review Two examined the quantitative correlates of physical activity in young people and Review Three reviewed the qualitative evidence on barriers and facilitators to participation in physical activity by young people (see Section 1.2).

Having established the likely correlates of physical activity (see Figure 1), these might then be used as moderators or mediators in physical activity behaviour change interventions. Typically, these are controlled interventions prior to being rolled out into 'real-world' practices. These latter phases of the model can also inform earlier stages, hence the feedback loops shown. The current review specifically considers

[3] Physical Activity and Children, Review 1: Descriptive Epidemiology

the evidence for the effectiveness of interventions to increase physical activity and/or improve core skills in adolescent girls, defined as aged 11-18 years.

1.2. The importance of focusing on adolescent girls

The descriptive epidemiology review (Review One) made a clear link between physical activity and health outcomes in adolescents. Specifically, it was reported that physical activity has small but significant physical health benefits in young people, notably prevention of overweight and obesity and type II diabetes, and improvements in skeletal health. In addition, physical activity has moderate psychological health benefits for adolescents, particularly for self-esteem and depression.

According to current recommendations (Department of Health, 2004), adolescents should achieve a total of at least 60 minutes of at least moderate intensity physical activity each day. At least twice a week this should include activities to improve bone health, muscle strength and flexibility. Recent estimates suggest that, despite children being the most active segment of the population, while 62% of 11y old girls are estimated to be meeting this guideline, this drops to only 42% by aged 14y (Department of Health, 2004). Moreover, one of the most robust findings is that adolescent girls are less active than their male counterparts (Biddle, Gorely, & Stensel, 2004; Biddle, Whitehead, O'Donovan, & Nevill, 2005; Sallis, Prochaska, & Taylor, 2000).

From the review of five quantitative reviews, correlates were identified in the categories of demographic/biological, psychological, behavioural, social/cultural, and environmental. For demographic/biological correlates, evidence showed that there is an association between male gender and physical activity in young people (i.e., males are more active than females) and there is a negative association between age and physical activity in adolescence (i.e., physical activity declines with age during this period).

For psychological correlates, evidence showed that, for adolescent girls, there is an association between positive motivation and physical activity and between positive body image and physical activity. For behavioural correlates, evidence showed that there is an association between previous physical activity and current physical

activity in young people, and between sport participation and total physical activity, with a stronger level of association in adolescent girls than other young people. Moreover, there is a negative association between smoking and physical activity, and between sedentary behaviour at weekends and after school and physical activity in young people.

For social/cultural correlates, evidence showed that there is a strong association between parental and social support and physical activity in young people. For environmental correlates, evidence showed that there is a positive association between access to facilities and participation in physical activity, a negative association between distance from home to school and physical activity in young people, a positive association between time spent outside and physical activity, and there is a small negative association between local crime and physical activity in young people.

In the review of qualitative studies of correlates of physical activity, 15 studies addressed adolescent girls and were conducted in the UK. The review identified the main barriers to being physically active as:

1. social pressure to conform, (e.g. wanting to fit in)
2. negative experience of the school environment (e.g. inappropriate school PE kit and discomfort about sharing showers, changing rooms, etc),
3. negative experiences of sports facilities (e.g. public spaces such as gyms or exercise classes were intimidating to teenage girls)
4. having to perform in public (e.g. being forced to perform a skill in front of peers)
5. fear of forced competition
6. fear of sexual or racial harassment (e.g. Asian girls described needing escorting by family member to places to participate in sports).

The main facilitators to being physically active were:

7. social and family influences (e.g. social sanctioning of activities by peers provided opportunities to gain social standing and was likely to encourage continued or increased participation; having active siblings and supportive parents)

8. enjoyment (e.g. enjoyment and fun during sport and physical activity; enjoyment might outweigh the impact of negative peer pressure not to participate)
9. socialisation (e.g. sport provides the opportunity to socialise with a friend and extend friendship networks beyond school)
10. intrinsic and extrinsic rewards (e.g. wanting to participate in sport as a means to achieve a socially desirable body type; receiving praise and encouragement from PE teachers helped with self confidence and a positive self identity).

Internationally, young people are the focus of initiatives by many governments, particularly for obesity prevention (Fussenegger, Pietrobelli, & Widhalm, 2007). Moreover, in addition to recommendations in the UK (Biddle, Sallis, & Cavill, 1998; Department of Health, 2004), user-friendly materials promoting physical activity for young people are available in Canada[4], and the Australian Government has recently developed physical activity recommendations for children and young people[5]. The latter state that:

1. Children and young people should participate in at least 60 minutes (and up to several hours) of moderate- to vigorous-intensity physical activity every day.
2. Children and young people should not spend more than 2 hours a day using electronic media for entertainment (e.g., computer games, Internet, TV), particularly during daylight hours.

1.3. Policies and initiatives relevant to adolescent girls

Many agencies, including the government, schools, commercial organisations and charities are supporting the promotion and development of physical activity opportunities for young people. This section briefly outlines several of the key initiatives/policies in order to provide context for the current review.

[4] See http://www.phac-aspc.gc.ca/pau-uap/paguide/child_youth/index.html

[5] See http://www.healthyactive.gov.au/internet/healthyactive/publishing.nsf/Content/recommendations-guidelines

Choosing Activity: a physical activity action plan (Department of Health, 2005). The aim of this plan is to promote physical activity for all in accordance with the Chief Medical Officer's report (Department of Health, 2004). The physical activity action plan sets out a cross-government plan that identifies an extensive range of commitments which cumulatively seek to achieve a more active England. The action plan is linked to **Public Service Agreement** (PSA) targets, one of which seeks to increase the percentage of 5-16 year olds participating in at least 2 hours per week of high-quality PE and sport at school and the percentage of 5-19 year olds participating in at least 3 further hours per week of sporting opportunities.

For children and young people the goals of the action plan are to encourage activity in early years, schools, and further and higher education, and to extend the use of education facilities as a community resource for sport and physical activity, including out-of-hours use. Within the action plan there is reference to travel to school, the healthy schools programme, school sport, the Physical Education, School Sport, and Club Links (PESSCL) strategy, building community capacity for clubs, coaches and volunteers in community sport, and outdoor play.

Gameplan (Department for Culture Media and Sport, 2002) is a publication from the Government's Strategy Unit. One of its four recommendations was for a range of initiatives to promote grassroots participation (in particular for young people, women and older people), by tackling barriers to participation and failures in provision.

Non-Government initiatives are also common in England. For example:

- **Children's Play Council** has several initiatives including *Home Zones* (designing streets to make them more attractive to pedestrians and cyclists by introducing traffic calming, parking areas, benches and play areas); *The Neighbourhood Play Toolkit*, (a CD-ROM published in 2006 to support and increase access to good play opportunities for children and young people in their neighbourhoods); and *Play England* (a new 5-year project which aims for all children and young people in England to have regular access and opportunity for free, inclusive, local play provision and play space).
- **Youth Sport Trust** has developed the *TOP programmes* which are a series of linked and progressive schemes for young people aged 18 months to 18 years. Resource cards, child-friendly equipment and quality training and support for the teachers and deliverers are core elements to the TOP programmes.

- **British Heart Foundation** has a number of initiatives/resources including the *Healthy Schools Physical Activity Toolkit* which is linked to the National Healthy Schools Scheme.

Regarding **active travel**, all schools in England are expected to have School Travel Plans by March 2010 and a grant payment has been made to all state schools with an approved Travel Plan since 2003 (Department for Education and Skills/Department for Transport, 2003). Moreover, in November 2006, the Department for Transport announced a grant scheme to help fund Walking Bus schemes where schools could bid[6].

The Women's Sports & Fitness Foundation[7] in the UK is an organisation seeking to "to increase the health, fitness and well-being of women and girls by making physical activity an integral part of their lives, where physical activity is defined as sport and exercise." It works with sports policy and strategy-makers at national and regional levels to "make sport as appealing to women and girls as it is to men and boys; make women aware of the importance of being active; make fit and healthy women and girls social and cultural role models."

There are many other relevant policy documents referred to in the initial Public Health Programme Guidance Scope and readers are referred to this.

1.4. Objectives

This review addressed the following question:

- What interventions are effective in increasing levels of physical activity/core physical skills in adolescent girls aged 11-18 years of age?

[6] Department for Transport, (2006): http://www.dft.gov.uk/pgr/sustainable/schooltravel/grantsforwalkingbuses/ (accessed 14th October 2007)

[7] http://www.wsff.org.uk/

1.5. Review team

This review has been carried out by a team from the Public Health Collaborating Centre (CC) for Physical Activity[8]. The Collaborating Centre is an alliance between the British Heart Foundation Health Promotion Research Group (University of Oxford) and the British Heart Foundation National Centre for Physical Activity and Health (Loughborough University).

[8] Lead reviewer: Professor Stuart Biddle (Loughborough University). Collaborating Centre team members: Andrew Atkin (Loughborough University), Dr Charlie Foster, Nick Cavill (University of Oxford). The helpful input of Dr Trish Gorely (Loughborough University) is acknowledged.

2. Methodology

2.1. *Literature* Search

Literature searches were conducted using the terms and databases listed below. References were downloaded into a Reference Manager database (see Figure 2 for data).

2.1.1. Search terms

All search strategies were designed by the CC and NICE. Tailored search terms were used appropriate to a particular database. Search terms followed the same order of (1) physical activity terms, (2) child terms and (3) location terms. A full search for MEDLINE is presented in Appendix A. All searches were performed from January 1990 to the most recently published version of the database (usually August 2007).

2.1.2. Databases and other searches

Databases searched were: Cochrane Database of Systematic Reviews (CDSR), Database of Abstracts of Reviews of Effectiveness (DARE), Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, PsycINFO, CINAHL, HMIC, SPORTDiscus, ASSIA, SIGLE, Current Contents, ERIC, TRANSPORT, Environline, EPPI Centre Databases, NRR.

Reviews of intervention studies were also located and the reference lists searched (DeMattia, Lemont, & Meurer, 2006; Jago & Baranowski, 2004; Kahn et al., 2002; Lister-Sharp, Chapman, Stewart-Brown, & Sowden, 1999; Micucci, Thomas, & Vohra, 2002; Ogilvie et al., 2007; Reilly & McDowell, 2003; Salmon, Booth, Phongsavan, Murphy, & Timperio, 2007; Stone, McKenzie, Welk, & Booth, 1998; Thomas, Ciliska, Micucci, Wilson-Abra, & Dobbins, 2004; Timperio, Salmon, & Ball, 2004; van Sluijs, McMinn, & Griffin, 2007; Wareham, Van Sluijs, & Ekelund, 2005).

2.2. Selection of studies for inclusion

After the initial screening (see Figure 2) 250 titles and abstracts were assessed for relevance against the following inclusion criteria:

- Is the study an **intervention study**?
- Is the age group studied **aged 11-18 years**?
- Is the study population **female**?
- Is an outcome reported on **physical activity behaviour** or **core physical skills?**

Consistency of screening was assessed by another researcher checking relevance on a 10% sample with no discrepancies found. In total 153 titles (including 28 studies identified from other sources) were assessed to be potentially relevant and the full papers retrieved. These were checked by one person, against the above inclusion/exclusion criteria. In addition, studies were excluded, based on the agreed project scope, if:

- They had a main focus on treating obesity
- They were from less economically developed countries or they were studies primarily investigating ethnic groups that do not have large populations in England (labelled inappropriate population in Figure 2)
- The intervention involved primarily school physical education lessons
- The study involved a change to the built or natural environment (and thus had been covered in NICE guidance on the environment and physical activity) or was more appropriate for one of the other four reviews in this series (e.g., active travel).

Another researcher checked 10% of the titles against the inclusion/exclusion criteria. In addition, this researcher independently assessed any full papers where there was uncertainty. Any discrepancies were resolved by a third reviewer (1 study). Twelve studies were accepted for full data extraction (see Evidence Tables) and 141 were rejected (see Appendix B). See Figure 2 for flow diagram of the study selection procedure.

Studies varied in scale from 57 to 1,040 female participants. The studies were conducted singly or in combination in schools, primary health care, or in unspecified settings, targeting physical activity alone or in combination with other health behaviours. Moreover, interventions used mediated, counselling, and educational approaches. Of the two outcomes under investigation (physical activity and core

physical skills/physical literacy), studies were only located for physical activity. Studies were conducted in the USA (n=6), the UK (n=2), other European (non-UK) countries (n=3), and Australia (n=1).

Eight interventions studied girls aged 11-13y, with four studying adolescents 14y or older. The measurement of physical activity involved objective assessment only (n=1), validated self-reported assessment only (n=4), self-reported assessment of unknown validity (n=5), and a combination of objective and validated self-report measures (n=2). Time from baseline to follow-up measurement varied from being immediately at the conclusion of the intervention to 2 years. Of the 12 studies, six investigated girls only, three of which targeted less active girls, and six investigated boys and girls.

2.2.1. Included studies

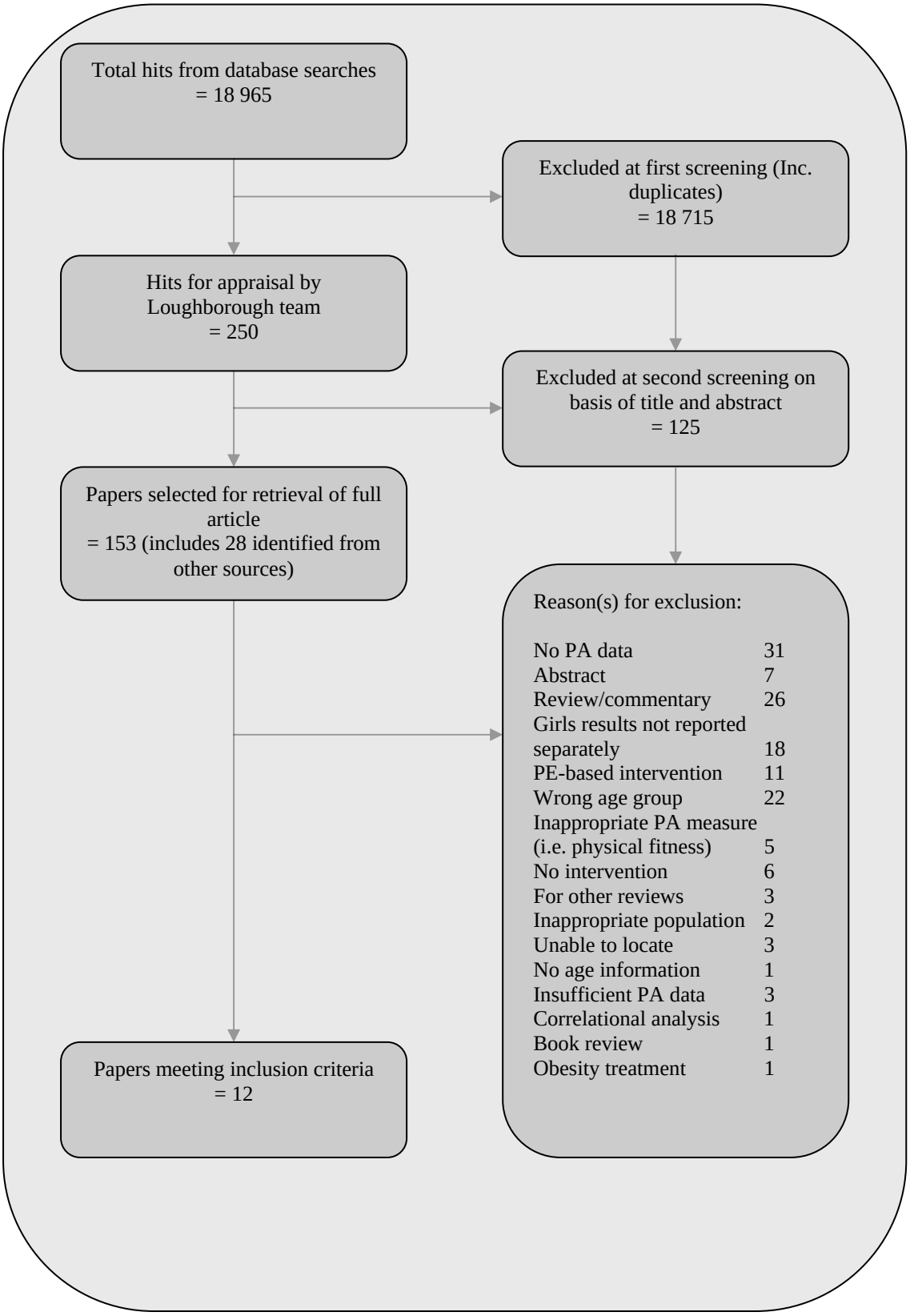
See Evidence Tables.

The main reasons for exclusion of studies were (a) wrong age group (b) not an intervention study or (c) no physical activity or core physical skills data presented (Appendix B).

2.3. Study type and quality *appraisal*

Each study was categorised by research design, as shown in Table 1. Studies were graded using a code '++', '+' or '-', based on the extent to which the potential sources of bias had been minimised. The included studies were quality assessed independently by two reviewers using the design specific quality assessment tools in Appendix A of the NICE manual (National Institute for Health and Clinical Excellence, 2006). Any discrepancies were resolved through discussion.

Figure 2. Flow diagram of study selection.



Grading criteria were:

++ **All or most** of the criteria have been fulfilled. Where they have not been fulfilled the conclusions are thought very unlikely to alter.

+ **Some** of the criteria have been fulfilled. Those criteria that have not been fulfilled or not adequately described are thought unlikely to alter the conclusions.

- **Few or no** criteria have been fulfilled. The conclusions of the study are thought likely or very likely to alter.

Table 1: Classification of research designs and summary quality assessment

Design	Abbreviation	Randomisation?		Control group?	Quality assessment and number of studies		
		By individual	By group		-	+	++
Randomised controlled trial	RCT	✓	X	✓			2
Cluster randomised controlled trial	CRCT	X	✓	✓		5	
Controlled non-randomised trial	CNRT	X	X	✓	4		
Randomised non-controlled trial[9]	RNCT	✓	X	X		1	

[9] Two interventions groups compared, therefore one might be considered a 'comparison' group.

Table 2 summarises study quality and outcomes. The main reason for studies being assessed as low quality [-] was the use of a measure of physical activity of unknown reliability and validity.

Table 2: Study type and quality.

Study Type	Authors	Study Quality	Physical activity change?
RCT	Prochaska & Sallis (2004)	++	No change
	Patrick et al. (2006)	++	No change
CRCT	Simon et al. (2004)	+	Positive
	Schofield et al. (2005)	+	Positive
	Haerens et al. (2006)	+	No change
	Murphy et al. (2006)	+	Positive
	Robbins et al. (2006)	+	No change
CNRT	Baxter et al. (1997)	-	No change
	Metzker (1999)	-	Positive
	Moon et al. (1999)	-	No change
	Winett et al. (1999)	-	Positive
RNCT	Marks et al. (2006)	+	Positive

2.4. *Description of studies*

The review sought to answer the research question of 'what interventions are effective in increasing levels of physical activity/core physical skills in adolescent girls aged 11-18 years of age?' No studies were located concerning core physical skills, therefore only interventions addressing increasing levels of physical activity are now considered.

The key characteristics and findings from each study are summarised in Evidence Tables (Section 12). The overall effectiveness of interventions is mixed, with 6 studies showing positive effects and 6 showing no intervention effects. Factors moderating these findings therefore need investigation, and key potential moderators are shown in Evidence Table two. Moreover, to guide readers towards possible practical implications of the findings, the 12 studies are presented under the following main, but overlapping, categories based on a) location (school and primary health care) and b) nature of the intervention (single v multiple behaviour, mediated, counselling, educational):

- School-based (single-behaviour) interventions (n=6)[10]

- School-based (multiple behaviour) interventions (n=5)[10]
- Primary health care intervention (n=1)
- Mediated interventions (n=6)
- Counselling interventions (n=3)
- Educational interventions (n=5)

2.5 Assessing applicability

Each study was assessed on its external validity: that is, whether or not it was directly applicable to the target population(s) and setting(s) in the scope. This assessment took into account whether the study was conducted in the UK, and any barriers identified by studies or the review team (NICE 2006).

2.6 Synthesis

It was not appropriate to use meta-analysis to synthesise the outcome data as interventions, methods and outcomes were heterogeneous. This review is restricted to a narrative overview of all studies that met the inclusion criteria and contained sufficient data for data extraction and quality assessment. The effects of physical activity studies and core physical skills studies were examined by setting and nature of the intervention, stratified by study quality. The evidence statements were developed using NICE criteria (NICE 2006) outlined below:

- The best available evidence
- The strength (quality and quantity) of supporting evidence and its applicability to the populations and settings in question
- The consistency and direction of the evidence.

It is noted that for some intervention settings contained within this review only one or two studies met the inclusion and quality criteria. Evidence statements were drafted for these sections but caution should be taken in generalising due to this limitation. This review did not produce any evidence statements based upon any cost-effectiveness data which will be considered in the economic review.

[10] One study (Prochaska & Sallis, 2004) tested both single-behaviour and multiple-behaviour interventions, and therefore is included in both classifications.

3. School-based (single-behaviour) interventions – summary of findings

3.1. Overall summary of studies identified

Five studies derived data from school, non-physical education curricula, settings for the targeting of physical activity only (Metzker, 1999; Murphy, Dhuinn, Browne, & ORathaille, 2006; Robbins, Gretebeck, Kazanis, & Pender, 2006; Schofield, Mummery, & Schofield, 2005; Simon et al., 2004), with an additional study testing the effectiveness of targeting physical activity alone versus physical activity and nutrition (J. J. Prochaska & Sallis, 2004). Various strategies were used across the six interventions, including counselling (Metzker, 1999), education (Murphy, Dhuinn, Browne, & ORathaille, 2006), mediated and counselling approaches combined (J. J. Prochaska & Sallis, 2004; Robbins, Gretebeck, Kazanis, & Pender, 2006), and self-monitoring involving pedometers (Schofield, Mummery, & Schofield, 2005). Four of the six studies showed positive physical activity effects and all but one study (Metzker, 1999) had a positive research grading. Four of the studies targeted girls only, and all studies were conducted outside of the UK.

3.2. Evidence of efficacy

Murphy et al. [CRCT +] allocated Irish adolescent girls, aged 16 years, to either a teacher-led physical activity (TLPA), self-led physical activity (SLPA), or control group. Although the primary outcome was bone health, the intervention sought to increase 'osteogenic' [11] physical activity, and physical activity was assessed using a diary. Intervention groups involved direct instruction (TLPA) or advice (SLPA). The TLPA condition involved two 60m activity sessions per week led by a qualified physical education teacher, with participants also encouraged to undertake at least two further sessions per week of appropriate physical activity. The SLPA condition asked participants to undertake 3-4 activity sessions weekly of between 20-90 minutes each.

Although the reporting of physical activity data was not detailed, with no data for the control group reported, the authors concluded that the TLPA group engaged in 4.5 h

[11] Physical activity suitable for bone health, usually including weight bearing activities.

per week of activity whereas the SLPA group engaged in only 3.4 h per week. Our own calculation of effect size strongly favoured the TLPA group (Cohen's d Effect Size = 2.75). However, the measure of activity was weak with only limited information provided, although changes in activity by the intervention groups were mirrored in increases in aerobic fitness.

Schofield et al. [CRCT +]. tested whether pre-selected 15 year-old low active adolescent girls in Australia could increase their physical activity through self-monitoring focusing on either step counts (pedometer) or time (minutes). All participants were assessed using a pedometer and self-reported physical activity, the latter using the 3-Day Physical Activity Recall (3DPAR). The step group received pedometers and were encouraged to increase their daily step count by 1000-2000 steps until they reached 10,000 steps per day. However, it is unclear whether the pedometer step counts were available to the participants throughout the study or were blinded after baseline. The time-based group were encouraged to increase their daily activity by 10-15 min until they reached 30-60 min per day. With baseline differences in activity, analyses were conducted that controlled for baseline values.

Both groups became more active, as assessed pedometer counts, at mid-intervention (6 w) and post-intervention (12 w). At 6 w, there was a positive effect for the pedometer intervention group (+24.5%) over the time-based group (+18.5%; effect size [ES]=1.17; 'large'), with the control group showing a small increase in step counts (+7.4%).

At 12 w, the pedometer intervention group (+36.6% from baseline) was superior to the time-based group (+34.5%; pedometer v time effect size [ES]=0.91; 'large'), with the latter showing no difference to the control group (+1.9%). Although increases across groups at 12 w, when controlling for baselines values, were reported as small (ES=0.13), the pedometer group did differ from controls after 12 w (ES=0.68), with the effect being moderate in magnitude. However, neither self-reported activity (p=0.94) nor BMI (p=0.32) showed any significant change.

Simon et al. [CRCT +] evaluated the 6-month impact of a 4-year multi-level intervention on physical activity in 11 year old French adolescent boys and girls. Four schools were randomised to the intervention condition (n=475) and four to the control (n=479). Psychological (knowledge, attitudes, beliefs and motivation), social (social support), and environmental (physical, structural and institutional) factors were

targeted. In particular, new opportunities were provided during school (e.g., break times) and after school for extra physical activity, with attention being paid to reducing barriers. Physical activity was assessed using a self-report questionnaire yielding weekly frequency and duration of "leisure-organised physical activity" (LOPA). Time in sedentary activities (TV and computer games) was also assessed.

Data only for the first 6 months were reported. After correcting for baseline values of age, overweight, and parental socio-occupational status, LOPA significantly increased from 59-83% among intervention girls compared to controls (48% to 50%; OR=3.38 p<0.01). Follow-up LOPA was associated with improvements in self-efficacy and intentions to be active. There was a significant reduction of high sedentary (screen-based) behaviour among intervention girls from 24% to 17% (OR=0.54; p<0.0001).

Robbins et al. [CRCT +] targeted low active 11-13 year old American girls in schools and used a computer-mediated approach[12], as well as counselling, to increase physical activity. Tailored feedback and nurse counselling was received over 12 weeks by the intervention group (n=45) based on their computerised assessment of their current activity status, while a control group received activity guidelines only. Support materials were also provided to parents of girls in the intervention group and follow-up phone calls were made to the intervention girls. Physical activity was assessed using the 'Child and Adolescent Activity Log' (CAAL), a diary approach requiring the recall of moderate-to-vigorous activities over the past 4 days (2 weekdays and one whole weekend). A measure of stage of change was also used, with participation on 5 days/week as the criterion level for the action stage.

No intervention effects were found on any of the physical activity variables, although the authors report no inferential statistics. Specifically, there was no difference in change scores across the 12 w between the groups and values for the number of days of activity were similar between intervention and control girls (ES=-0.06). However, it should be noted that both groups increased their physical activity, with number of days per week of activity increasing by 32.6% in the intervention group

[12] Computer-mediated refers to the intervention being delivered via computer. Other 'mediated' approaches might include delivery via print material or text message.

and by 42.7% in the control group. This trend was reflected in analyses of other physical activity data derived from the CAAL.

Metzker [CNRT -] was a PhD thesis reporting a non-randomised controlled design with 57 American adolescent girls, aged 15 years, and tested the effectiveness of an 8-week stage-based counselling on physical activity. Specifically, girls in the intervention group were counselled every week concerning their physical activity, with content based on the processes (strategies) of change from the Transtheoretical Model of Behaviour Change that were deemed appropriate for their stage of change (J. O. Prochaska & Marcus, 1994; J. O. Prochaska, Norcross, & DiClemente, 1994). Counselling was delivered by the female PhD researcher in sessions of 5-10 minutes each in small groups. Physical activity was assessed using an unpublished 24-h recall method, and stage of change was used using a validated tool developed by Marcus et al. (1992).

A significant effect was reported over the 8w trial showing the intervention group increasing their physical activity while a small decline was shown in the control group. Comparison of intervention and control group means, unadjusted for baseline values, showed a large effect (ES=0.93). Forward stage movement was also more likely in the intervention group.

The study may have been underpowered. There were no concomitant changes in 10 determinants of physical activity, while 6 of 19 (32%) barriers were perceived to be reduced by the intervention group.

Prochaska and Sallis [RCT ++] was a small, but well designed, intervention with American adolescents, aged 12 years, testing the effectiveness of promoting physical activity alone (PA; n=29) versus physical activity and nutrition in combination (PAN; n=28) over a 3-month period. Accelerometers were used to measure physical activity.

Using a modification of the PACE+[13] methodology originally designed for primary health care settings (Patrick et al., 2001; J. J. Prochaska, Zabinski, Calfas, Sallis, & Patrick, 2000), the intervention groups received computerised assessment and

[13] PACE+: “Patient-centered Assessment and Counselling for Exercise + Nutrition”.

tailored feedback, via a single counselling session of 30 minutes, to create individualised plans for behaviour change. Results showed a non-significant decline in physical activity for the PA group (-14 mins/d) (time x group interaction p=0.72). No detailed statistics were provided for girls, but graphic representation suggested that the PA and control groups showed very similar trends. It is possible the study may have been underpowered to detect differences by gender.

3.3. Applicability

All six studies were conducted outside of the UK and are therefore applicable only to the populations or settings included in the studies. The success of broader application is uncertain.

3.4. Implementability

All of the studies can be implemented in the UK with suitable resources.

School-based (single-behaviour) interventions: Evidence statement

There is evidence from three cluster randomised controlled trails, one each in Australia (Schofield et al., 2005 [+]), France (Simon et al., 2004 [+]), and Ireland (Murphy et al., 2006 [+]), and one controlled non-randomised trial in the USA (Metzker, 1999 [-]), that school-based interventions, outside of physical education lessons, targeting the single behaviour of physical activity, can lead to moderate-to-large increases in physical activity in adolescent girls for up to 6 months. One randomised controlled trail (J.J. Prochaska & Sallis, 2004 [++]) and one cluster randomised controlled trail (Robbins et al., 2006 [+], both from the USA, failed to show an effect. Characteristics of successful interventions were not consistent across studies, although three of the four successful trials targeted girls only. Successful interventions included self-monitoring techniques, stage-matched counselling, teacher-led extra-curricula physical activity, and multi-level programming targeting psychological, social and environmental correlates.

The evidence is drawn from non-UK studies and therefore the applicability to the UK is limited.

4. School-based (multiple-behaviour) interventions

4.1. Overall summary of studies identified

Five studies derived data from school, non-physical education curricula, settings where multiple health behaviours were targeted, that is physical activity and at least one other health behaviour, such as nutrition (Baxter et al., 1997; Haerens et al., 2006; Moon et al., 1999; J. J. Prochaska & Sallis, 2004; Winett et al., 1999). Various strategies were used, including education (Moon et al., 1999), mediated and educational approaches combined (Winett et al., 1999), mediated and environmental approaches combined (Haerens et al., 2006), mediated approaches alone (J. J. Prochaska & Sallis, 2004), and broad-based education and policy initiatives combined (Baxter et al., 1997). In four of the five studies, no effects were found for physical activity. The two strongest designs showed no effect (Haerens et al., 2006; J. J. Prochaska & Sallis, 2004), while three of the five studies were rated as weak designs. Only one of the studies targeted girls only (Winett et al., 1999), and two studies were conducted in the UK (Baxter et al., 1997; Moon et al., 1999).

4.2. Evidence of efficacy

Prochaska and Sallis [RCT ++] was described above and tested the effectiveness of promoting physical activity alone versus physical activity and nutrition in combination (PAN). Results showed a decline in physical activity for the PAN group (-9 mins/d), with no significant effect (time x group interaction p=0.72). No detailed statistics were provided for girls, but graphic representation suggested that the decline in physical activity for the PAN group was less than for the control group. It is possible the study may have been underpowered to detect differences by gender.

Haerens et al. [CRCT +] conducted an intervention with 1,040 13-year old Belgian adolescents whereby physical activity and nutritional behaviours were targeted. The intervention combined mediated and environmental approaches. Specifically, the participants in the intervention groups received either the intervention plus parental involvement, or the intervention alone. The intervention consisted of a fitness test plus computer tailored advice. The parental arm comprised educational input to enable parents to create a supportive home environment for physical activity and/or nutrition. For both intervention groups, schools were also encouraged to create a

more supportive environment, such as through provision of breaks and support materials. Flemish Physical Activity Questionnaire (FPAQ) assessed leisure-time physical activity (LTPA), with subgroup (n=77) accelerometer data on light PA and MVPA .

For self-reported LTPA, there was no effect for the intervention over 1 or 2 years. Both intervention (+19.2%) and control (+25.5%) groups increased LTPA over 2 years, with no difference between groups (ES= -0.02). For accelerometry data obtained with a sub-sample, there was a significant 2y effect for light activity with the intervention group remaining stable (-0.02%) and control group decreasing (-17%). The intervention effect for this was 'moderate' at 2y (ES=0.43) and 1y (ES=0.49). Both intervention (+21%) and control (+22.5%) groups increased accelerometer-assessed MVPA over 2 years, with no difference between groups at 2y (ES= 0.12) but a small effect after 1y in favour of the intervention group (ES=0.35).

Winett et al. [CNRT -] tested the effectiveness of an educational package delivered via the internet over a 3-week period with 14-15 year old American adolescent girls (n=180). The focus of the educational material was on physical activity and nutrition. Using self-reported frequency of 'aerobic conditioning activity', expressed as days per week, as their measure of physical activity, results showed that there was greater physical activity at follow up for the intervention (+21%) compared to the control group (-5.3%), when controlling for baseline values ($p<0.05$). However, the measure of activity was vague and of unknown validity. This is the only school-based intervention targeting multiple health behaviours that showed a positive effect for physical activity.

Baxter et al. [CNRT -] reported the results of a broad-based intervention in the UK targeting lifestyle risk factors for CHD. The intervention components were largely school based, with some wider community elements including publicity and policies. The former comprised educational and policy initiatives such as educational materials, peer-led projects, and school policies. However, the intervention is poorly described. Using a self-report measure of unknown validity, results show a 2% decline in physical activity for girls in the intervention schools (n=229) compared to a 7% decline for those in the control schools (n=108). Other health behaviours showed mixed results with positive changes in diet but negative changes in smoking.

Moon et al. [CNRT -] test the effectiveness of a 'Healthy Schools Award' scheme in the UK. This education-based scheme addresses multiple health behaviours, including physical activity, nutrition, smoking and other behaviours. Each area has a policy target that schools try to address. Physical activity in this study was operationally defined as 'taking part in sports once or more per week' and excluded curriculum physical education. Clearly this is a very weak measure of physical activity. Results showed that sports participation declined for girls at year 8 (age ~12 y), by 7.5% in the intervention schools compared with 10.7% in controls, while there was a very small improvement in year 11 (age ~15 y) for the intervention group girls (+4.3%), and controls (+1.1%). However, visual inspection of a graph showed overlapping 95% confidence intervals, suggesting no significant behaviour change between intervention and control schools.

4.3. Applicability

Two of the studies were conducted in the UK and therefore provide directly applicable evidence.

4.4. Implementability

All of the studies can be implemented in the UK with suitable resources.

School-based (multiple behaviour) interventions: Evidence statement

There is evidence from one randomised controlled trial in the USA (Prochaska & Sallis, 2004 [++]); one cluster randomised controlled trial in Belgium (Haerens et al., 2006 [+]); and two controlled non-randomised trials in the UK (Baxter et al., 1997; Moon et al., 1999; both [-]) that school-based interventions, outside of physical education lessons, targeting multiple health behaviours, including physical activity, do not lead to increases in physical activity in adolescent girls. Characteristics of these interventions included targeting younger boys and girls (<14 y), and those with a range of activity levels with strategies that included education, mediated approaches, and broad-based education and policy initiatives.

Only one [-] quality study reported a beneficial effect. This was a controlled non-randomised trial in the USA (Winett et al., 1999 [-]). Characteristics of this study included educational material delivered via the internet to older girls only.

The evidence is drawn from UK and non-UK studies and therefore the applicability to the UK is moderate.

5. Primary health care intervention

5.1. Evidence of efficacy

Patrick et al. [RCT ++] was the only intervention study meeting inclusion criteria that took place in a primary health care environment in the USA. The intervention targeted boys and girls (n=438) aged 12 y. The intervention, located in private health clinics in California, used the PACE+ protocol and had two components. First, the participants undertook a computerised assessment of their physical activity and nutritional status, including stage of change. Physical activity was assessed using self-reported 7-day recall, with a sub-sample assessed using accelerometers (n=180). Participants then received tailored feedback and behavioural planning, through brief counselling. In addition, the intervention participants received a guidance booklet at home supported by telephone counselling. The control participants received a sun protection programme.

Results showed that the intervention was not effective in changing objective measures of physical activity in the intervention group (p=0.80). Similarly, self-report measures of physical activity in the intervention group (+2.7%) did not differ from controls at post-intervention. There was a significant reduction in sedentary behaviour for the PACE+ intervention (-21%) over controls (+4.8%). Small between-group differences were evident post-intervention (ES= -0.32), with greater sedentary behaviour for controls.

5.2. Applicability

The one study was conducted outside of the UK and is therefore applicable only to the population and setting included. The success of broader application is uncertain.

5.3. Implementability

The study can be implemented in the UK with suitable resources.

Primary health care intervention: Evidence statement

There is evidence from one randomised controlled trial in the USA (Patrick et al. 2006 [++]) that a primary health care intervention designed to increase physical activity in adolescent girls which included targeting physical activity and nutrition through computer-mediated and counselling approaches with younger adolescent boys and girls was not successful.

The evidence is drawn from a non-UK study and therefore the applicability to the UK is limited.

6. Mediated interventions

6.1. Overall summary of studies identified

This category describes interventions that are delivered via a medium such as computer, phone or printed materials. Six interventions used mediated approaches, with five of the studies already reported above (Haerens et al., 2006; Patrick et al., 2006; J. J. Prochaska & Sallis, 2004; Robbins, Gretebeck, Kazanis, & Pender, 2006; Winett et al., 1999). In addition, an intervention was conducted by Marks et al. (2006).

Considering all six mediated interventions, only the interventions by Marks et al. and Winett et al. showed positive behaviour change, both targeting girls only, but one targeted multiple behaviours while the other just physical activity. Both were of short duration (2-3 weeks).

6.2. Evidence of efficacy

Marks et al. [RNCT +] tested the effectiveness of web versus similar print material on physical activity with American adolescent girls. Although participants were recruited via schools, the intervention materials were mailed to them at home. Therefore, this study has been classified separately from the school-based studies reported above. The website material was modified from the 'LifeBytes' website developed as part of the 'Wired for Health' project of the UK government's Departments of Health and Education & Skills[14]. Comparable material was also provided in print format for the print-only condition. The participants were instructed to view the materials at least four times over a 2-week period. Physical activity was assessed using the Centres for Disease Control (CDC) Youth Risk Behaviour Surveillance System Survey, which requests self-reporting of a range of activities over the past 7 days.

Results showed no between-group effect for physical activity post-intervention, but the print group did show a significant within-group increase in activity (means not provided; p=.002). Sub-group analysis of low active girls showed an increase in

[14] www.lifebytes.gov.uk/phys/phys_menu.html

moderate intensity physical activity for both web (p<.001) and print (p<.001) groups, but with a larger increase for the print group (p=.04). No follow-up was conducted to test for effectiveness over time. Intentions to be active and self-efficacy for physical activity increased in both groups.

6.3. Applicability

All six studies were conducted outside of the UK and are therefore applicable only to the populations or settings included in the studies. The success of broader application is uncertain.

6.4. Implementability

All of the studies can be implemented in the UK with suitable resources.

Mediated interventions: Evidence statement

There is evidence from two randomised controlled trials in the USA (Patrick et al., 2006 [++]; Prochaska & Sallis, 2004 [++]) and two cluster randomised controlled trials, one in the USA (Robbins et al., 2006 [+]), and one in Belgium (Haerens et al., 2006 [+]), that interventions delivered via a medium such as computer, phone or printed materials do not lead to increases in physical activity in adolescent girls.

However, there is evidence from one cluster randomised controlled trial in the USA (Marks et al., 2006 [+]) and one randomised non-controlled trial in the USA (Winett et al., 1999 [-]) that mediated interventions can lead to increases in physical activity in adolescent girls. A characteristic of these interventions is that they included younger girls (aged < 15 y).

The evidence is drawn from non-UK studies and therefore the applicability to the UK is limited.

7. Counselling interventions

7.1. Overall summary of studies identified

Three of the studies reviewed above used counselling as a tool for behaviour change (Metzker, 1999; Patrick et al., 2006; Robbins, Gretebeck, Kazanis, & Pender, 2006). Only Metzker found positive changes in physical activity but that was a study with a low research quality rating. Patrick et al. used primary care 'providers' [15] to counsel adolescents for only 3-5 mins face-to-face, with follow-up telephone counselling over the next year. Robbins et al. provided counselling through school nurses. A 10 min session was conducted after completion of a mediated computer-based intervention. Metzker provided physical activity counselling in a school setting. Sessions were face-to-face individually or in small groups and were based on the processes of change from the Transtheoretical Model, as well as determinants of, and barriers to, physical activity. Each session lasted 5-10 mins.

7.2. Evidence of efficacy

A brief summary of previously reported results is now presented. Metzker tested the effectiveness of an 8-week stage-based counselling on physical activity. A significant effect was reported over the 8w trial showing the intervention group increasing their physical activity while a small decline was shown in the control group. Comparison of intervention and control group means, unadjusted for baseline values, showed a large effect (ES=0.93). Forward stage movement was also more likely in the intervention group.

Patrick et al. targeted boys and girls in private health clinics The participants undertook a computerised assessment of their physical activity and received tailored feedback and behavioural planning, through brief counselling. In addition, the intervention participants received a guidance booklet at home supported by telephone counselling. Results showed that the intervention was not effective in changing objective measures of physical activity in the intervention group (p=0.80). Similarly, self-report measures of physical activity in the intervention group (+2.7%) did not differ from controls at post-intervention.

[15] The term 'providers' was not clearly defined but is likely to involve primary health care nurses.

Robbins et al. targeted low active girls and used counselling and a computer-mediated approach to increase physical activity. Tailored feedback and nurse counselling was received over 12 weeks by the intervention group based on their computerised assessment of their current activity status. No intervention effects were found on any of the physical activity variables. However, it should be noted that both groups increased their physical activity, with number of days per week of activity increasing by 32.6% in the intervention group and by 42.7% in the control group. This trend was reflected in analyses of other self-reported physical activity data.

7.3. Applicability

All three studies were conducted outside of the UK and are therefore applicable only to the populations or settings included in the studies. The success of broader application is uncertain.

7.4. Implementability

All of the studies can be implemented in the UK with suitable resources.

Counselling interventions: Evidence statement

There is evidence from a randomised controlled trail in the USA (Patrick et al., 2006 [++]) and a cluster randomised controlled trail in the USA (Robbins et al., 2006 [+]), that counselling interventions do not lead to changes in physical activity in adolescent girls. A characteristic of these interventions is that they included younger girls (<15 y).

There is evidence from one controlled non-randomised trial in the USA (Metzker, 1999 [-]), that a counselling intervention can lead to an increase in physical activity in adolescent girls. A characteristic of this intervention is that it is was short (8 weeks) and included older girls (>14 y) only.

The evidence is drawn from non-UK studies and therefore the applicability to the UK is limited.

8. Educational interventions

8.1. Overall summary of studies identified

Five of the studies reviewed in other categories above used education as a tool for behaviour change. Three of the studies showed positive changes in physical activity (Murphy, Dhuinn, Browne, & ORathaille, 2006; Simon et al., 2004; Winett et al., 1999), with two of these studies being of good research quality (Murphy et al. and Simon et al.). The two studies not showing an effect for the intervention were both of low quality (Baxter et al., 1997; Moon et al., 1999).

8.2. Evidence of efficacy

Murphy et al. showed effects for teacher-led physical activity over self-led. The positive effects of the teacher-led intervention may have been due to the greater interaction and educational opportunities afforded in such a context. Winett et al. provided an educational package via the internet. Positive changes in physical activity were achieved. Simon et al. provided a more complex educational intervention through individual, social and environmental strategies in school. Positive changes in physical activity were found.

Neither Baxter et al. nor Moon et al. were able to demonstrate changes in physical activity. Baxter et al. reported the results of a broad-based educational intervention in the UK targeting lifestyle risk factors for CHD while Moon et al. used an education-based scheme to address multiple health behaviour change, also in the UK.

8.3. Applicability

Two of the studies were conducted in the UK and therefore provide directly applicable evidence. Three studies were conducted outside of the UK and are therefore applicable only to the populations or settings included in the studies. The success of broader application is uncertain.

8.4. Implementability

All of the studies can be implemented in the UK with suitable resources.

Educational interventions: Evidence statement

There is evidence from one controlled non-randomised trial in the USA (Winett et al., 1999 [-]), and two cluster randomised controlled trials, one in Ireland (Murphy et al., 2006 [+]) and one in France (Simon et al., 2004 [+]), that educational interventions can increase levels of physical activity in adolescent girls for up to 6 months. These interventions took place in schools but other characteristics were non-consistent across interventions.

There is evidence from two controlled non-randomised trials in the UK (Baxter et al., 1997; Moon et al., 1999 [both -]) that educational interventions do not lead to increases in physical activity in adolescent girls. These interventions took place in schools, targeted physical activity alongside other health behaviours in younger girls (<15 y), and assessed physical activity with a self-report instrument on unknown validity.

The evidence is drawn from UK and non-UK studies and therefore the applicability to the UK is moderate.

9. Focused questions

9.1. What non-curriculum physical activity interventions or programmes in a school setting produce an increase in physical activity in girls aged eleven to eighteen who do less than the recommended level of physical activity?

Three school-based interventions targeted low active adolescent girls (Murphy, Dhuinn, Browne, & ORathaille, 2006; Robbins, Gretebeck, Kazanis, & Pender, 2006; Schofield, Mummery, & Schofield, 2005), with two studies showing a positive effect for older girls (>14 y) using either a teacher-led or a pedometer based sefl-monitoring intervention. The unsuccessful intervention used a mediated and counselling approach. Evidence suggests that non-curriculum interventions in a school setting for adolescent girls who do less than the recommended level of physical activity can be effective.

9.2. Are physical activity interventions or programmes more effective at increasing participation by girls aged 11-18 if they are delivered to girls only rather than a mixed gender group?

Six studies targeted physical activity behaviour change by intervening with girls only. Five of these studies showed positive effects. Of the six studies targeting boys and girls together in the same intervention, five did not show increases in physical activity. Targeting girls only, rather than boys and girls together, may be an effective strategy for increasing physical activity.

9.3. Does organising recreational physical activity around groups of friends rather than groups of similar ability increase levels of physical activity in girls aged 11-18?

No evidence.

9.4. Does providing non-competitive recreational physical activities such as dance and aerobics alongside more traditional activities in a school setting increase physical activity in those girls aged 11-18 who would normally not take part?

No evidence.

9.5. Do reward structures that focus on individual improvement and participation increase participation and enjoyment of organised physical activity in girls aged 11-18?

No evidence.

9.6. Does providing opportunities to participate in physical activities out of normal school hours increase levels of physical activity in girls aged 11-18?

No evidence.

9.7. What mass media and information campaigns or strategies are effective in increasing positive attitudes towards participation in physical activity among girls aged 11-18?

No evidence.

10. Additional Research Questions

In addition to the classification of studies provided above, there are other research questions that should be addressed. Most of these involve testing for moderation effects and are summarised in Tables 3 and 4. Moderators are variables for which outcomes may differ, such as age or study design. For example, an intervention may increase physical activity for adolescent girls over 14 years of age but not girls younger that this. If so, age is acting as a moderating variable.

10.1. Is the effectiveness of physical activity behaviour change moderated by research quality?

There are 6 interventions showing positive physical activity behaviour change and 6 showing no effect (see Evidence Tables). Of the 6 showing an effect, four are of good quality (+), and two are of low quality (-).Of the 6 showing no effect, two are of high quality (++), two are of good quality (+), and two are of low quality (-). Therefore, it is inconclusive whether the effectiveness of physical activity behaviour change is moderated by research quality.

10.2. Is the effectiveness of physical activity behaviour change moderated by the way physical activity is measured?

Of the six studies showing positive effects for physical activity, one assessed physical activity using an objective measurement tool, two used validated self-report instruments, and three used self-reports of unknown validity. Of the six studies not showing intervention effects, two used an objective measurement tool, two used validated self-report instruments, and two used self-reports of unknown validity. On balance, although the two best designed studies used objective measures of physical activity and found no effect, the evidence concerning the role of physical activity measurement is inconclusive.

10.3. Is physical activity behaviour change moderated by age?

Most of the interventions studied younger adolescent girls (under 14 y). Of these 8 studies, six showed no effect for the intervention. Conversely, all four of the studies targeting girls 14-18y showed positive effects. Therefore, age appears to moderate intervention effectiveness in favour of older adolescent girls.

10.4. Are tailored interventions more effective than non-tailored?

Four studies tailored their intervention to match the participant's stage of readiness of physical activity. Only one of the studies was shown to be effective and this was a weak research design. We conclude that interventions tailored to the individual's stage of readiness, based on the Transtheoretical Model, are not effective in increasing physical activity levels of adolescent girls.

Moderators of intervention effectiveness: Summary

All 12 studies provided evidence concerning the factors affecting intervention success for increasing physical activity in adolescent girls. The evidence suggests that achieving successful behaviour change for physical activity in adolescent girls is more likely if the intervention targets girls alone rather than boys and girls together, and is targeted at older adolescent girls. It is inconclusive whether intervention effectiveness is moderated by research quality, physical activity measurement type or validity, or whether the intervention specifically targets low active girls (see 9.1). Evidence suggests that stage-matched tailored interventions are not effective.

11. Discussion

In discussing the evidence presented, it is important to recognise the parameters that delimit this review. First, the review sought to determine intervention effectiveness only in adolescent girls of cultural and socio-demographic background that has relevance to the UK. Second, interventions that focussed on school physical education lessons, environmental change, active travel, and family/community contexts were excluded as these were dealt with by other reviews in this programme. Comparison with findings from elsewhere should therefore be cautious. For example, the recent systematic review by van Sluijs et al. (2007) reports 24 controlled intervention trials designed to increase physical activity in adolescents, but only 6 were included in the present review due to the inclusion and exclusion criteria specified. The two main reasons for excluding studies in the present review that appeared in the review by van Sluijs and colleagues were a) data not reported separately for girls, and b) the intervention included school physical education lessons.

11.1. Overall effectiveness

Effectiveness across all 12 studies was mixed with 50% showing positive changes in physical activity. This was also the case for the eight interventions with strong (++) or good (+) research designs, and for the four studies with weaker (-) designs. Although research design appears not to be associated with intervention effectiveness, it is a common theme in reviews in this field to recommend stronger research designs, including better measurement of physical activity (Salmon, Booth, Phongsavan, Murphy, & Timperio, 2007; Stone, McKenzie, Welk, & Booth, 1998; van Sluijs, McMinn, & Griffin, 2007). Of the interventions included in the current review, it is certainly the case that authors need to better report what they did, how they assessed physical activity and other outcomes, and to better document any process evaluation that took place.

11.2. Targeting single versus multiple health behaviours in schools

In the school environment, targeting physical activity alone seemed to prove more effective than when promoted alongside other health behaviours. These interventions were effective using primarily educational and self-monitoring approaches. One reason their effectiveness could be that such an approach reduces the likelihood of diluting elements of the intervention. Moreover, schools are busy places and further demands on the time of staff may lead to inefficiencies and interventions that have

low fidelity. However, logically there is a strong argument for promoting physical activity alongside other health behaviours, such as healthy nutrition, particularly if we are interested in energy balance. More investigation is needed on this topic.

11.3. Primary health care settings

With only one study concerning the primary health care setting, conclusions must be cautious. The study was of a high quality and showed no intervention effectiveness. Van Sluijs et al. reported inconclusive effects from two studies in this setting. In the case of the one study we included, it is difficult to ascertain whether the key issue is the setting or other features of the intervention. For example, the study targeted both physical activity and nutrition in boys and girls and used mediated and counselling approaches. Primary health care is a viable setting for health behaviour change but more needs to be known about its potential for effectiveness in physical activity with adolescents.

11.4. Types of intervention: Mediated, counselling, and educational approaches

Mediated approaches, where print or electronic materials were used to prompt physical activity, were generally unsuccessful in changing behaviour. Although the potential for technology-based has been recognised for some time (Dirkin, 1994), it is only recently that review level evidence has been made available. For example, web-based interventions with adults have shown mixed success, with authors of a review suggesting that such interventions are not as straight forward as some have suggested (Vandelanotte, Spathonis, Eakin, & Owen, 2007). However, this area will inevitably develop and may lead to some interesting and successful approaches that should have appeal to adolescents.

Counselling approaches were not shown to be effective. However, it is unclear how well trained the individuals delivering the counselling were, what exactly the counselling entailed, and how appropriate it was for the individuals concerned. For example, a basic premise of counselling is that it should be client centred. If some adolescents are allocated to a counselling condition in an intervention but do not see that physical activity is relevant personal issue, effectiveness will be limited. Moreover, some of the so-called ‘counselling’ interventions may be no more than simple advice giving.

Educational interventions showed some effectiveness. All of these interventions were conducted in school settings where educational approaches are expected and accepted. This may be as important as the intervention itself. Nevertheless, educational approaches appear to be worthwhile for adolescent girls.

11.5. Moderators of effectiveness

The two moderators showing greatest effect were the targeting of girls alone and older adolescent girls. Targeting girls may be associated with the dislike of participating in physical activity with boys. Review level evidence suggests that adolescent girls are concerned about their body weight and appearance (Biddle, Whitehead, O'Donovan, & Nevill, 2005), and this aspect of self-presentation may be exacerbated by certain social environments, including those containing boys (Biddle et al., 2005).

The success of targeting older girls may be due to two factors. First, younger girls are likely to be reasonably active and thus an intervention may find it difficult to change an already positive behaviour. Moreover, older girls are likely to show lower levels of activity and be more amenable to change. Second, the older girls may be better placed to understand certain types of interventions, such as educational materials and mediated approaches. Their more advanced cognitive development may assist them in this regard.

12. Conclusion

This review has resulted in some evidence statements that can form the basis of recommendations for practice. The evidence suggests that achieving successful behaviour change for physical activity in adolescent girls is more likely if the intervention targets girls alone rather than boys and girls together, and is targeted at older adolescent girls, using an intervention focussed on physical activity rather than additional health behaviours. Within the parameters of this review other approaches such as mediated, counselling or stage-matched tailored interventions have not demonstrated consistent effects in promoting physical activity.

13. Evidence Tables

Evidence Table one. Physical activity interventions with adolescent girls: Study details

Author & date	Study design & research type/ quality	Setting	Research question	Study population, country, sample size	Description of intervention	Length of follow-up	Physical activity outcome variables (inc measures)	Main results	Non physical activity outcomes	Confounders / potential sources of bias	Applicability to the UK
Baxter et al. (1997)	Controlled non-randomised trial CNRT: -	Community	To evaluate lifestyle changes known to have an impact on CHD risk factors	Adolescents UK Age at baseline = 11 y Yr 7 intervention group n=293 at follow-up	Broad community and school intervention Action Heart Project – School – various aspects, including policy, Action Heart Charter, My Body project, peer led projects Intervention components not reported in detail and, in places, quite confusing.	3 y	Participant self-reported "exercise 3 or more times weekly". No details provided but claims made that questions taken from previously validated questionnaires.	2% decline in INT group; 7% decline in C group. Overall odds ratio for boys and girls combined showed negative effect for intervention (OR=0.65)	Positive effects over 3 years for girls at age 11yrs at baseline for diet, but higher levels of smoking in I group	Non-randomised design. Internal validity weak. Intervention poorly detailed. Inadequate reporting of PA measure	Good. Applicable to UK population and settings included in the study (broader application is uncertain)
Metzker (1999)	Controlled non-randomised trial CNRT: -	School	To determine the effectiveness of a stage matched counselling intervention on increasing physical activity	Adolescent girls USA Age=15 n=57	8-week intervention with I and C groups: I: Stage-based counselling using processes of change to change exercise behaviour, determinants, values and barriers. Also instructed in physical fitness skills	8 w intervention (no post intervention follow-up)	Unpublished 24-hr recall (2 d data) Marcus et al's measure of exercise 'Stage of Change'	Large significant increase in PA for I group and slight decline for C. Analysis used baseline scores as covariate. ES for unadjusted means = 0.93 ('large'). Estimated ES for adjusted means = 1.04 ('large'). Forward stage movement more likely in I group.	The variable of "PA values" showed little difference between I and C groups after intervention. No effect on 10 determinants of PA. Some evidence for decrease in barriers in I group (6 of 19).	Non-randomised design. PA recall measure of unknown validity. Limited data on sample. Some analyses may be under-powered.	Limited. Applicable to US population and settings included in the study (broader application is uncertain)

Author & date	Study design & research type/ quality	Setting	Research question	Study population, country, sample size	Description of intervention	Length of follow-up	Physical activity outcome variables (inc measures)	Main results	Non physical activity outcomes	Confounders / potential sources of bias	Applicability to the UK
Moon et al. (1999)	Controlled non-randomised trial CNRT: -	School	Evaluation of the effectiveness of the Wessex Healthy Schools Award in secondary schools. Tests an audit of process and policy change in school, questionnaire-based assessment of pupils' knowledge, attitudes, and behaviour, and semi-structured interviews exploring attitudes to and involvement in health promotion of support staff, parents and school governors.	Adolescents UK Year 7 pupils – 11-12 y. Year 11 – 15-16 y with cross sectional assessment only. Sample sizes vary with PA data available from 321 year 7's, 204 year 11's.	Wessex Healthy Schools Award – 9 key areas: curriculum links with the wider community, a smoke free school, healthy food choices, physical activity, responsibility for health, health promoting workplace, environment , and equal opportunities and access to health. Each key area has target statements which schools work to fulfil. Schools select one member of staff to co-ordinate. Schools supported by the LEA.	15 mo	Questionnaire: % of pupils taking part in sports at school once a week or more (not PE).	Girls declined in sport participation more in control than intervention group at Yr 8. Marginal improvement at Yr 11, but no statistical tests reported. Graph shows overlapping CIs, thus non-significant.	Positive intervention effects reported for smoking and drug use.	Non-randomised design. Weak, unvalidated outcome measure.	Good. Applicable to UK population and settings included in the study (broader application is uncertain)
Winett et al. (1999)	Controlled non-randomised trial CNRT: -	School	To test the effectiveness of a web-based intervention designed to change health behaviours.	Adolescent girls USA Ages 14.9 & 15.9y Intervention n=103 Control n=77	5-module educational package delivered via internet in school classes. Focus on nutrition and physical activity with information, assessment and individualised feedback.	3 weeks	Frequency of participation in 'aerobic conditioning activity'.	Significantly greater participation in aerobic PA by girls in the intervention condition at follow-up, controlling for baseline values ($p<.05$). I group increased 0.65 d/w (21%). C group increased 0.15 d/w (5.3%).	Positive effects for increasing fruit & vegetable and fibre consumption, and decreasing soft ('soda') drink consumption.	Non-randomised design. Outcome measure of unknown validity	

Author & date	Study design & research type/ quality	Setting	Research question	Study population, country, sample size	Description of intervention	Length of follow-up	Physical activity outcome variables (inc measures)	Main results	Non physical activity outcomes	Confounders / potential sources of bias	Applicability to the UK
Prochaska & Sallis (2004)	Randomised controlled trial RCT + +	Non-specific (data collected in schools)	To compare the efficacy of targeted PA and nutrition (PAN) versus PA alone	Adolescents USA Age at baseline = 12.1 y PA and N group N = 28 (girls) PA group N = 29 (girls)	Modified version of the PACE + intervention. Intervention groups: Completed a computerised health assessment and then received tailored feedback and created individualised behaviour change or relapse prevention plans. Tested the effectiveness of targeting PA alone versus in combination with fruit and vegetable (F&V) consumption No treatment control group.	3 mo	Accelerometer counts	All groups showed decline in activity: PAN=9 mins/d; PA=14 mins/d; C=15 mins/d), but overall, no significant effect for either intervention condition on PA (time x group interaction p=.72).	No effect for either intervention condition on F&V consumption.	Power estimates suggest that analyses for girls are slightly under-powered.	Limited. Applicable to US population and settings included in the study (broader application is uncertain)
Simon et al. (2004)	Cluster randomised controlled trial CRCT +	School	To evaluate the impact of a physical activity multi-level intervention on activity patterns, sedentary behaviour, and psychological predictors of PA among adolescents	Adolescents France Ages at baseline: Intervention 11.6 yrs (n=475) Control: 11.7 yrs (n=479)	A multi-level programme designed to influence intrapersonal, social and environmental determinants of PA. 3 principal targets: 1. Knowledge, attitudes, beliefs and motivation towards PA, developed through information provision, debates and supervised PA sessions 2. social support by parents, peers, teachers and PA instructors. 3. Environmental – physical, structural, and institutional conditions for PA that encourage the students to use the knowledge and skills they have learnt. 4 schools randomised to Intervention; 4 to Control.	4 years (6-month data reported here)	Adapted version of the 'modifiable activity questionnaire for adolescents' (MAQ). Past year recall yielding weekly frequency and duration estimates. Participation in Leisure organised physical activity (LOPA) used for analysis. This excluded school PE.	After correcting for baseline co-variates (age, overweight, parental socio-occupational status) LOPA significantly increased from 59-83% among intervention girls compared to controls (48% to 50%; OR=3.38 p<0.01).	Follow-up LOPA was associated with improvements in self-efficacy and intentions to be active. Significant reduction of high sedentary (screen-based) behaviour among intervention girls from 24% to 17%; OR=0.54; p<0.0001	Randomised by schools Some differences at baseline. No ITT analysis.	Limited. Applicable to French population and settings included in the study (broader application is uncertain).

Author & date	Study design & research type/ quality	Setting	Research question	Study population, country, sample size	Description of intervention	Length of follow-up	Physical activity outcome variables (inc measures)	Main results	Non physical activity outcomes	Confounders / potential sources of bias	Applicability to the UK
Schofield et al. (2005)	Cluster randomised controlled trial CRCT +	School	To test pedometer (steps) versus time-based approach to increase PA	Low active adolescent girls Australia Age at baseline = 15.7-15.9 y Intervention n=55 Control n=30	PED: pedometer (step count) intervention group MIN: minutes intervention group CON: control group. PED and MIN groups told to increase step or minutes of PA respectively. Session conducted before or after school or during lunchtime. Small group meetings (n=8), 30 min duration weekly for 6 weeks. Followed by 6 week maintenance phase.	12 week study from baseline	Pedometer step counts & self-reported '3-Day Physical Activity Recall' (3DPAR)	PED > CON for step counts after 12 weeks (ES=0.68, 'moderate' calculated from PED v CON post-intervention data at 12w). MIN increased step count over 12 w but did not differ from CON after 12 w. No differences for self-reported PA (3DPAR).	No effects on BMI.	Randomised by schools Some differences at baseline. No ITT analysis.	Limited. Applicable to Australian population and settings included in the study (broader application is uncertain)
Haerens et al. (2006)	Cluster randomised controlled trial CRCT +	School	To evaluate the effects of a middle school physical activity and healthy eating intervention, including an environmental and computer tailored component, and to investigate the effects of parental involvement	Middle school children Belgium Age at baseline = 13.1 y Intervention + parent n=1226 Intervention only n=1006 Control n=759	A school based intervention programme to promote healthy food and physical activity over 2 school years PA, food and parental components. PA – focused on increasing PA to at least 60 mins per day. Schools encouraged to create more opportunities to be physically active during breaks, at lunchtime and after school. Extra sports materials provided for break / lunchtime and after school. Pupils received a fitness test and a computer-tailored intervention for physical activity. Goal of parent component was to create supportive environment for PA outside of school – 3 times a year printed materials on healthy food and PA sent home. Parents	2 y	Flemish Physical Activity Questionnaire (FPAQ) assessed LTPA, with subgroup accelerometer data on light PA and MVPA.	For self-reported LTPA, there was no effect for the intervention over 1 or 2 years. Both I (19.2%) and C (25.5%) groups increased LTPA over 2 years, with no difference between groups (ES= -0.02). For accelerometry data, there was a significant 2y effect for light activity with I remaining stable (-0.02%) and C decreasing (-17%). The intervention effect was 'moderate' at 2y (ES=0.43) and 1y (ES=0.49). Both I (21%) and C (22.5%) groups increased accelerometer-assessed MVPA over 2 years, with no difference between groups at 2y (ES= 0.12) but a small effect after 1y in favour of the I group (ES=0.35).	Significantly greater reductions in fat intake and percent energy from fat in intervention compared to control groups.	Randomised by schools 25% dropout No ITT analysis.	Limited. Applicable to Belgian (Flemish) population and settings included in the study (broader application is uncertain).

Author & date	Study design & research type/ quality	Setting	Research question	Study population, country, sample size	Description of intervention	Length of follow-up	Physical activity outcome variables (inc measures)	Main results	Non physical activity outcomes	Confounders / potential sources of bias	Applicability to the UK
					also sent a CD-rom of a computer-tailored intervention for PA and fat intake – same as that completed by pupils. Food component – focused upon increasing fruit consumption, reducing soft drink consumption and increasing water consumption and reducing fat intake. Schools encouraged to offer free or reduced price fruit and vegetables and water.						
Marks et al. (2006)	Randomised non-controlled trial RNCT +	Non-specific	To compare the effectiveness of web versus print media on physical activity self-efficacy, intentions and self-reported physical activity.	Adolescent girls USA Age = 12.1-12.2y N=319	Participants phoned at home for collection of baseline data, then randomly assigned to print or web groups. Website – "LifeBytes" – developed by the DoH and DfES, UK. Print workbook designed to be highly comparable only differing by mode of delivery. Girls instructed to view the materials at least 4 times over 2 week period.	2w	Self-reported PA (items from CDC Youth Risk Behaviour Surveillance System Survey)	No between-group effect for PA . Within-group increase in PA greater for print than web group (p=.002). Sub-group analysis of low active girls showed increase in moderate for both web (p<.001) and print (p<.001) groups, but with a larger increase for the print group (p=.04).	Intentions and self-efficacy increased in both groups.	No true control group. No ITT analysis.	Limited. Applicable to US population and settings included in the study (broader application is uncertain). 51% African-American; 11% Hispanic/ other.
Murphy et al. (2006)	Cluster randomised controlled trial CRCT +	School & community	To investigate the effect of a 6-month teacher led 'osteogenic' physical activity programme vs. a self led programme on ultrasound measurements of bone health in inactive teenage girls	Inactive adolescent girls Ireland Age at baseline = 16.3 y TLPA n= 30 SLPA n= 30 control n= 28	Compared the effectiveness of 2 intervention types, plus control group. Teacher-led PA (TLPA) vs. Self-led PA (SLPA). For 3 initial sessions girls were divided into small groups and taught how to perform all exercises safely and optimally and how to monitor intensity. TLPA – 2 x 60 activity sessions per	6 mo	Weekly duration and intensity of PA (totalled over the 6 month period) assessed with activity diary.	No tests of statistical significance reported for PA outcomes and no data for control group. "On average, girls in the TLPA group engaged in PA for 4.5 hours per week and girls in the SLPA group took part in 3.4 hrs per week." Calculation of effect size (Cohen's d) from data shows very large effect (ES=2.75) in	BMI, fitness, food frequency, bone measurements - broadband ultrasound attenuation (BUA), os calcis stiffness index score (OCSI), speed of sound (SOS). Both intervention groups showed improved BUA, OCSI and SOS and	Randomised by schools Some differences at baseline. Unvalidated PA diary.	Good. Applicable to Irish population and settings included in the study therefore application to UK assumed to be good.

Author & date	Study design & research type/ quality	Setting	Research question	Study population, country, sample size	Description of intervention	Length of follow-up	Physical activity outcome variables (inc measures)	Main results	Non physical activity outcomes	Confounders / potential sources of bias	Applicability to the UK
					week led by a qualified PE teacher. Encouraged to undertake at least 2 additional sessions per week. 24 weeks duration. Encouraged to work at intensity of 12-13 on the Borg scale. SLPA – asked to undertake 3-4 activity sessions per week of 20-90 min duration.			favour of TLPA.	fitness.		
Patrick et al. (2006)	Randomised controlled trial RCT + +	Primary Health Care & Home	To assess the effects of a PA and nutrition intervention, delivered through primary care and at home, on PA, sedentary behaviour and diet	Adolescents USA Age = 12.6-12.8y N=438	PACE+ intervention. To promote improved eating and PA behaviours through a computer-supported intervention initiated in primary health care settings. 2 components. Primary care: computer assessment of key diet / PA behaviours and stage of change. Computer generated progress plans and summary record, followed by a short one to one counselling session. Home element: 12 month duration printed 'teen guide' containing information on diet and PA issues, and advice on modifying behaviour. Supported with postal prompts and advice. 11 telephone counselling calls over 12 months. Comparison (control) condition: sun protection behaviour programme.	12 mo	Self-reported PA (7-d recall). Accelerometer counts for sub-sample. Self-reported sedentary behaviours (TV, computer, sitting & talking, listening to music).	No intervention effect for self-reported MVPA with increases in both PACE+ (2.7%) and C group (10.4%), and no post-intervention group differences (ES=0.17). For accelerometer data, the sub-sample analysis showed no significant intervention effect (p=.80) . There was a significant reduction in sedentary behaviour for PACE+ (-21%) over controls (+4.8%). Small between group differences were evident post-intervention (ES= -0.32), with greater sedentary behaviour for controls.	No change in BMI.	Sub-sample only assessed used accelerometry	Limited. Applicable to US population and settings included in the study (broader application is uncertain). 55-63% White; 13-15% Hispanic.

Author & date	Study design & research type/ quality	Setting	Research question	Study population, country, sample size	Description of intervention	Length of follow-up	Physical activity outcome variables (inc measures)	Main results	Non physical activity outcomes	Confounders / potential sources of bias	Applicability to the UK
Robbins et al. (2006)	Cluster randomised controlled trial CRCT +	School	To determine the efficacy of 'girls on the move', a computerised individually tailored physical activity programme plus nursing counselling intervention, in increasing physical activity	Low active adolescent girls USA Age = 11-13.5y Intervention n=45 Control n=32	To examine the efficacy of a two component intervention: computerized, individually tailored PA plus nurse counselling (similar to the PACE+). Girls completed a computerised health assessment / questionnaire. Control group received age-specific PA recommendations. Intervention group received tailored feedback and nurse counselling at baseline, 3 weeks and 9 weeks. A mail-out for parents at baseline and 6 weeks offered tips on how to encourage their daughter to be more active. Follow-up phone calls at weeks 1, 6 and 11 assessed progress and provided advice on meeting goals.	12 w study. No follow-up.	Self-reported PA (Child Adolescent Activity Log). 4d recall of activities that led to breathing hard, sweating, and heart beat that was 'fast'. Analysed by 'moderate', 'vigorous', weekday, weekend. Stage of change assessment (criterion for action stage = 5d/w).	No differences between intervention and control groups on any PA measure (d/w; stage; mins MVPA weekday etc). For example, between group differences post-intervention on mins of weekday MVPA were close to zero (ES=0.02). 12w increases for both I (+42.7% and C (32.6%) groups in number of days/week of PA, but between group differences post-intervention were close to zero (ES= -0.06).	Larger changes in PA associated with perceived benefits of PA, PA self-efficacy, enjoyment.	Randomised by school and school year. Small sample size and could be underpowered No ITT analysis	Limited. Applicable to US population and settings included in the study (broader application is uncertain).

Key:
I: Intervention; C: Control (group); PA: physical activity; ITT: Intention-to-treat; OR: odds ratio; 3DPAR: 3-Day Physical Activity Recall (Pate, Ross, Dowda, Trost, & Sirard, 2003); LTPA: leisure-time physical activity; MVPA: moderate-to-vigorous physical activity; PACE+: "Patient-centered Assessment and Counselling for Exercise + Nutrition".**Evidence Table two: Summary of possible moderators of physical activity change with adolescent girls**

Author & date	Study design & research type/ quality	Change in physical activity	Main setting	Girls only?	Measurement of PA[1]	Age group	Type of intervention			
						11-13y or 14-18y	Targeted at low active?	Education, mediated, or counselling	Single or multi behaviour	Tailored
Baxter et al. (1997)	Controlled non-randomised trial	0	School (& community)	X	SR-UV	11-13y	X	E	MB	
Metzker (1999)	CNRT: - Controlled non-randomised trial	+	School	✓	SR-UV	14-18y	X	C	S	✓
Moon et al. (1999)	CNRT: - Controlled non-randomised trial	0	School	X	SR-UV	11-13y	X	E	MB	
Winett et al. (1999)	CNRT: - Controlled non-randomised trial	+	School	✓	SR-UV	14-18y	X	E & M	MB	
Prochaska & Sallis (2004)	CNRT: - Randomised controlled trial	0	School	X	OB	11-13y	X	M	S & MB[2]	✓
Simon et al. (2004)	RCT + + Cluster randomised controlled	+	School	X	SR-V	11-13y	X	E	S	

Author & date	Study design & research type/ quality trial	Change in physical activity	Main setting	Girls only?	Measurement of PA[1]	Age group		Type of intervention		
Schofield et al. (2005)	CRCT + Cluster randomised controlled trial	+	School	✓	OB + SR-V	14-18y	✓		S	
Haerens et al. (2006)	CRCT + Cluster randomised controlled trial	0	School	X	SR-V (OB with sub-group)	11-13y	X	M	MB	✓
Marks et al. (2006)	CRCT + Randomised non-controlled trial	+	Home	✓	SR-V	11-13y	X	M	S	
Murphy et al. (2006)	RNCT + Cluster randomised controlled trial	+	School	✓	SR-UV	14-18y	✓	E	S	
Patrick et al. (2006)	CRCT + Randomised controlled trial	0	Primary Health Care	X	OB + SR-V	11-13y	X	M & C	MB	
	RCT + +									

Author & date	Study design & research type/ quality	Change in physical activity	Main setting	Girls only?	Measurement of PA[1]	Age group		Type of intervention		
Robbins et al. (2006)	Cluster randomised controlled trial CRCT +	0	School	✓	SR-V	11-13y	✓	M & C	S	✓

Notes:

1. OB: objective assessment; SR-V: self-report (validity reported); SR-UV: self-report (unknown validity)
2. Tested multiple behaviour vs. single behaviour.

Appendix A – Example search strategy

Medline

1 child$.tw.
2 exp adolescent/
3 young people$.tw.
4 youth$1.tw.
5 young person$.tw.
6 girl$1.tw.
7 young adult$.tw.
8 young wom#n.tw.
9 (under 18 or under 18s or 11 to 18).tw.
10 teen$1.tw.
11 teenager$.tw.
12 ((comprehensive or secondary or high or elementary) adj1 school$1).tw.
13 sixth form college$.tw.
14 (Scout$1 or Girl Guid$3 or scouting or ranger guide$1 or explorer$1).tw.
15 (secondary education or further education).tw.
16 (play ground$ or playground$).tw.
17 health club$1.tw.
18 (leisure adj5 (centre$1 or center$1 or facilit$)).tw.
19 (fitness adj5 (centre$1 or center$1 or facilit$)).tw.
20 parks.tw.
21 (fitness club$1 or wellness centre$ or wellness center$).tw.
22 gym$1.tw.
23 (family or families).tw.
24 (communit$ or settings$).tw.
25 (neighbourhood$ or neighborhood$).tw.
26 garden$.tw.
27 (pitch or pitches).tw.
28 (youth club$ or youth center$ or youth centre$).tw.
29 (open space$ or outdoor space$).tw.
30 swimming pool$.tw.
31 gymnasia$1.tw.
32 health spa$1.tw.
33 public facilities/ or swimming pools/
34 (physical$ adj5 (fit$4 or activ$3 or endur$4)).tw.
35 (exercis$3 adj5 (fit$4 or activ$3 or endur$4)).tw.
36 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain$) adj5 physical$ activit$).tw.
37 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain$) adj5 exercis$).tw.
38 ((decreas$ or reduc$ or discourag$) adj5 sedentary).tw.
39 motor skill$.tw.
40 (physical$ adj5 inactiv$3).tw.
41 physical$ litera$.tw.
42 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain$ or self esteem or confidence or self efficacy or abilit$ or enjoy$ or learn$) adj5 (swim$ or walk$ or running or biking or bicycl$ or bike$)).tw.
43 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain$ or self esteem or confidence or self efficacy or abilit$ or enjoy$ or learn$) adj5 (dance$1 or dancing or aerobics)).tw.
44 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain) adj5 (sport$ or horse riding)).tw.

45 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain$ or self esteem or confidence or self efficacy or abilit$ or enjoy$ or learn$) adj5 (football or rugby or netball or cricket or hockey or rounders)).tw.
46 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain$ or self esteem or confidence or self efficacy or abilit$ or enjoy$ or learn$) adj5 (rollerblading or rollerskating or skating or skateboard$)).tw.
47 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain$ or self esteem or confidence or self efficacy or abilit$ or enjoy$ or learn$) adj5 (jump$1 or jumping)).tw.
48 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain$ or self esteem or confidence or self efficacy or abilit$ or enjoy$ or learn$) adj5 (play$1 or playing or playfulness)).tw.
49 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain$ or self esteem or confidence or self efficacy or abilit$ or enjoy$ or learn$) adj5 (games or tennis or badminton or racquet sport$)).tw.
50 physical education.tw.
51 exp "Physical Education and Training"/
52 exp Dancing/
53 exp Sports/
54 Recreation/
55 "Play and Playthings"/
56 Exercise/
57 motor activity/
58 free play.tw.
59 ((self esteem or confidence or self efficacy or abilit$ or enjoy$ or learn$ or body image$) adj5 (physical activit$ or exercise$ or sport$)).tw.
60 (activ$ adj1 (play$1 or playing or playfulness)).tw.
61 (letter or editorial).pt.
62 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain$ or self esteem or confidence or self efficacy or abilit$ or enjoy$ or learn$) adj5 cycling).tw.
63 ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$ or maintain$ or sustain$ or self esteem or confidence or self efficacy or abilit$ or enjoy$ or learn$) adj5 (pilates or spinning or step$ class$)).tw.
64 or/1-11
65 or/12-33
66 (editorial or letter).pt.
67 or/34-63
68 64 and 65 and 67
69 68 not 66
70 limit 69 to (english language and yr="1990 - 2007")

Appendix B: Excluded studies

Study	Reason for Exclusion
Junior Aerobics. Kidsport scores a 'first', opening fun and fitness centres for children around the world. (1990). *American Fitness, 8*(6), 18-19.	No PA data
National bicycling and walking study. Case study No. 18 Final Report: Analyses of successful provincial, state, and local bicycle and pedestrian programs in Canada and the United States. (1993).	Unable to locate
Guidelines for school and community programs to promote lifelong physical activity among young people. National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and prevention. (1997). *Journal of School Health, 67*(6), 202-219.	Review / commentary
Physical activity promotion and school physical education. (1999). *President's Council on Physical Fitness and Sports Research Digest, 3*(7), 1-8.	Review / commentary
Couch Kids. The growing epidemic; looking at physical activity in children in the UK. (2000). British Heart Foundation, London (GB).	No PA data
Eight week program introduces girls to heart healthy living. (2002). *Active Living, 11*(2), 25.	Abstract / extended abstract
High Five given its official launch. (2002). *Active Living, 11*(2), 25.	Abstract / extended abstract
Children get physically active on a daily basis. (2003). *Input*, 8.	Abstract / extended abstract
Active for life: developmentally appropriate movement programs for young children. (2004). *Active Living, 13*(2), 25.	Abstract / extended abstract
Australia promotes physical activity for children. (2004). *Active Living, 13*(6), 24.	Abstract / extended abstract
Kids Get Lean at Local YMCA: Wheeler Regional Family YMCA. (2005). *Fitness Management, 21*(10), 32.	No PA data
The effectiveness of school-based interventions in promoting physical activity and fitness among children and youth: a systematic review. (2007). Database of Abstracts of Reviews of Effects: Centre for Reviews and Dissemination.	Review / commentary
Increasing physical activity: a quantitative synthesis. (2007). Database of Abstracts of Reviews of Effects: Centre for Reviews and Dissemination.	Review / commentary
Abraham, A., O'Neill, J. J., & Reedy, M. E. (1996). The implementation of a fitness based curriculum for high school students. In R. Lidor, E. Eldar & I. Harari (Eds.), *Windows to the future: Bridging gaps between disciplines, curriculum and instruction: Proceedings of the 1995 AISEP World Congress.* Netanya, Isreal: The Wingate Institute.	No PA data
Agron, P., Takada, E., & Purcell, A. (2002). California Project LEAN's Food on the Run program: an evaluation of a high school-based student advocacy nutrition and physical activity program. *Journal of American Dietetic Association, 102*(3 Suppl), S103-105.	Girls data not reported separately

Albright, C. L., Pruitt, L., Castro, C., Gonzalez, A., Woo, S., & King, A. C. (2005). Modifying physical activity in a multiethnic sample of low-income women: one-year results from the IMPACT (Increasing Motivation for Physical ACTivity) project. *Annals of Behavioral Medicine, 30*(3), 191-200.	Wrong age group
Alcaraz, J. E., Faucette, F. N., McKenzie, T. L., & Sallis, J. F. (1998). Effects of a physical education program on children's manipulative skills. *Journal of Teaching in Physical Education, 17*(3), 327-341.	Wrong age group
Ammerman, A. S., Ward, D. S., Benjamin, S. E., Ball, S. C., Sommers, J. K., Molloy, M., et al. (2007). An intervention to promote healthy weight: Nutrition and Physical Activity Self-Assessment for Child Care (NAP SACC) theory and design. *Preventing Chronic Disease, 4*(3), A67.	No PA data
Annesi, J. J., Westcott, W. L., Faigenbaum, A. D., & Unruh, J. L. (2005). Effects of a 12-week physical activity protocol delivered by YMCA after-school counsellors (Youth Fit for Life) on fitness and self-efficacy changes in 5-12-year-old boys and girls. *Research Quarterly for Exercise Sport, 76*(4), 468-476.	Inappropriate PA measure
Babey, S. H., Brown, E. R., & Hastert, T. A. (2005). Access to Safe Parks Helps Increase Physical Activity Among Teenagers. (pp. 1-6): Policy Brief (UCLA Centre for Health Policy Research).	No intervention
Baker, J. E., & Witt, P. A. (1999). Making a R.E.A.L. difference. For the past year, leaders of the Austin Parks and Recreation Departments Get R.E.A.L. program have gone into the city's neighbourhoods to work with kids who are particularly vulnerable to gangs, drugs violence, and alcohol. *Parks and Recreation, 34*(3), 70-80.	No PA data
Balamurugan, A., Oakleaf, E. J., & Rath, D. (2005). Using paid radio advertisements to promote physical activity among Arkansas tweens. *Preventing Chronic Disease, 2: special issue* (Available from: http://www.cdc.gov/pcd/issues/2005/nov/05_0071.htm.).	Girls data not reported separately
Balding, A. (2000). Fit to succeed: a partnership between the children of Exeter, Exeter Academic Council, Exeter City Council, Devon Curriculum Services, the Schools Health Education Unit and DC Leisure Management, to promote physical activity and achievement in schools. : Schools Health Education Unit.	No PA data
Baldwin, S. (1993). *An evaluation of the physical fitness effects of a high school aerobic dance curriculum*, University of Oregon.	Inappropriate PA measure
Baranowski, T., Simons-Morton, B., Hooks, P., Henske, J., Tiernan, K., Dunn, J. K., et al. (1990). A center-based program for exercise change among black-American families. *Health Education Quarterly, 17*(2), 179-196.	Wrong age group
Barenholtz, D. E. (1995). *The effects of an exercise program on the eating behavior, body image and self-esteem of adolescent girls.*, California School of Professional Psychology.	No PA data
Bar-Or, O., Grenier, D., Issenman, R. M., Leblanc, C., Nieman, P., Pavilanis, A., et al. (2002). Healthy active living for children and youth. *Paediatrics and Child Health, 7*(5).	Review / commentary
Biddle, S. J., Gorely, T., & Stensel, D. J. (2004). Health-enhancing	Review /

physical activity and sedentary behaviour in children and adolescents. *Journal of Sports Sciences, 22*(8), 679-701.	commentary
Bowles, H. R., Rissel, C., & Bauman, A. (2006). Mass community cycling events: who participates and is their behaviour influenced by participation? *International Journal of Behavioral Nutrition and Physical Activity, 3*, 39.	No intervention
Boyd, E. (1998). Girl's physical education - is single sex teaching the answer? *Scottish Journal of Physical Education, 26*(2), 29-39.	No intervention
Boyd, K. R., & Hrycaiko, D. W. (1997). The effect of a physical activity intervention package on the self-esteem of pre-adolescent and adolescent females. *Adolescence, 32*(127), 693-708.	No PA data
Bush, K. A., Leenders, N. Y., & O'Sullivan, M. (2004). Implementation of a walking program for urban youth during school hours. *Physical Educator, 61*(1), 2-13.	Insufficient PA data
Cale, L., & Harris, J. (2006). Interventions to promote young people's physical activity - issues, implications and recommendations for practice. *Health Education Journal, 65*(4), 348-365.	Review / commentary
Cale, L., & Harris, J. (2006). School-based physical activity interventions: effectiveness, trends, issues, implications and recommendations for practice. *Sports Education and Society, 11*(4), 401-420.	Review / commentary
Claxton, C., & Kirk, D. (2000). Promoting girl's participation in physical education and sport: the girls in sport partnership project. *British Journal of Teaching Physical Education, 31*(1), 27-29.	No PA data
Clemmens, D., & Hayman, L. L. (2004). Increasing activity to reduce obesity in adolescent girls: a research review. *Journal of Obstetric, Gynecologic and Neonatal Nursing, 33*(6), 801-808.	Review / commentary
Colchico, K., Zybert, P., & Basch, C. E. (2000). Effects of after-school physical activity on fitness, fatness, and cognitive self-perceptions: a pilot study among urban, minority adolescent girls. *American Journal of Public Health, 90*(6), 977-978.	Inappropriate population
Collins, R., Lee, R. E., Albright, C. L., & King, A. C. (2004). Ready to be physically active? The effects of a course preparing low-income multiethnic women to be more physically active. *Health Education and Behaviour, 31*(1), 47-64.	Inappropriate population
Corbin, C. B., Dale, D., & Pangrazi, R. P. (1999). Promoting physically active lifestyles among youths. *The Journal of Physical Education Recreation and Dance 70*(6), 26-28.	Review / commentary
Covington, C. Y., Cybulski, M. J., Davis, T. L., Duca, G. E., Farrell, E. B., Kasgorgis, M. L., et al. (2001). Kids on the Move: Preventing Obesity Among Urban Children. . *American Journal of Nursing, 101*(3), 73-82.	Review / commentary
Crompton, J. L., & Witt, P. A. (1997). The at-risk youth recreation project. *Parks and Recreation, 32*(1), 54-61.	No PA data
Currie, J. L., & Develin, E. D. (2000). The Strollers Pramwalking Program: a community intervention aimed at increasing the physical activity level of mothers with young children. *Health Promotion Journal of Australia, 10*(1), 57-59.	No age information
Davison, A., Dieser, R. B., & Scholl, K. G. (2005). Together We	No PA data

Play: An ecological approach to inclusive recreation. *Therapeutic Recreation Journal, 39*(4), 299-311.	
Dishman, R. K., & Buckworth, J. (1996). Increasing physical activity: a quantitative synthesis. *Medicine and Science in Sports and Exercise, 28*(6), 706-719.	Review / commentary
Dishman, R. K., Motl, R. W., Saunders, R., Felton, G., Ward, D. S., Dowda, M., et al. (2004). Self-efficacy partially mediates the effect of a school-based physical-activity intervention among adolescent girls. *Preventive Medicine, 38*(5), 628-636.	PE-based intervention
Dishman, R. K., Motl, R. W., Saunders, R., Felton, G., Ward, D. S., Dowda, M., et al. (2005). Enjoyment mediates effects of a school-based physical-activity intervention. *Medicine and Science in Sports and Exercise, 37*(3), 478-487.	PE-based intervention
Elder, J. P., McGraw, S. A., Stone, E. J., Reed, D. B., Harsha, D. W., Greene, T., et al. (1994). CATCH: process evaluation of environmental factors and programs. *Health Education Quarterly, Suppl 2*, S107-127.	No PA data
Ernst, M. P., & Pangrazi, R. P. (1999). Effects of a physical activity program on children's activity levels and attraction to physical activity. *Pediatric Exercise Science, 11*(4), 393-405.	Wrong age group
Ewart, C. K., Young, D. R., & Hagberg, J. M. (1998). Effects of school-based aerobic exercise on blood pressure in adolescent girls at risk for hypertension. *American Journal of Public Health, 88*(6), 949-951.	Inappropriate PA measure
Flay, B. R., Graumlich, S., Segawa, E., Burns, J. L., & Holliday, M. Y. (2004). Effects of 2 prevention programs on high-risk behaviors among African American youth: a randomized trial. *Archives of Pediatrics and Adolescent Medicine, 158*(4), 377-384.	No PA data
Franks, A., Kelder, S. H., Dino, G. A., Horn, K. A., Gortmaker, S. L., Wiecha, J. L., et al. (2007). School-based programs: lessons learned from CATCH, Planet Health, and Not-On-Tobacco. *Preventing Chronic Disease, 4*(2), A33.	Review / commentary
Frenn M, Malin S, Brown RL, Greer Y, Fox J, Greer J, et al. Changing the tide: an Internet/video exercise and low-fat diet intervention with middle-school students. *Applied Nursing Research* 2005;18(1):13-21.	Girls data not reported separately
Goerlich, S., Lauver, S., & Maynard, R. A. (2006). Impacts of After-School Programs on Student Outcomes: A Systematic Review for the Campbell Collaboration.	Review / commentary
Gormley, B. (2003). Making fitness a family affair: when it comes to getting kids active, the best strategy for parents is to walk the talk. Choose an organized program or create your own family fun. *Active Woman Canada, 1*(4), 18-20.	Review / commentary
Gortmaker, S. L., Peterson, K. E., Wiecha, J., Sobol, A. M., Dixit, S., Fox, M. K., et al. (1999). Reducing obesity via a school-based interdisciplinary intervention among youth: Planet Health. *Archives of Pediatrics and Adolescent Medicine, 153*, 409-418.	PE-based intervention
Haerens, L., De Bourdeaudhuij, I., Maes, L., Cardon, G., & Deforche, B. (2007). School-Based Randomized Controlled Trial of a Physical Activity Intervention among Adolescents. *Journal of*	Insufficient PA data

Adolescent Health 40(3), 258-265.	
Haerens, L., Deforche, B., Maes, L., Stevens, V., Cardon, G., & De Bourdeaudhuij, I. (2006). Body mass effects of a physical activity and healthy food intervention in middle schools. *Obesity, 14*(5), 847-854.	No PA data
Halas, J. (2002). Engaging alienated youth in physical education: an alternative program with lessons for the traditional class. *Journal of Teaching in Physical Education, 21*(3), 267-286.	No PA data
Halas, J., & Orchard, T. (2002). Culturally relevant physical activity for adolescent mothers: an action research study. *Physical and Health Education Journal, 68*(1), 42.	No intervention
Hall, T. (1993). Mom, will you play catch with me? Teaching girls to throw a ball. *Tennessee Association for Health, Physical Education, Recreation & Dance*, 26-27.	No intervention
Harageonas, M., Pizzaro, D., Ratliffe, T., & Sander, A. (1993). A survey update on Florida's Fit to Achieve program. *Florida Journal of Physical Education Recreation and Dance, 31*(2), 29-32.	No PA data
Harrell, J. S., McMurray, R. G., Gansky, S. A., Bangdiwala, S. I., & Bradley, C. B. (1999). A public health vs a risk-based intervention to improve cardiovascular health in elementary school children: the Cardiovascular Health in Children Study. *American Journal of Public Health, 89*(10), 1529-1535.	Wrong age group
Harris, J., & Cale, L. (1997). How healthy is school PE? A review of the effectiveness of health-related physical education programmes in schools. *Health Education Journal, 56*(1), 84-104.	Review / commentary
Hayes, J. M. (1997). Programs that Work: HICO school-year and summer recreation program. *Journal of Park and Recreation Administration, 15*(4), 92-101.	No PA data
Hortz, B., & Petosa, R. (2006). Impact of the "Planning to be Active" leisure time physical exercise program on rural high school students. *Journal of Adolescent Health, 39*(4), 530-535.	Girls data not reported separately
Huhman, M., Potter, L. D., Wong, F. L., Banspach, S. W., Duke, J. C., & Heitzler, C. D. (2005). Effects of a mass media campaign to increase physical activity among children: year-1 results of the VERB campaign. *Pediatrics, 116*(2), e277-284.	Girls data not reported separately
Huhman, M. E., Potter, L. D., Duke, J. C., Judkins, D. R., Heitzler, C. D., & Wong, F. L. (2007). Evaluation of a national physical activity intervention for children: VERB campaign, 2002-2004. *American Journal of Preventive Medicine, 32*(1), 38-43.	Girls data not reported separately
Hultsman, W. Z. (1999). Promoting physical activity through parks and recreation: a focus on youth and adolescence. *The Journal of Physical Education Recreation and Dance, 70*(2), 66-70.	No PA data
Jackson, N. W., Howes, F. S., Gupta, S., Doyle, J. L., & Waters, E. (2007). Interventions implemented through sporting organisations for increasing participation in sport. *Cochrane Database of Systematic Reviews, 3*.	Review / commentary
Kelleher, C., Fallon, U., McCarthy, E., Dineen, B., O'Donnell, M., Killian, M., et al. (1999). Feasibility of a lifestyle cardiovascular health promotion programme for 8-15-year-olds in Irish general practice: results of the Galway Health Project. *Health Promotion*	Girls data not reported separately

International, 14(3), 221-229.	
Klebanoff, R., & Muramatsu, N. (2002). A community-based physical education and activity intervention for African American preadolescent girls: a strategy to reduce racial disparities in health. *Health Promotion Practice, 3*(2), 276-285.	No PA data
Knutsen, S. F., & Knutsen, R. (1991). The Tromso Survey: the Family Intervention study--the effect of intervention on some coronary risk factors and dietary habits, a 6-year follow-up. *Preventive Medicine, 20*(2), 197-212.	Insufficient PA data
Leslie, E., Fotheringham, M., Veitch, J., & Owen, N. (2000). A university campus physical activity promotion program. *Health Promotion Journal of Australia, 10*(1), 51-54.	Wrong age group
Lionis, C., Kafatos, A., Vlachonikolis, J., Vakaki, M., Tzortzi, M., & Petraki, A. (1991). The effects of a health education intervention program among Cretan adolescents. *Preventive Medicine, 20*(6), 685-699.	No PA data
Lowden, K., Powney, J., Davidson, J., & James, C. (2001). The Class Moves![R] Pilot in Scotland and Wales: An Evaluation. Research Report Series.	Wrong age group
Luepker, R. V., & Perry, C. L. (1991). The Minnesota Heart Health Program. Education for youth and parents. *Annals of the New York Academy of Sciences, 623*, 314-321.	No PA data
Luepker, R. V., Perry, C. L., McKinlay, S. M., Nader, P. R., Parcel, G. S., Stone, E. J., et al. (1996). Outcomes of a field trial to improve children's dietary patterns and physical activity. The Child and Adolescent Trial for Cardiovascular Health. CATCH collaborative group. *Journal of the American Medical Association, 275*(10), 768-776.	Wrong age group
Luepker, R. V., Perry, C. L., Osganian, V., Nader, P. R., Parcel, G. S., Stone, E. J., et al. (1998). The child and adolescent trial for cardiovascular health (CATCH). *Journal of Nutritional Biochemistry, 9*(9).	Wrong age group
Marcus, B. H., Owen, N., Forsyth, L. H., Cavill, N. A., & Fridinger, F. (1998). Physical activity interventions using mass media, print media, and information technology. *American Journal of Preventive Medicine, 15*(4), 362-378.	Review / commentary
McKenzie, T. L. (1999). School health-related physical activity programs: what do the data say? *The Journal of Physical Education Recreation and Dance, 70*(1), 16-19.	Review / commentary
McKenzie, T. L., Li, D., Derby, C. A., Webber, L. S., Luepker, R. V., & Cribb, P. (2003). Maintenance of effects of the CATCH physical education program: results from the CATCH-ON study. *Health Education and Behaviour, 30*(4), 447-462.	Wrong age group
McKenzie, T. L., Nader, P. R., Strikmiller, P. K., Yang, M., Stone, E. J., Perry, C. L., et al. (1996). School physical education: effect of the Child and Adolescent Trial for Cardiovascular Health. *Preventive Medicine, 25*(4), 423-431.	Wrong age group
Morrison, D., Petticrew, S., & Thomson, H. (2003). What are the most effective ways of improving population health through transport interventions?: evidence from systematic reviews.	Review / commentary

Journal of Epidemiology and Community Health, 57(5), 327-333.	
Mott, D. S., Virgilio, S. J., Warren, B. L., & Berenson, G. S. (1991). Effectiveness of a personalized fitness module on knowledge, attitude, and cardiovascular endurance of fifth-grade students: "heart smart". *Perceptual Motor Skills, 73*(3 Pt 1), 847-858.	Inappropriate PA measure
Nader, P. R., Sellers, D. E., Johnson, C. C., Perry, C. L., Stone, E. J., Cook, K. C., et al. (1996). The effect of adult participation in a school-based family intervention to improve Children's diet and physical activity: the Child and Adolescent Trial for Cardiovascular Health. *Preventive Medicine, 25*(4), 455-464.	Wrong age group
Nader, P. R., Stone, E. J., Lytle, L. A., Perry, C. L., Osganian, S. K., Kelder, S., et al. (1999). Three-year maintenance of improved diet and physical activity: the CATCH cohort. Child and Adolescent Trial for Cardiovascular Health. *Archives of Pediatrics and Adolescent Medicine, 153*(7), 695-704.	Wrong age group
O'Hara Tompkins, N., Rye, J. A., Zizzi, S., & Vitullo, E. (2005). Engaging rural youth in physical activity promotion research in an after-school setting. *Preventing Chronic Disease, 2 Spec no*, A15.	No PA data
Ortega-Sanchez, R., Jimenez-Mena, C., Cordoba-Garcia, R., Munoz-Lopez, J., Garcia-Machado, M. L., & Vilaseca-Canals, J. (2004). The effect of office-based physician's advice on adolescent exercise behavior. *Preventive Medicine, 38*(2), 219-226.	Girls data not reported separately
Pabayo, R., O'Loughlin, J., Gauvin, L., Paradis, G., & Gray-Donald, K. (2006). Effect of a ban on extracurricular sports activities by secondary school teachers on physical activity levels of adolescents: a multilevel analysis. *Health Education and Behaviour, 33*(5), 690-702.	Girls data not reported separately
Parker, H., & Young, J. (1991). *Girls, boys and Sportsfun: an examination of the influence of Sportsfun on the self-esteem and participation patterns of high school leaders: a report.* University of Western Australia.	Unable to locate
Pate, R. R., Saunders, R. P., Ward, D. S., Felton, G., & Trost, S. G. (2003). Evaluation of a community-based intervention to promote physical activity in youth: Lessons from Active Winners. *American Journal of Health Promotion, 17*(3), 171-182.	Family review
Pate, R. R., Ward, D. S., Saunders, R., Felton, G., Dishman, R. K., & Dowda, M. (2005). Promotion of Physical Activity Among High-School Girls: A Randomized Controlled Trial. *American Journal of Public Health, 95*(9), 1582-1587.	PE-based intervention
Patrick, K., Sallis, J. F., Prochaska, J. J., Lydston, D. D., Calfas, K. J., Zabinski, M. F., et al. (2001). A multicomponent program for nutrition and physical activity change in primary care: PACE+ for adolescents. *Archives of Pediatrics and Adolescent Medicine, 155*(8), 940-946.	Girls data not reported separately
Ransdell, L. B., Dratt, J., Kennedy, C., O'Neill, S., & DeVoe, D. (2001). Daughters and mothers exercising together (DAMET): a 12-week pilot project designed to improve physical self-perception and increase recreational physical activity. *Women Health, 33*(3-4), 101-116.	Family review
Ransdell, L. B., Taylor, A., Oakland, D., Schmidt, J., Moyer-Mileur,	Family review

L., & Shultz, B. (2003). Daughters and mothers exercising together: effects of home- and community-based programs. *Medicine and Science in Sports and Exercise, 35*(2), 286-296.	
Rees, R., Kavanagh, J., Harden, A., Shepherd, J., Brunton, G., Oliver, S., et al. (2006). Young people and physical activity: a systematic review matching their views to effective interventions. *Health Education Research, 21*(6), 806-825.	Review / commentary
Reilly, J. J., & McDowell, Z. C. (2003). Physical activity interventions in the prevention and treatment of paediatric obesity: systematic review and critical appraisal. *Proceedings of the Nutrition Society, 62*(3), 611-619.	Review / commentary
Resnicow, K., Yaroch, A. L., Davis, A., Wang, D. T., Lyn, R., London, J., et al. (1999). Gem no. 306. GO GIRLS!: Development of a community-based nutrition and physical activity program for overweight African-American adolescent females. *Journal of Nutrition Education, 31*(5).	No PA data
Ridgers, N. D., Stratton, G., Fairclough, S. J., & Twisk, J. W. (2007). Children's physical activity levels during school recess: a quasi-experimental intervention study. *International Journal of Behavioral Nutrition and Physical Activity, 4*, 19.	Wrong age group
Ridgers, N. D., Stratton, G., Foweather, L., Henaghan, J., McWhannell, N., & Stone, M. R. (2006). The Active City of Liverpool, Active Schools and Sportslinx (A-CLASS) project. *Education and Health, 24*(2), 26-29.	No PA data
Ringuet, C. J., & Trost, S. G. (2001). Effects of physical activity interventions in youth: a review. *International SportMed Journal, 2*(5).	Review / commentary
Robinson, T. N., Killen, J. D., Kraemer, H. C., Wilson, D. M., Matheson, D. M., Haskell, W. L., et al. (2003). Dance and reducing television viewing to prevent weight gain in African-American girls: the Stanford GEMS pilot study. *Ethnicity and Disease, 13*(1 Suppl 1), S65-77.	Wrong age group
Rosenberg, D. E., Norman, G. J., Sallis, J. F., Calfas, K. J., & Patrick, K. (2007). Co-variation of adolescent physical activity and dietary behaviors over 12 months. *Journal of Adolescent Health, 41*(5), 472-478.	Correlation analysis
Rountree, A. C. (2001). Healthy weight management in adolescent females: A school-based intervention study. *Dissertation Abstract International Section B: The Sciences and Engineering, 61*(8-B).	No PA data
Rowley, C., Dixon, L., & Palk, R. (2007). Promoting physical activity: walking programmes for mothers and children. *Community Practitioner, 80*(3), 28-32.	No PA data
Rydell, S. A., French, S. A., Fulkerson, J. A., Neumark-Sztainer, D., Gerlach, A. F., Story, M., et al. (2005). Use of a Web-based component of a nutrition and physical activity behavioral intervention with Girl Scouts. *Journal of the American Dietetic Association, 105*(9), 1447-1450.	No PA data
Sallis, J. F., McKenzie, T. L., Conway, T. L., Elder, J. P., Prochaska, J. J., Brown, M., et al. (2002). Promoting and measuring youth physical activity throughout the school day. *Acta*	PE-based intervention

Kinesiologiae Universitatis Tartuensis, 7 Supp, 44-53.	
Sallis, J. F., McKenzie, T. L., Conway, T. L., Elder, J. P., Prochaska, J. J., Brown, M., et al. (2003). Environmental interventions for eating and physical activity: a randomized controlled trial in middle schools. *American Journal of Preventive Medicine, 24*(3), 209-217.	PE-based intervention
Sallis, J. F., Patrick, K., Frank, E., Pratt, M., Wechsler, H., & Galuska, D. A. (2000). Interventions in health care settings to promote healthful eating and physical activity in children and adolescents. *Preventive Medicine, 31*(2).	Review / commentary
Scruggs, P. W., Beveridge, S. K., & Watson, D. L. (2003). Increasing children's school time physical activity using structured fitness breaks. *Pediatric Exercise Science, 15*(2), 156-169.	Inappropriate PA measure
Simon, C., Wagner, A., Platat, C., Arveiler, D., Schweitzer, B., Schlienger, J. L., et al. (2006). ICAPS: a multilevel program to improve physical activity in adolescents. *Diabetes and Metabolism, 32*(1), 41-49.	Girls data not reported separately
Simons-Morton, B., Parcel, G. S., Baranowski, T., Forthofer, R., & O'Hara, N. M. (1991). Promoting physical activity and a healthful diet among children: results of a school-based intervention study. *American Journal of Public Health, 81*(8), 986-991.	Wrong age group
Singh, A. S., Chin, A. P. M. J., Brug, J., & van Mechelen, W. (2007). Short-term effects of school-based weight gain prevention among adolescents. *Archives of Pediatrics and Adolescent Medicine, 161*(6), 565-571.	PE-based intervention
Singh, A. S., Chin, A. P. M. J., Kremers, S. P., Visscher, T. L., Brug, J., & van Mechelen, W. (2006). Design of the Dutch Obesity Intervention in Teenagers (NRG-DOiT): systematic development, implementation and evaluation of a school-based intervention aimed at the prevention of excessive weight gain in adolescents. *BMC Public Health, 6*, 304.	PE-based intervention
Sleap, M., & Walker, L. (1992). Usage of community sports centres by adolescents: a case study of a secondary school. *Physical Education Review, 15*(1), 61-71.	No intervention
Stone, E. J., Osganian, S. K., McKinlay, S. M., Wu, M. C., Webber, L. S., Luepker, R. V., et al. (1996). Operational design and quality control in the CATCH multicenter Trial. *Preventive Medicine, 25*(4), 384-399.	Wrong age group
Story, M., Sherwood, N. E., Himes, J. H., Davis, M., Jacobs, D. R., Jr., Cartwright, Y., et al. (2003). An after-school obesity prevention program for African-American girls: the Minnesota GEMS pilot study. *Ethnicity and Disease, 13*(1 Suppl 1), S54-64.	Wrong age group
Stratton, G., & Sweeney, S. (1998). Kids EXCEL: a community programme promoting health related exercise in Sefton. *British Journal of Physical Education, 29*(3), 6-10.	Wrong age group
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