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School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18 (Review)

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[Intervention Review]

School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18

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ABSTRACT

Background

The World Health Organization (WHO) estimates that 1.9 million deaths worldwide are attributable to physical inactivity and at least 2.6 million deaths are a result of being overweight or obese. In addition, WHO estimates that physical inactivity causes 10% to 16% of cases each of breast cancer, colon, and rectal cancers as well as type 2 diabetes, and 22% of coronary heart disease and the burden of these and other chronic diseases has rapidly increased in recent decades.

Objectives

The purpose of this systematic review was to summarize the evidence of the effectiveness of school-based interventions in promoting physical activity and fitness in children and adolescents.

Search methods

The search strategy included searching several databases to October 2011. In addition, reference lists of included articles and background papers were reviewed for potentially relevant studies, as well as references from relevant Cochrane reviews. Primary authors of included studies were contacted as needed for additional information.

Selection criteria

To be included, the intervention had to be relevant to public health practice (focused on health promotion activities), not conducted by physicians, implemented, facilitated, or promoted by staff in local public health units, implemented in a school setting and aimed at increasing physical activity, included all school-attending children, and be implemented for a minimum of 12 weeks. In addition, the review was limited to randomized controlled trials and those that reported on outcomes for children and adolescents (aged 6 to 18 years). Primary outcomes included: rates of moderate to vigorous physical activity during the school day, time engaged in moderate to vigorous physical activity during the school day, and time spent watching television. Secondary outcomes related to physical health status measures including: systolic and diastolic blood pressure, blood cholesterol, body mass index (BMI), maximal oxygen uptake (VO₂max), and pulse rate.

Data collection and analysis

Standardized tools were used by two independent reviewers to assess each study for relevance and for data extraction. In addition, each study was assessed for risk of bias as specified in the *Cochrane Handbook for Systematic Reviews of Interventions*. Where discrepancies existed, discussion occurred until consensus was reached. The results were summarized narratively due to wide variations in the populations, interventions evaluated, and outcomes measured.

Main results

In the original review, 13,841 records were identified and screened, 302 studies were assessed for eligibility, and 26 studies were included in the review. There was some evidence that school-based physical activity interventions had a positive impact on four of the nine outcome measures. Specifically positive effects were observed for duration of physical activity, television viewing, VO₂ max, and blood cholesterol. Generally, school-based interventions had little effect on physical activity rates, systolic and diastolic blood pressure, BMI, and pulse rate. At a minimum, a combination of printed educational materials and changes to the school curriculum that promote physical activity resulted in positive effects.

In this update, given the addition of three new inclusion criteria (randomized design, all school-attending children invited to participate, minimum 12-week intervention) 12 of the original 26 studies were excluded. In addition, studies published between July 2007 and October 2011 evaluating the effectiveness of school-based physical interventions were identified and if relevant included. In total an additional 2378 titles were screened of which 285 unique studies were deemed potentially relevant. Of those 30 met all relevance criteria and have been included in this update. This update includes 44 studies and represents complete data for 36,593 study participants. Duration of interventions ranged from 12 weeks to six years.

Generally, the majority of studies included in this update, despite being randomized controlled trials, are, at a minimum, at moderate risk of bias. The results therefore must be interpreted with caution. Few changes in outcomes were observed in this update with the exception of blood cholesterol and physical activity rates. For example blood cholesterol was no longer positively impacted upon by school-based physical activity interventions. However, there was some evidence to suggest that school-based physical activity interventions led to an improvement in the proportion of children who engaged in moderate to vigorous physical activity during school hours (odds ratio (OR) 2.74, 95% confidence interval (CI), 2.01 to 3.75). Improvements in physical activity rates were not observed in the original review. Children and adolescents exposed to the intervention also spent more time engaged in moderate to vigorous physical activity (with results across studies ranging from five to 45 min more), spent less time watching television (results range from five to 60 min less per day), and had improved VO₂max (results across studies ranged from 1.6 to 3.7 mL/kg per min). However, the overall conclusions of this update do not differ significantly from those reported in the original review.

Authors' conclusions

The evidence suggests the ongoing implementation of school-based physical activity interventions at this time, given the positive effects on behavior and one physical health status measure. However, given these studies are at a minimum of moderate risk of bias, and the magnitude of effect is generally small, these results should be interpreted cautiously. Additional research on the long-term impact of these interventions is needed.

PLAIN LANGUAGE SUMMARY

School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18

It is estimated that as many as 1.9 million deaths worldwide are attributable to physical inactivity, and that inactivity is a key risk factor in the development of most chronic diseases and cancers. This is alarming particularly because it is known that physical activity patterns track from childhood into adulthood.

There is some evidence to suggest that school-based physical activity interventions are effective in increasing the number of children engaged in moderate to vigorous physical activity, as well as how long they spend engaged in these activities. There is also evidence to suggest that these interventions reduce the amount of time spent watching television.

This review included 44 studies that evaluated the impact of school-based interventions focused on increasing physical activity among 36,593 children and adolescents. Participants were between the ages of six and 18 living in Australia, South America, Europe, China, and North America. Duration of interventions ranged from 12 weeks to six years. No two school-based physical activity promotion programs had the same combination of interventions. Furthermore, the duration, frequency, and intensity of interventions varied greatly across studies. Data collection methods for outcomes were reported to be valid and reliable in a little over half of the included studies.

There is some evidence that school-based physical activity interventions are effective in increasing duration of physical activity from five to 45 min more per day, reducing time spent watching television from five to 60 min less per day, and increasing maximal oxygen uptake or aerobic capacity, reflecting physical fitness level of an individual. The evidence also suggests that children exposed to school-based physical activity interventions are approximately three times more likely to engage in moderate to vigorous physical activity during the school day than those not exposed. At a minimum, a combination of printed educational materials and changes to the school curriculum that promote physical activity during school hours result in positive effects for these outcomes. School-based interventions are not effective in increasing physical activity rates among adolescents, or in reducing systolic and diastolic blood pressure, blood cholesterol, body mass index, and pulse rate.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18 years

School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18

Patient or population: children and adolescents aged 6 to 18 years

Settings: primarily within the school setting

Intervention: educational, health promotion, counseling, and management strategies focused on the promotion of physical activity and fitness

Comparison: standard, currently existing physical education programs in schools

Outcomes	Range of effects	No of participants (studies)	Quality of the evidence (GRADE)
Television viewing (minutes spent watching TV) [follow-up: end of intervention to 4 years]	Intervention: 85 to 285 Control: 89 to 288	9372 (16)	⊕⊕⊕⊕ low^a
Physical activity rates (% of participants physically active) [follow-up: end of intervention to 1 year]	Intervention: 53 to 92 Control: 44 to 91	4123 (5)	⊕⊕⊕⊕ low^a
Physical activity duration (minutes engaged in physical activity) [follow-up: end of intervention to 4 years]	Intervention: 3 to 158 Control: 3 to 143	15743 (23)	⊕⊕⊕⊕ low^a
Mean systolic / diastolic blood pressure (mm Hg) [follow-up: end of intervention to 4 years]	Intervention: 96 to 138 / 50 to 73 Control: 97 to 139 / 50 to 76	13,739 (16)	⊕⊕⊕⊕ low^a
Body mass index (BMI) (kg/m ²) [follow-up: end of intervention to 4 years]	Intervention: 11.3 to 26.0 Control: 12.0 to 26.1	27,567 (32)	⊕⊕⊕⊕ low^a

GRADE Working Group grades of evidence

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.

^aSubstantial heterogeneity between trials regarding type of intervention and measured outcomes; wide and overlapping range of effects.

BACKGROUND

Description of the condition

International public health and health promotion organizations have identified the health risks across the lifespan associated with physical inactivity. The World Health Organization (WHO) estimates that 1.9 million deaths throughout the world are attributable to physical inactivity and at least 2.6 million deaths are a result of being overweight or obese (WHO 2004a). Globally, physical inactivity is estimated to cause 10% to 16% of cases each of breast cancer, colon, and rectal cancers as well as type 2 diabetes, and 22% of coronary heart disease and the burden of these and other chronic diseases has rapidly increased in recent decades (WHO 2004a). In addition, the literature indicates that an elevated body mass index (BMI) places children and adolescents at greater risk for cardiovascular disease (CVD) as adults (Haque 2008; USDHHS 2008), and that diet and physical activity are important factors in maintaining a healthy BMI range (Elgar 2005). Recognizing the unique opportunity that exists to formulate and implement an effective strategy to reduce deaths and disease burden worldwide substantially by improving diet and promoting physical activity, WHO adopted, in May 2004, the "Global Strategy on Diet, Physical Activity and Health". Since its adoption, WHO has been working with stakeholders providing technical assistance and support to facilitate implementation of this global strategy.

The promotion of physical activity is an essential public health and health promotion strategy to improve the health of individuals and populations (WHO 2004a). In fact several systematic reviews have been published highlighting the benefits of physical activity among healthy children (Armstrong 1994; Brown 2009; CDC 1997; CDC 1999; McMurray 2002; Thakor 2004; Tolfrey 2000; Whitt-Glover 2009; Zahner 2006). To ensure sustained progress toward major improvements in chronic disease prevention, the WHO called on public health organizations within and between countries to work collaboratively with key partners, including educators and health professional bodies, educational institutions, consumer groups, the research community, and the private sector, in providing a comprehensive strategy to promote physical activity among children and adolescents (WHO 2004a). The WHO specifically identified schools as a target setting for the promotion of physical activity among children and youth. To this end, activities include the provision of collaboration on the development of health-related curricula; educational policy and guideline development; professional development opportunities for educators and other partners; and, research, evaluation, and knowledge exchange to facilitate the development of evidence-informed policies, programs, and practices.

This systematic review was first published in 2009. Since that time, several new trials have been published and have been included in this update. While addition of these new studies contributed further to the evidence-base, they did not substantively alter the findings of the original review or change recommendations made for promoting physical activity and fitness in children and adolescents within the school system. The purpose of this update is to synthesize new data on the effectiveness of school-based physical activity interventions with data included in the original review. This update includes evaluations of published studies indexed up to and including 21 October 2011. While evidence exists documenting the benefits of physical activity for healthy children, at the time the original review was conducted, no other reviews had

systematically examined the effectiveness of various combinations of school-based interventions in promoting physical activity and fitness in children. In addition, since one of the goals of the public health system is to reduce obesity-related mortality and morbidity (OMoH 1997; WHO 2008), it is important to identify and then implement effective strategies to address obesity and overweight among children.

Magnitude of the problem

Physical inactivity is one of the leading causes of the major chronic diseases, and largely contributes to the burden of disease, death, and disability in developing and developed countries (WHO 2004a). Elimination of modifiable risk factors including an unhealthy diet, tobacco use, and physical inactivity would prevent 80% of premature heart disease, 80% of premature stroke, 80% of type 2 diabetes, and 40% of cancer (WHO 2008). Physical inactivity has been identified as a serious problem and major public health concern for people of all ages (Health Canada 2007; USDHHS 2008). In fact, physical activity was labeled as "today's best buy in public health" almost two decades ago (Morris 1994) with a suggestion that significant savings in health care could result from a mere 10% increase in physical activity population wide (CFLRI 1997; Katzmarzyk 2000; Katzmarzyk 2004). Despite these assertions, physical inactivity rates have risen rather than decreased in the past two decades. In addition to significant savings, being physically active is stated to be one of the most important steps people can take to improve their health (USDHHS 2008). Yet, according to the latest international Health Behaviour in School-aged Children (HBSC) study, less than two-thirds of all young people report participating in sufficient physical activity to meet current guidelines (CDC 2008; WHO 2004b). Previous reports have concluded that the intensity, frequency, and duration of physical activity contribute to overall physical health status and suggest that a 'threshold' must be maintained in order to produce positive health effects (CDC 1997; CDC 1999; McMurray 2002; Pate 1994; Shephard 1997; Thakor 2004; Tolfrey 2000; Zahner 2006). In fact, a positive linear association between duration of physical activity and positive health effects has been established, with longer duration associated with increased physical health (Pate 1994; Shephard 1997). Maximal oxygen uptake (VO₂max) is a standard measure associated with fitness levels, with increasing values expected as fitness level improves, and is an important indicator of successful physical activity interventions. Current guidelines suggest that children and adolescents should engage in 60 min or more of active play per day (Janssen 2010; USDHHS 2008; WHO 2004b) and that the majority of this time should be spent engaged in aerobic activity. The guidelines also recommend that adolescents should engage in three or more sessions per week of activities that last 20 min or more at a time, that require moderate to vigorous levels of exertion.

Examples of moderate to vigorous activities include brisk walking, jogging, stair climbing, basketball, racquet sports, soccer, dance, swimming laps, skating, strength training, lawn mowing, strenuous housework, cross-country skiing, and cycling. Research suggests that the best primary strategy for improving the long-term health of children and adolescents through exercise may be creating a lifestyle pattern of regular physical activity that will carry over to the adult years (Freedson 1992; Telama 2005; Twisk 2000). Longitudinal data have shown that for each weekday that normal weight adolescents participated in physical education (PE), the odds of

becoming overweight in adulthood decreased by 5% (Menschik 2008). It is therefore of primary importance to identify approaches that will be effective in increasing and sustaining activity levels of children and adolescents during school hours.

International surveys of physical activity (Cale 1992; CFLRI 1997; CFLRI 2007; Kannas 1992; Marella 1992; WHO 2004b) highlight the epidemic of physical inactivity among children. Despite many methodological differences, these surveys have consistently reported that fewer than 50% of boys and girls are active enough to produce health benefits, that a considerably smaller proportion of girls than boys are sufficiently active, and that activity participation declines with age during adolescence (Adams 1995; CDC 1997; CDC 1999; CDC 2008; WHO 2004b). However, it is not clear at what age the decline begins, if the rate of decline is linear (Sallis 2000; Stone 1998), and if the decline is greater in girls than boys (Story 2009; WHO 2004b).

These data are alarming for several reasons: a) changes in risk-related behaviors (e.g. increasing physical activity) may modify risk factors for chronic diseases such as hypertension or raised blood lipids among children (Arbeit 1992; Ball 2003; Gutin 1997; Hagberg 1983; Hansen 1991; Harrell 1996; Killen 1989; Walter 1988); b) physical activity affects physical and psychosocial health as physically active adolescents had lower prevalence of anxiety and depression (Summerbell 2005); c) physical activity patterns track from childhood into adulthood (CDC 2008; Dennison 1988; Kelder 1994; Klepp 1993; Malina 1996; Malina 2001; Raitakari 1994; Sallis 1992; Summerbell 2005); d) children are increasingly exhibiting risk factors for CVD, such as obesity (Hill 1998; Katz 2009; Moran 1999; Troiano 1995; Warden 1997), elevated blood lipids (Lee 1986), and hypertension (Fernandes 2000; Katz 2009), conditions that are known to track into adulthood (Gonzalez-Suarez 2009; Kemper 1990; Lauer 1989; Mahoney 1991; Nicklas 1995; Porkka 1991; Power 1997; Shear 1986; Webber 1983; Webber 1991; Whitaker 1997); and d) atherosclerotic fatty streaks in the coronary arteries, indicative of coronary heart disease, have been found in overweight adolescents (Haque 2008), and postmortem in children (Berenson 1992).

Determinants of physical activity among children

Increasing physical activity among children and adolescents is difficult as behavior is influenced by several factors including: personal factors; institutional, community, and public policy; and the physical environment (CIHR 2004). Lindquist 1999, basing their work on Kohl 1998, provided a typology for understanding the multitude of factors that may influence children's physical activity patterns. This classification considers determinants at four levels: physiological, psychological, sociocultural, and ecological.

Physiological determinants of physical activity among children and adolescents include age, gender, and ethnicity (Hudson 2008; Lindquist 1999; Pate 1994; Reynolds 1990; Sallis 1993; Sallis 2000). Specifically, girls have been found to be less active than boys, older children and adolescents less active than younger children, and black girls less active than white girls (Adams 1995; CDC 1997; Kelder 1995b; Ogden 2006; Robinson 1995; Zakarian 1994). Psychological determinants of physical activity include confidence in one's ability to engage in exercise (self efficacy) (Dishman 2004), perception of physical or sport competence (Sallis 2000), having a positive attitude toward physical activity (Troost 1997), enjoyment of physical activity (Dishman 2005), and perceiving benefits from engaging in physical activity (Ferguson 1989; Tappe 1990; Zakarian

1994). Conversely, perceived barriers to physical activity, such as lack of time or feeling tired, are negatively associated with physical activity among adolescents (Tappe 1990; Zakarian 1994). Sociocultural influences include support for and participation in physical activity of peers and siblings (Sallis 1988), parental level of physical activity (Adkins 2004; Andersen 1992; Biddle 1992; Butcher 1985; Freedson 1992; Garcia 1995; McMurray 1993; Moore 1991; Poest 1989; Reynolds 1990; Sallis 1988; Sallis 1992; Stucky-Ropp 1993; Zakarian 1994), parental support (Sallis 2000), and parental income. Ecological determinants of physical activity include access to play spaces, facilities, availability of equipment (Stucky-Ropp 1993), and transportation to activities or programs (Sallis 1992). In addition, time spent outdoors in the early years is positively correlated with physical activity levels among children (Sallis 1993).

Description of the intervention

The school setting is an ideal environment for population-based physical activity interventions as no other institution has as much influence on children during their first two decades of life (Story 2009). Physical activity in schools has also been shown to be indirectly associated with academic achievement including lower drop-out rates, better classroom behavior, self-esteem and engagement in school, and on-task behavior (Mahar 2006; Trudeau 2008). While the schools alone cannot solve the problem of inactivity, they do have the potential to become the central element in a community that ensures students participate in the recommended amount of time engaged in physical activity (Koplan 2005; Pate 2006). Schools provide benefit to children from all risk groups (Harrell 1996; WHO 2004a), particularly those with limited or no access to play areas (McKenzie 1996); and avoids stigmatization of at-risk children (Harrell 1998). Leading organizations recommend that schools implement policies that require daily PE; elementary school recess; and physical activity before, during, and after school (Pate 2006). However, it is not clear what the most effective strategies are to promote life-long healthy behaviors.

Worrisome trends in the school setting are occurring concurrently with the increasing prevalence of obesity including a decline in physically active transport to and from school, recess duration, and enrolment in PE classes (Pate 2006). Although most schools require PE as part of their curriculum, PE classes may occur infrequently and children are often relatively inactive in them (McKenzie 1995; Pate 2006; Simons-Morton 1990; Simons-Morton 1994). Increasing the frequency and duration of PE is not always feasible given competing curriculum demands. It is thus essential to promote physical activity throughout the school day during classes, lunch times, and recess, and to develop strategies to promote more efficient use of PE class time.

The studies included in the original review and now in this update, all implemented different combinations of physical activity promotion interventions in schools, with some also implementing interventions concurrently in the community as well as in the home. Generally the interventions focused on providing students with information about the benefits of physical activity and healthy nutrition, the risks associated with inactivity and unhealthy food choices, and increasing the amount of time students were engaged in physical activity during the school day, as well as ensuring they expended greater amounts of energy during physical activity sessions. The interventions targeted school curriculum (related to PE classes specifically and whole curriculum generally), teacher

training, educational materials, changes to the format of the school day, and accessibility to exercise equipment. Interventions included: training sessions for teachers (to learn more effective ways to promote physical activity and to incorporate it into curricula); training materials including kits, packages of materials to be used in curricula, and materials to be given to students and parents. Packages included teaching notes on exercise, how the body works, healthy eating and nutrition. They also targeted PE classes by increasing the level of activity students engaged in during these classes, introduced activities geared to the age and level of development of the child, and put greater emphasis on games. Students were also encouraged to be more active outside of school during leisure time. The curriculum focused on creating a positive self-image through awareness of physical activity benefits. Curriculum changes were also implemented in other courses, such as science, where discussions of healthy eating and physical activity were incorporated. Some interventions also included changes to the food provided in school cafeterias so as to increase the number of healthy food choices. Other strategies included a risk factor assessment of students to identify students with established risk factors and develop a plan to reduce their risk through increased physical activity, healthy nutrition, and goal attainment.

Adverse effects of the intervention

There are a number of advantages to school-based physical activity promotion strategies. For example, school-based strategies targeting all students through curriculum, ensures 100% of students are exposed to the intervention, thereby increasing the reach of these interventions. In addition, targeting the interventions at all students in a school could avoid stigmatizing children who are overweight, obese, or with established risk factors for chronic diseases. Stigmatization of children and adolescents has been shown to have a negative impact on self esteem, self worth, and mental health. Therefore interventions directed at entire school populations could effectively avoid these negative impacts. However, it is also likely that stigmatization will not be avoided, particularly when unfit students must engage in rigorous physical activity in front of their peers. In fact the more rigorous the activity, the greater the likelihood that certain students will be identified as being particularly unfit by their peers, and potentially subjected to ridicule. In addition, having to change clothes to engage in physical activity may be particularly stressful for overweight and obese students and it is difficult to identify strategies to reduce issues associated with changing clothes that would not further stigmatize these students. Another potential adverse effect of school-based physical activity promotion interventions arises from 'forcing' students to engage in rigorous activity when they do not want to. Instead of promoting positive perceptions of exercise this intervention could produce the opposite effect resulting in students not wanting to engage in any activity, and having very negative perceptions. This may result in worse outcomes with respect to activity levels. Furthermore, being made to engage in certain behavior may result in reactance, which means students will do the exact opposite. In both instances it is possible that an even further reduction in physical activity levels could occur. Another adverse effect of school-based interventions related to the development of a reward system, such as a grade, is the loss of the intrinsic motivation to engage in an activity that was previously viewed as fun. In other words students might become unmotivated to engage in physical activity because they now perceive it to be 'work', or they require larger and larger

rewards for doing a behavior they previously engaged in for no reward. Finally, it is possible that soft tissue injuries might occur among students associated with the increased rigorous physical activity.

How the intervention might work

Given school-aged children spend a significant amount of their wakeful hours either in transit to or in the school setting, and that in many countries, all children attend school until they reach adolescence, school-based physical activity promotion interventions have potential to reduce population-wide chronic diseases. School-based interventions can target simultaneously, children both at risk and not at risk for future chronic diseases, and can increase both knowledge and behavior conducive to healthier lifestyles. The intent of school-based physical activity interventions is to increase the overall percentage of children and adolescents engaged in physical activity each day and to increase the duration of moderate to vigorous activity engaged in on a weekly basis. The aim is to create a school environment that is more conducive to achieving higher rates of physical activity among children and adolescents as well as increasing the time spent engaged in moderate to vigorous physical activity. Generally this means significant changes to school curriculum that support increased time for physical activity as well as increased levels of activity during this time. There is an important opportunity through school-based interventions to ensure greater attention to improving knowledge of chronic disease prevention and health promotion, and by providing students with both knowledge and the opportunity to be more active during the school day, children will develop healthier behaviors that may track in adulthood.

Why it is important to do this review

A number of reviews have been conducted on similar topics. For example, [Summerbell 2005](#) explored the impact of interventions to prevent obesity in children, and [Thomas 2004a](#) assessed the impact of strategies to promote healthy body weight in children and adolescents. Both reviews are of rigorous methodological quality and provide important direction for healthy body weight promotion policies and programs. What is difficult to ascertain from these reviews is the specific impact of school-based strategies on healthy body weight, as well as the specific role of physical activity in reducing risk factors associated with chronic diseases. In both the [Summerbell 2005](#) and [Thomas 2004a](#) reviews, interventions were multifaceted, meaning the interventions targeted multiple behaviors including diet and physical activity simultaneously, and that they were implemented congruently in multiple settings such as the community, schools, and public places. In both reviews it is unclear what specific contribution the school setting had on intervention effectiveness as well as the individual contribution of physical activity on improved health status measures, such as blood pressure, blood lipids, weight, and fitness measures.

However, given school-aged children spend such a significant amount of time in the school setting, and that many barriers exist to participation in physical activity outside of the school setting (e.g. resources, availability), it is particularly important to understand the extent to which school-based physical activity promotion interventions are effective in increasing activity and fitness levels. When school-based interventions are combined with broader community-based interventions, it is difficult to ascertain the impact of school-based strategies. However, in developing

comprehensive physical activity or chronic disease prevention strategies, it is crucial to incorporate effective school-based strategies. Therefore, it is timely, given the worldwide attention to physical inactivity, that a review focused solely on the effectiveness of school-based physical activity interventions be conducted and regularly updated.

OBJECTIVES

The purpose of this systematic review was to assess, analyze, and draw conclusions about the effectiveness of school-based interventions in promoting physical activity and fitness in school-attending children and adolescents aged 6 to 18 years. The specific objectives were:

- to evaluate the effects of school-based interventions on promoting physical activity and fitness in children and adolescents;
- to evaluate the effects of school-based interventions on improving measures of physical health status;
- to determine if certain combinations or components (or both) of school-based interventions are more effective than others in promoting physical activity and fitness in this target population.

METHODS

Criteria for considering studies for this review

Types of studies

In the original review and this update the following criteria were used to select studies. The intervention had to be relevant to public health practice (meaning the focus was on health promotion from an individual or population-wide perspective, was not physician or clinic based); b) the intervention could be implemented, facilitated, or promoted by staff in local public health units, meaning interventions that were only relevant to other health professionals (e.g. physicians), or fitness experts (e.g. personal trainers) were not considered 'regular' practice for public health professionals; c) the intervention was implemented in a school setting and was aimed at increasing physical activity and fitness in children and adolescents.

Furthermore, in this update we included data only from randomized controlled trials (RCTs) with a minimum intervention duration of 12 weeks.

Three unique changes were made to the protocol of this update in comparison to the original review.

1. Due to the availability of numerous RCTs, both those included in the original review and those that became available after the original review was published in *The Cochrane Library*, the inclusion/exclusion criteria were modified to include only those studies that were RCTs. This change in inclusion criterion resulted in a number of non-RCTs included in the original review being excluded from the update.
2. Studies had to have at a minimum an intervention duration of at least 12 weeks otherwise they were excluded from the update. Again this resulted in some studies included in the original review being excluded from the update.
3. Studies not aimed at the general population (e.g. studies including obese children only, or only low-active children) were

excluded from this update. Again this resulted in a small number of studies included in the original review being excluded in the update.

The review authors are aware that post hoc questions are susceptible to bias ([Higgins 2011](#)); however, in light of the growing body of literature on the effectiveness of school-based physical activity promotion interventions, we believe the changes in inclusion and exclusion criteria were necessary to ensure the most rigorous evidence answering our research question was included in this update.

Types of participants

Studies that included school-attending children and adolescents between the ages of 6 to 18 years were included in this review. This included all otherwise healthy children and adolescents whether they were overweight, obese, or not. We excluded studies where participants received a physical activity intervention as part of a treatment regimen for a specific critical illness or comorbidity (e.g. diabetes).

Types of interventions

Strategies

Any study that assessed educational, health promotion, counseling, and management strategies focused on the promotion of physical activity and fitness, that were or could be provided by public health professionals was included in this review.

Interventions included

The range of interventions included changes to school curriculum; changes in school routines to increase time spent by students being physically active; increase in the time students engaged in vigorous physical activity during PE classes; provision of equipment; training for teachers in incorporating physical activity into school curriculum and routines; and educational materials for teachers, students, and parents. In some instances the intervention included strategies to engage parents in the intervention, as well as community-based strategies, mass media, and policy development.

Setting

Studies where the interventions were targeted primarily within the school setting were included in this review. In some instances interventions were also implemented in the community and home setting in addition to the school-based interventions, although the primary focus had to be the school setting. We excluded studies when the intervention was conducted entirely outside of the school setting (e.g. community setting, public place, recreation facility, physician office, camp setting).

Types of comparisons

Generally, these programs were compared to standard, currently existing PE programs in schools.

Intervention personnel

The interventions were implemented by a variety of professionals including PE teachers, classroom teachers, research staff, health professionals, peers and in a few studies parents.

Indicators of theory and process

In a number of studies the development of the intervention was guided by one or more theories such as the health-belief model, social-cognitive theory, stages of change, or a combination. Where theory informed the development of the intervention this was noted.

Interventions excluded

Interventions excluded from this review included those that were not focused on changing physical activity and fitness levels or were not implemented primarily in the school setting among healthy children aged 6 to 18 years or were implemented by physicians, or fitness experts.

Types of outcome measures

To be included, studies had to report one or more of the following outcomes, presenting a baseline and a post intervention measurement. These data were used to evaluate change from baseline if not reported in the study.

Primary outcomes

- Rate of moderate to vigorous physical activity (MVPA) (per cent of sample engaged in MVPA). The rate of MVPA was assessed either through self-report or through the use of accelerometers during both school or non-school (or both) time. The rate was calculated by dividing the number of students engaged in MVPA by the total number of students allocated to either the intervention or control group.
- Duration of physical activity (time spent engaged in MVPA). Duration of physical activity was measured as the total minutes per hour or week spent engaged in MVPA generally through self-report, although some studies collected these data via accelerometers.
- Television viewing (time spent watching TV). Television viewing was measured by self-report or parental report as the minutes per hour or week spent watching television, outside of school.

Secondary outcomes

- Mean systolic blood pressure (mmHg). This outcome was measured either manually using a mercury sphygmomanometer or via a Dinamap machine. The timing of when blood pressure was measured differed significantly across studies with timing varying between 5 and 15 min following active periods during school hours. Additionally, in some studies the average of three measures taken one minute apart

were used, in others five measures were averaged, and in others the second and third of three measures were averaged.

- Mean diastolic blood pressure (mmHg). This outcome was measured in the same way as systolic blood pressure.
- Mean blood cholesterol (mg/dL). Blood samples were taken for some studies after fasting, and for others with no fasting. Blood samples were taken by health professionals trained to follow a given protocol and sent for processing.
- BMI (kg/m²). This outcome was measured by trained health professionals using calibrated scales. However, differences existed across studies in which clothes were worn by participants during measurement; and when height and weight were measured during school time.
- Maximal oxygen consumption (VO₂max) (mL/kg/minute). This outcome was measured in different ways by trained professionals. In some instances pulse rate recovery was used as a proxy for VO₂max and in other instances actual maximal oxygen uptake was measured.
- Pulse rate (beats/minute). This outcome was measured by trained professionals during school time, during seated rest. It was usually taken at the same time as blood pressure.

Timing of outcome measurement

Outcomes were primarily measured at baseline and immediately post intervention. In a small subset of studies outcomes were measured six months, nine months, 12 months, and, in one study, up to four years post intervention.

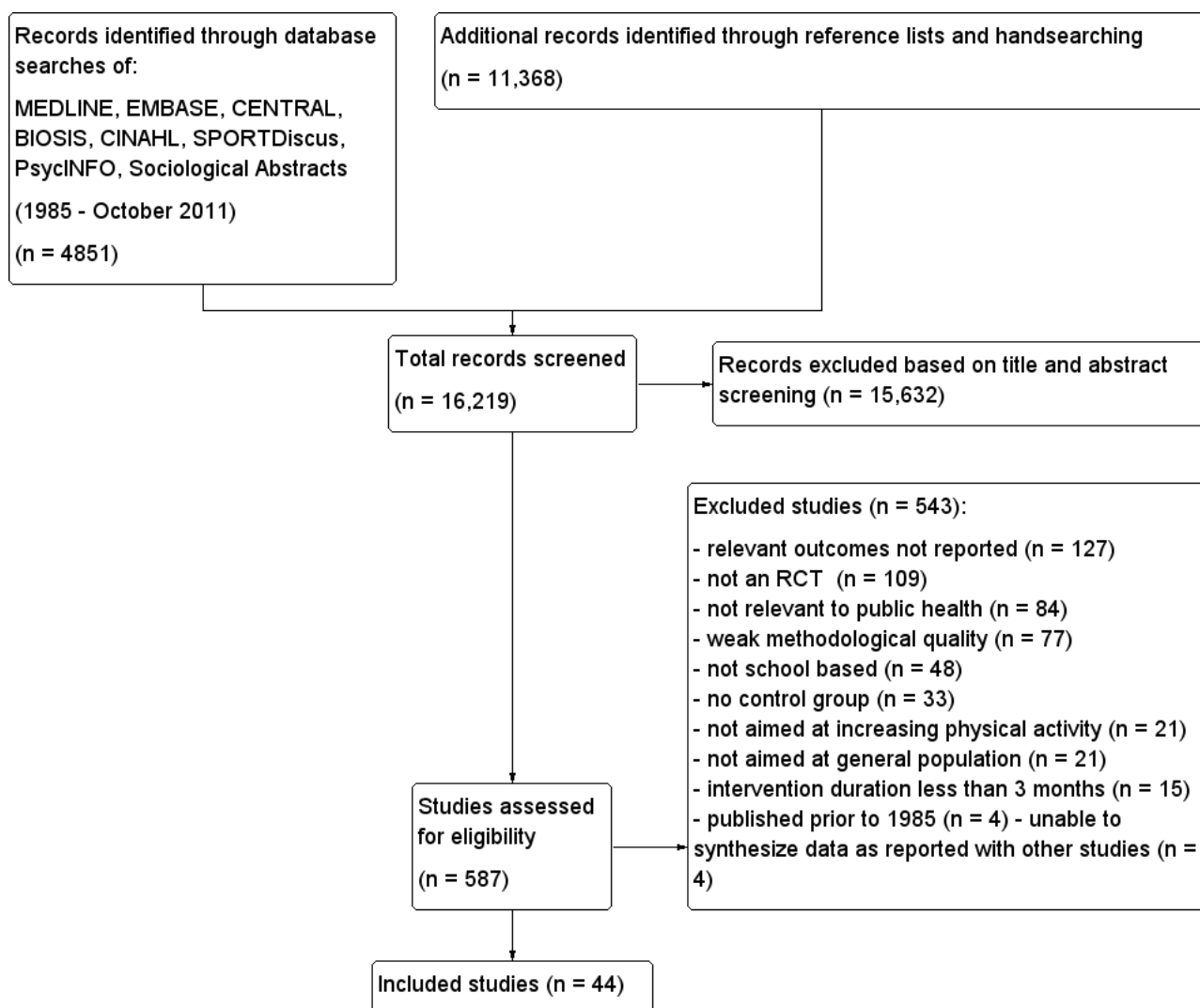
Search methods for identification of studies

Electronic searches

The search strategy, was developed to be inclusive and rigorous ([Higgins 2011](#)) and consistent with The Cochrane Collaboration methodology for conducting a comprehensive search of the literature.

For the original review the following databases were searched from 1985 to July 2007: MEDLINE, BIOSIS, CINAHL, EMBASE, SPORTDiscus, PsycINFO, Sociological Abstracts and the Cochrane Central Register of Controlled Trials (CENTRAL). For the updated review, the same databases were searched again to capture studies published between July 2007 to October 2011. Search strategies for each database are included in [Appendix 1](#). Additional key words of relevance were detected during initial electronic searches. The search strategies were then modified to incorporate these terms. The MEDLINE search strategy was adapted for use in the above databases. Studies were not excluded on the basis of language. For an overview of the search process see [Figure 1](#).

Figure 1. Study flow diagram.



Searching other resources

Contacting experts

Experts in the field of physical activity promotion in children and adolescents were contacted with a view to seeking additional references.

Reference lists checked

We identified additional studies by searching the reference lists of included studies and (systematic) reviews, meta-analyses, and health technology assessment reports.

Data collection and analysis

Selection of studies

The review team was composed of a health services researcher (MD), a project coordinator (KD), program manager (HH), and research assistants (DT, PR, for the original review and RL, for this update) from an academic research center. Where multiple publications for the same study existed, a project account was created and relevant data extracted from all articles.

The abstracts from all search strategies were imported into Reference Manager and screened independently by RL, HH, and KD. Project accounts (studies) judged as being potentially relevant were retrieved in their entirety and assessed for relevance independently by two review authors (MD, RL) using a standardized tool. Where disagreement occurred, discussion ensued until consensus was achieved. Selection criteria for the original review included: a) an intervention relevant to public health practice was described (meaning the focus was on health promotion from an individual or population-wide perspective, was not physician or clinic based); b) the intervention could be implemented, facilitated, or promoted by staff in local public health units, meaning interventions that were only relevant to other health professionals (e.g. physicians), or fitness experts (e.g. personal trainers) were not considered 'regular' practice for public health professionals; c) the intervention was implemented in a school setting and was aimed at increasing physical activity and fitness in children and adolescents; d) outcomes were reported for children and adolescents (aged 6 to 18 years); and e) the study design was prospective and included a control group. New selection criteria were added for the update including: f) the study was an RCT; g) the intervention was targeted at all school children; and h) the intervention was implemented

for 12 or more weeks. All criteria had to be met for a study to be included in the review. Those studies that were deemed relevant were then assessed for risk of bias. An adapted PRISMA (preferred reporting items for systematic reviews and meta-analyses) flow-chart of study selection is attached ([Figure 1](#)) ([Liberati 2009](#)).

Data extraction and management

For this update three review authors (MD, RL, KD) independently abstracted relevant population and intervention characteristics for all new studies using standard data extraction templates (see [Characteristics of included studies](#), [Table 1](#), [Appendix 3](#), and [Appendix 4](#)). All disagreements were resolved by discussion. Any relevant missing information was sought from the primary author of the study. Data from all new studies were extracted using the same data extraction tool as used in the original review ([Thomas 2004b](#)). Extracted data included year and country of study, research design, sample, intervention (descriptors, theoretical framework, provider, setting, target group, target group size, consumer involvement), intervention duration and intensity, length of follow-up, and outcome data.

Dealing with duplicate publications

Where multiple publications for the same study existed, a project account was created and relevant data extracted from all articles. The article containing the most complete data on the project was identified as the primary article for a project account. All other related articles were identified as companion articles for a project account. All primary and companion article groupings are available in the section [Included studies](#). The final data collection point for each outcome in each study has been used to assess intervention effectiveness.

Assessment of risk of bias in included studies

In the original review the methodological rigor of included studies was assessed using a previously developed and tested quality assessment tool ([Thomas 2004b](#)). For the update all studies from the original review as well as studies identified for this update were assessed independently for risk of bias by two of three review authors (MD, RL, KD). MD assessed all studies for risk of bias while RL and KD each conducted risk of bias on approximately half of the studies. Critical assessments were made separately for each of seven domains with judgments of low risk of bias, high risk of bias, and unclear risk of bias ([Higgins 2011](#)). The following domains were assessed: sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting, and two 'other issues': control of confounders, and data collection methods, which were two criteria used in the original review to assess methodological quality ([Thomas 2004b](#)). Disagreements were resolved through discussion until consensus was reached.

We assessed if the allocation sequence was adequately generated and likely to produce comparable groups. If the investigators utilized and described a random component in the sequence generation process we a

ssigned a judgment of low risk of bias. If there was no description of allocation sequence given beyond a statement claiming to allocate participants randomly, a rating of unclear risk of bias was given.

We also assessed whether the allocation sequence was adequately concealed prior to and during recruitment. If the investigators

utilized and described an adequate process for concealing the allocation sequence we assigned a judgment of low risk of bias.

If the process was not adequate a rating of high risk of bias was assigned. If there was no description of the process of allocation concealment a rating of unclear risk of bias was given.

For blinding, we assessed whether any steps were taken to blind participants, intervention providers, and outcome assessors to which group participants were allocated. If adequate blinding occurred a rating of low risk of bias was given. If blinding was not adequate, we assigned a judgment of high risk of bias, and if it was not described, a judgment of unclear risk of bias.

We assessed whether incomplete data were adequately addressed. Where studies did not report intention-to-treat (ITT) analysis, review authors assessed how data related to attrition and exclusions were reported and whether the data were comparable to the total randomized number. A judgment of low risk of bias was given when incomplete data were addressed adequately. A judgment of high risk of bias was given when incomplete data were not addressed adequately and unclear risk of bias if incomplete data were not addressed.

For selective outcome reporting, we assessed whether reports of the study were free of suggestion of selective outcome reporting. Where all outcomes identified a priori were reported upon a rating of low risk of bias was given. When prespecified outcomes were not reported or outcomes were not prespecified and given no justification, a rating of high risk of bias was given. If there was insufficient information to permit judgment, we assigned a rating of unclear risk of bias.

We assessed the extent to which potential confounders were assessed in the primary studies and whether differences at baseline in these variables across groups were accounted for in the analysis. Studies that assessed all important confounders and accounted for differences at baseline (if relevant) were given a rating of low risk of bias. Those that did not assess for and take into account all relevant confounders and those that either did not assess most relevant confounders or did not account for differences at baseline in the analysis (or both) were given a rating of high risk of bias. Where there was not enough information to assess this criteria, we assigned a rating of unclear risk of bias.

The reliability and validity of all data collection measures were also assessed and data extracted only for those outcomes for which some degree of reliability and validity was demonstrated. However, in this literature the degree to which validity was established in the most rigorous sense, for self-reported physical activity levels was limited to construct or face validity. The majority of studies measured physical activity rates through self-report. Therefore, this criterion was not overly helpful in discriminating studies of lower risk of bias.

Although in the original review, studies judged as having significant limitations were removed, none of the new studies identified for this update were removed from further analysis as a result of being judged to have a high risk of bias.

Measures of treatment effect

No recalculations were performed. Unless otherwise stated, all data are presented in the format mean and standard deviation (SD) with

95% confidence intervals (CI), where provided. Results with $P > 0.05$ are reported as not significant (NS).

Unit of analysis issues

Generally the unit of analysis was either classes or schools depending on how groups were allocated to intervention and control groups. Attention was paid to the extent to which the appropriate unit of analysis was used in data analysis. However, in some studies individuals were randomly allocated to intervention and control groups and this was noted as needed in the risk of bias assessment.

Dealing with missing data

Relevant missing data were sought from the primary authors. Evaluation of important numerical data such as screened, eligible, and randomized participants as well as ITT and per-protocol (PP) populations was conducted. Attrition rates, for example drop-outs, losses to follow-up, and withdrawals, were investigated.

Assessment of heterogeneity

Variation in the interventions, populations, and outcomes measured made it inappropriate to combine the results statistically across studies, therefore the results are synthesized narratively. For example, the populations studied varied greatly in socioeconomic status, ethnicity, and country. No two school-based physical activity promotion programs had the same combination of interventions. Furthermore, the duration, frequency, and intensity of interventions varied greatly across studies. Finally, the outcomes were measured differently across studies: some measured television viewing as minutes per hour while some measured in minutes per week. Due to this level of variation among studies, meta-analysis was deemed inappropriate even for those outcomes such as systolic and diastolic blood pressure, BMI, and blood cholesterol where greater standardization of the measurement existed. Heterogeneity across studies was assessed by visually evaluating the results for each outcome in tables. When heterogeneity was suspected, we assessed potential reasons for the differences by examining individual study characteristics and those of subgroups of the main body of evidence.

Assessment of reporting biases

Assessment for reporting biases was conducted. However, published protocols for all of the studies included in this update were not identified through our search strategy. Therefore, it is not possible to know with certainty if all outcomes that were meant to be reported on actually were in the published reports. It appears, from the published reports included in this update, that all studies reported on the outcomes that they intended to as reported in the Methods sections of the published papers.

Data synthesis

Each study was summarized and described according to variables such as characteristics of participants, characteristics of interventions, follow-up, and outcomes measured. Results are summarized narratively across all outcomes.

Subgroup analysis and investigation of heterogeneity

Only those subgroup analyses conducted in the primary studies are reported on. This was limited to age and gender.

Sensitivity analysis

Given meta-analysis was not conducted sensitivity analyses were not conducted in this review.

RESULTS

Description of studies

A total of 13,841 records related to physical activity interventions with children and adolescents were identified in the original review. Of these, 302 studies were assessed for eligibility, and 26 were deemed of sufficient quality to be included in the original review. The most common reasons studies were judged as not relevant were data on relevant outcomes for children and adolescents (aged 6 to 18 years) were not reported, and the intervention was not an intervention normally performed by public health professionals. For example, the intervention was conducted by a physician in a physician's office, or by a fitness specialist in a fitness center.

For the update, when the new inclusion and exclusion criteria were applied (i.e. RCTs only, all children in a school, and intervention duration of 12 weeks), 12 of the original 26 studies were excluded: nine because they were not RCTs ([Alexandrov 1988](#); [Berenson 1993](#); [Graf 2005](#); [Klepp 1994](#); [Lionis 1991](#); [Manios 1999](#); [Marcus 1987](#); [Plotnikoff 1999](#); [Sallis 1997](#)); one was excluded because the study sample included overweight or obese children only ([Carrel 2005a](#)) and two others were excluded because the intervention was shorter than 12 weeks ([Eliakim 1996](#); [Fardy 1996](#)). Therefore, this update includes 14 of the original 26 studies ([Bayne-Smith 2004](#); [Burke 1998](#); [Bush 1989](#); [Ewart 1998](#); [Haerens 2006](#); [Luepker 1996](#); [Petchers 1988](#); [Robinson 1999](#); [Simon 2004](#); [Stephens 1998](#); [Stone 2003](#); [Trevino 2004](#); [Verstraete 2006](#); [Walter 1988](#)).

In addition, the search strategy for this update from July 2007 to October 2011 identified 2378 records related to physical activity interventions with children and adolescents. Of these, 285 unique studies were assessed for eligibility. Of the 285 unique studies, 30 met all relevance criteria and were included in this update ([Angelopoulos 2009](#); [Araujo-Soares 2009](#); [Barbeau 2007](#); [Colin-Ramirez 2010](#); [Dishman 2004](#); [Donnelly 2009](#); [Dorgo 2009](#); [Gentile 2009](#); [Haerens 2009](#); [Jones 2008](#); [Kipping 2008](#); [Kriemler 2010](#); [Li 2010](#); [Lubans 2009](#); [Martinez 2008](#); [McManus 2008](#); [Neumark-Sztainer 2009](#); [Neumark-Sztainer 2010](#); [Peralta 2009](#); [Reed 2008](#); [Salmon 2008](#); [Singh 2009](#); [Singhal 2010](#); [Walther 2009](#); [Wang 2008](#); [Webber 2008](#); [Weeks 2008](#); [Williamson 2007](#); [Wilson 2011](#); [Young 2006](#)). The most common reasons studies were judged as not relevant were: the design was not an RCT; data on relevant outcomes for children and adolescents (aged 6 to 18 years) were not reported; or the intervention was not school based. This update includes 44 studies (14 from the original review and 30 from the update), and represents complete data for 36,593 study participants. A flow diagram depicting these results is presented in [Figure 1](#). Citations for the 543 excluded studies are available in the [Excluded studies](#) section, and reasons for exclusion are provided in the [Characteristics of excluded studies](#) table.

In addition to the information in the characteristics of Included studies tables, more detail is provided for each study in [Table 1](#) (overview of included studies), [Appendix 3](#) (summary of baseline characteristics for each included study), and [Appendix 4](#) (Matrix of endpoints for each study).

The majority of studies were conducted in the US (24), Australia (5), Belgium (3), China (2), and Greece (1). Several other countries, mostly in Europe, conducted one study each, as well as one study from Canada and one from India. All but 11 studies involved children 12 years of age and under at baseline, three of which included participants who were 16 years at baseline. The majority of children were between nine to 11 years of age at baseline. Others also targeted to receive interventions during these studies included parents, teachers, and cafeteria staff. The majority of studies evaluated outcomes immediately following the intervention ($n = 34$), with one study evaluating outcomes two weeks post intervention (Wilson 2011), one at three months (Haerens 2009), three at six months (Burke 1998; Gentile 2009; McManus 2008), one at nine months (Araujo-Soares 2009), and four at 12 months (Li 2010; Petchers 1988; Salmon 2008; Singh 2009). The samples were comprised of multiple ethnicities including African-American, Asian, Australian, European, First Nations/Aboriginal, Greek, Hispanic, Scandinavian, and white participants. Generally, the interventions were implemented in urban centers among all socioeconomic classes.

All studies had intervention components that were delivered in the school setting. Some projects provided additional interventions in the home, community, physician offices, local theatre, and via the telephone or computer. A number of studies ($n = 15$) focused primarily on grade school programs that included some parental involvement (Burke 1998; Bush 1989; Colin-Ramirez 2010; Ewart 1998; Gentile 2009; Haerens 2006; Lubans 2009; Luepker 1996; Neumark-Sztainer 2010; Petchers 1988; Reed 2008; Robinson 1999; Stone 2003; Trevino 2004; Young 2006). The three most common intervention providers across the 44 included studies were classroom teachers ($n = 28$), members of the research team ($n = 13$), and PE teachers ($n = 9$). Specialist teachers, nurses, social workers, physicians, volunteers, psychologists, dentists, nutritionists, and peers were occasionally identified as intervention providers.

All studies included a control group that represented either a school or group of schools from a different community, city, or state that did not receive the school-based intervention. However, in some studies the control schools received other physical activity promotion interventions provided through other health organizations or venues or standard PE curriculum. The duration of the interventions varied greatly from a minimum of 12 weeks to six years, with six studies reporting intervention periods of three years or greater (Bush 1989; Donnelly 2009; Luepker 1996; Simon 2004; Walter 1988; Wang 2008).

Several theoretical models were used to develop the physical activity interventions, although in several studies it was unclear if a theoretical model had been used. The most commonly used theories were social cognitive theory and the health-belief model while self-determination theory, PRECEDE, social learning theory, and the transtheoretical model were used to a lesser extent. Social cognitive theory suggests that motivations and actions are controlled by thought and in order for behavior change to occur, an individual will anticipate an outcome by considering: perceived self-efficacy (the belief in one's capabilities); situation-

outcome (belief that consequences will occur without interfering personal action); and action-outcome (belief a behavior will lead to an outcome) (Bandura 1982; Luszczynska 2005). The health-belief model (Rosenstock 1966) acts on the premise that an individual's behaviors are affected by perceived susceptibility of developing health problems, perceived impact of health problems on one's quality of life, and the belief that changing behavior will be beneficial in avoiding the health problem (Hochbaum 1958; Rosenstock 1966). PRECEDE uses cues, prompts, and reinforcements to alter behavior (Skinner 1953). This framework is a cost-benefit evaluation that provides a comprehensive structure for assessing health and quality of life needs for designing, implementing, and evaluating health promotion programs (Green 1974). Social learning theory proposes that behavior change is affected by environmental influences, personal factors, and attributes of the behavior itself (Bandura 1977). The transtheoretical model suggests that individuals progress through six stages (precontemplation, contemplation, preparation, action, maintenance, and termination) to enable health behavior change and the individual's stage of change must match the messages in order to be effective in changing the behavior (Prochaska 1997).

The studies reported in this review differed in funding levels, the number of project staff, and the resources available to deliver the program or training provided for the delivery of the program. Further, although all of the projects were primarily school-based, none of the projects used the same combination of interventions with the same intensity, making each project unique. However, some similarities with respect to the ways in which the interventions were delivered were observed. For example, almost all studies implemented curricula focused on increasing time spent in physical activity and on increasing knowledge about the benefits of an active lifestyle. The majority of studies also distributed printed or audio-visual educational materials primarily to students, but sometimes to parents as well, often in association with educational sessions. About a quarter of the studies involved school-based activities other than school curricula (e.g. school fun nights, walkathons, educational materials or sessions (or both) for school staff and parents, game equipment). Community-based interventions, such as training sessions and workshops for parents and parent involvement in home-based physical activities (homework), were used in conjunction with school-based interventions in about half of the studies. Finally, some studies also reported the use of counseling, health screening, and support groups.

Risk of bias in included studies

The results of the risk of bias assessment for the 44 studies are presented in Figure 2 and Figure 3. The most notable methodological weakness of these studies was the lack of blinding of participants, providers, outcome assessors, and data analysts. More specifically most studies in this review did not have blinded outcome assessors. For example, for behavioral outcomes in most studies the data were collected through student self-report (e.g. time engaged in physical activity, time spent watching television). It was also likely, though difficult to determine, that the students were aware of the outcomes being assessed.

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

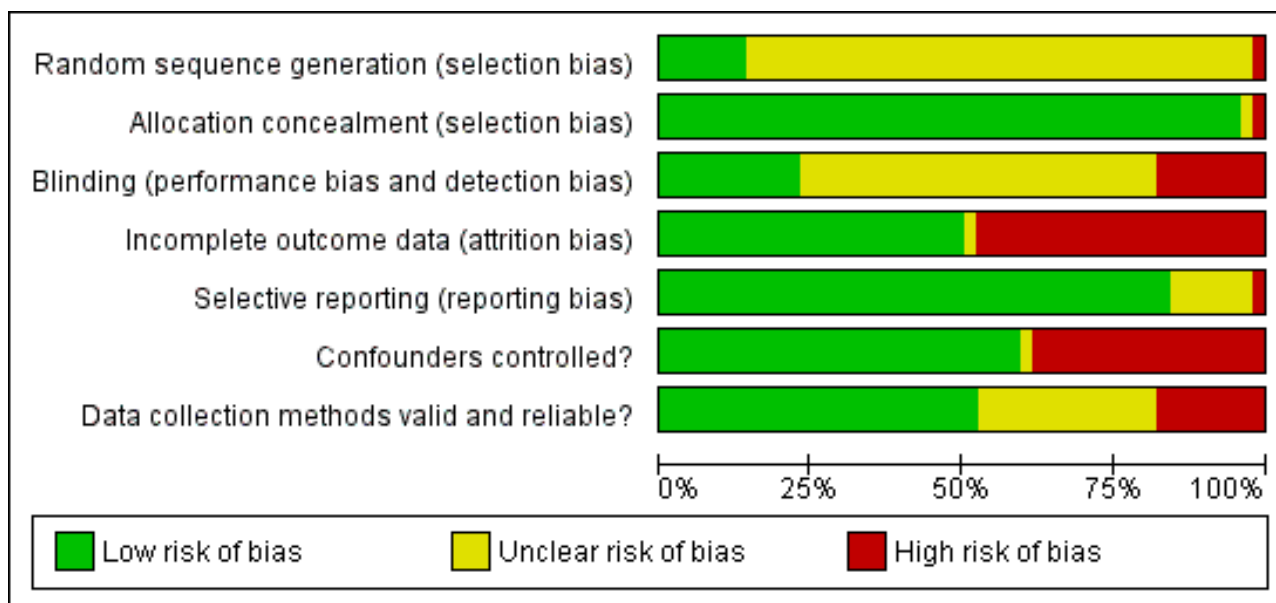


Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding (performance bias and detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Confounders controlled?	Data collection methods valid and reliable?
Angelopoulos 2009	+	+	?	-	+	+	+
Araujo-Soares 2009	?	+	?	+	+	-	+
Barbeau 2007	?	+	?	-	+	-	-
Bayne-Smith 2004	?	+	?	?	+	-	-
Burke 1998	?	+	?	+	+	+	-
Bush 1989	?	+	?	-	+	+	?
Colin-Ramirez 2010	?	+	-	+	?	-	?
Dishman 2004	?	+	?	+	+	+	+
Donnelly 2009	?	+	+	+	+	+	+
Dorgo 2009	?	+	?	-	+	-	+
Ewart 1998	?	+	+	+	+	?	?
Gentile 2009	?	+	?	-	+	+	+
Haerens 2006	?	+	?	-	+	+	+
Haerens 2009	?	+	?	-	+	+	+
Jones 2008	?	+	-	-	+	+	+
Kipping 2008	?	+	+	-	+	+	-
Kriemler 2010	+	+	-	+	+	+	+
Li 2010	?	+	+	+	?	-	?
Lubans 2009	?	+	+	-	+	-	+
Luepker 1996	?	+	?	+	+	+	+
Martinez 2008	+	+	-	+	+	-	+
McManus 2008	+	+	-	-	-	+	+

Figure 3. (Continued)

McManus 2008	+	+	-	-	-	+	+
Neumark-Sztainer 2009	?	+	?	-	+	-	?
Neumark-Sztainer 2010	?	+	-	+	?	-	?
Peralta 2009	+	+	+	+	+	+	-
Petchers 1988	?	+	?	-	+	-	+
Reed 2008	?	-	?	-	+	+	-
Robinson 1999	?	+	+	+	+	+	+
Salmon 2008	-	?	-	-	+	+	+
Simon 2004	?	+	?	+	+	+	+
Singh 2009	?	+	-	+	+	+	+
Singhal 2010	?	+	?	+	?	-	-
Stephens 1998	?	+	?	-	+	+	?
Stone 2003	?	+	?	+	+	+	+
Trevino 2004	+	+	+	+	+	+	?
Verstraete 2006	?	+	?	-	+	-	?
Walter 1988	?	+	?	+	+	+	?
Walther 2009	?	+	?	-	+	-	+
Wang 2008	?	+	?	-	+	+	-
Webber 2008	?	+	+	-	+	-	?
Weeks 2008	?	+	?	-	+	+	?
Williamson 2007	?	+	?	+	+	-	+
Wilson 2011	?	+	+	+	?	+	+
Young 2006	?	+	?	+	?	-	?

Another important limitation of this literature was the lack of consistency in how outcomes were measured across studies. While the data collection procedures for the physical health measures (blood pressure, cholesterol, BMI, pulse, and maximal oxygen uptake (VO₂max)) were generally more objective than the behavioral measures, there were still significant differences in how the data were collected. Even BMI, which was measured most consistently across studies, differed in terms of the amount of clothing worn by participants. Blood pressure measures were least consistent where in some studies blood pressure was taken manually using a mercury sphygmomanometer, and in others electronically using a Dinamap machine. Furthermore, the timing of when blood pressure was measured differed significantly across studies with timing varying between 5 and 15 min following active periods during school hours. Additionally, in some studies the

average of three measures taken one minute apart were used, in others five measures were averaged, and in others the second and third of three measures were averaged. For cholesterol, while the procedures for taking a blood sample and analyzing the sample were similar, about half the studies used nonfasting blood samples and the other half used fasting blood samples. Finally, for the six studies measuring VO₂max half measured blood gases following exertion, while the other half used pulse rate recovery as a proxy for maximal oxygen uptake. Data collection methods were reported to be valid and reliable in a little over half of the included studies. In the remaining studies it was either unclear whether methods were valid and reliable or methods were used that were subject to bias.

While all of the studies were RCTs, generally there was little description across studies of how the randomization sequence

was generated. Another limitation of this literature was unit of allocation errors. In some of the studies allocation was often by institution (e.g. school) or classroom, but assessment occurred at the level of the individual. Furthermore, in very few cases were measures taken to account for clustering effects within schools and only just over a third of studies ($n = 16$) reported that they conducted an ITT analysis. This, along with the other risks of bias identified in this literature, has likely resulted in an overestimation of treatment effects.

Components for which many studies were considered to have low risk of bias were only observed for allocation concealment. For all but one study, allocation to treatment or intervention groups occurred at one point in time after study recruitment, and was unknown in one other. Studies were also found to be free of selective reporting; however, because many of these studies did not have published protocols it is impossible to know for certain if all outcomes were reported on. For over 90% of studies, all of the study's prespecified outcomes of interest were reported upon. For the most part, confounders were adequately controlled in over 50% of studies although for some studies important confounders such as socioeconomic status and parental education were not accounted for. Finally, many studies attempted to evaluate the extent to which the intervention was implemented as intended (intervention integrity), and some conducted process evaluations in addition to evaluating intervention effectiveness. However, cost-effectiveness was assessed in only one study. Finally, adverse effects associated with exposure to the school-based physical activity interventions were generally not addressed in the published reports of studies.

Effects of interventions

See: [Summary of findings for the main comparison School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18 years](#)

The outcomes included in this review represent two broad outcome categories: behavior and physical health status. Specific outcomes related to behavior included: physical activity rates (five studies), duration of physical activity (23 studies), and time spent watching television (16 studies). Specific outcomes of physical health status included: mean systolic blood pressure (16 studies), mean diastolic blood pressure (16 studies), blood cholesterol level (10 studies), BMI (32 studies), VO_{2max} (six studies), and pulse rate (six studies).

Primary outcomes: behavior (physical activity)

Physical activity rates

Seven studies reported results for physical activity rates in the original review ([Alexandrov 1988](#); [Fardy 1996](#); [Klepp 1994](#); [Marcus 1987](#); [Petchers 1988](#); [Simon 2004](#); [Verstraete 2006](#)). However, four of these were excluded from this update ([Alexandrov 1988](#); [Fardy 1996](#); [Klepp 1994](#); [Marcus 1987](#)). In this update an additional two studies have been added to the results presented in [Appendix 5](#) ([Colin-Ramirez 2010](#); [Dishman 2004](#)). In total, this update includes five studies evaluating the impact of school-based physical activity interventions on physical activity rates.

Of these, four studies focused on grade school children only ([Colin-Ramirez 2010](#); [Petchers 1988](#); [Simon 2004](#); [Verstraete 2006](#)), and one reported on grade school and secondary school students ([Dishman 2004](#)). All studies reported results for a mixed sample of

boys and girls combined, except for [Dishman 2004](#), who included girls only. All but one study evaluated impact on physical activity rates immediately following the intervention, while [Colin-Ramirez 2010](#), evaluated impact one year post intervention.

The results were mixed. Two of the studies reported statistically significant positive effects on physical activity rates of children ([Simon 2004](#); [Verstraete 2006](#)), and three did not report statistically significant effects ([Colin-Ramirez 2010](#); [Dishman 2004](#); [Petchers 1988](#)). [Simon 2004](#) reported a statistically significant increase in physical activity rates in those exposed to the intervention compared to those in the control group ($P < 0.0001$), and found that intervention group children were almost three times more likely to be physically active outside of school compared to controls (OR 2.74). The 95% CI ranged from 2.01 to 3.75. [Verstraete 2006](#), who measured MVPA using accelerometers, also reported a statistically significant difference in moderate to vigorous physical activity (MVPA) among children in the intervention group compared to those in the control group ($P < 0.01$), although an effect size and 95% CI were not provided. Children in the intervention group experienced a smaller decrease in MVPA from baseline to follow-up (57% to 53%) compared to the control group (56% to 44%). The results reported by [Colin-Ramirez 2010](#) and [Dishman 2004](#) did not illustrate a trend toward a positive effect, and data to make this assessment were not available for [Petchers 1988](#). The sample sizes of the five studies ranged from 235 to 2111 participants. It is likely all studies had significant power to detect a moderately large treatment effect. With the exception of Simon, the magnitude of effect is relatively small.

Of the two studies reporting statistically significant positive effects the intervention ranged from three months ([Verstraete 2006](#)) to four school years ([Simon 2004](#)), while for those reporting no effect the intervention ranged from one school year to 12 months. Interventions across all studies sought to increase MVPA in children during school hours, and all but one study ([Verstraete 2006](#)) included changes to the curriculum. Among the two studies showing statistically significant positive effects, one involved a comprehensive, intensive intervention comprised of school curriculum changes, printed education materials, greater time spent engaged in MVPA during the school day, audio-visual materials, and community-based strategies, while the second provided printed education materials, game equipment for children to play on, with play cards illustrating how the equipment was to be used. Intervention providers also varied widely from research staff, to teachers, to physical education (PE) teachers, nutritionists, and peers. One of the two studies reporting a statistically significant positive effect used accelerometers to measure physical activity rates ([Verstraete 2006](#)), while all other studies used self-report.

Generally, those studies not reporting a statistically significant effect on physical activity rates implemented similar combinations of interventions, (i.e. school curricula, physical activity sessions, parental involvement, and some community-based activities). Studies reporting a statistically significant positive effect differed slightly from those not reporting an effect on intervention provider, with the former using PE teachers and research staff, while the latter used classroom teachers to implement the intervention.

Duration of physical activity

Duration of physical activity was reported in seven studies in the original review and all but one, [Manios 1999](#), remained in this update ([Bayne-Smith 2004](#); [Ewart 1998](#); [Haerens 2006](#); [Luepker 1996](#); [Robinson 1999](#); [Stone 2003](#)). Interestingly there was no overlap in studies between those that studied physical activity rates, and those that studied duration of physical activity. In this update 16 additional studies were identified that measured the impact of a school-based intervention on duration of physical activity ([Araujo-Soares 2009](#); [Barbeau 2007](#); [Donnelly 2009](#); [Haerens 2009](#); [Jones 2008](#); [Kriemler 2010](#); [Lubans 2009](#); [McManus 2008](#); [Neumark-Sztainer 2009](#); [Neumark-Sztainer 2010](#); [Peralta 2009](#); [Salmon 2008](#); [Webber 2008](#); [Weeks 2008](#); [Williamson 2007](#); [Wilson 2011](#)). In addition, the results of one study in the original review, for which four-year post intervention data were published in 2008 have been added ([Simon 2004](#)). The results are presented in [Appendix 6](#). In total this update includes 23 studies reporting the impact of school-based physical activity interventions on physical activity duration.

Of these, 17 studies reported results for grade school children only ([Araujo-Soares 2009](#); [Barbeau 2007](#); [Donnelly 2009](#); [Haerens 2006](#); [Haerens 2009](#); [Jones 2008](#); [Kriemler 2010](#); [Luepker 1996](#); [McManus 2008](#); [Neumark-Sztainer 2009](#); [Peralta 2009](#); [Robinson 1999](#); [Salmon 2008](#); [Stone 2003](#); [Webber 2008](#); [Williamson 2007](#); [Wilson 2011](#)), two included grade school and secondary school students ([Lubans 2009](#); [Weeks 2008](#)), and three reported results for adolescents only ([Bayne-Smith 2004](#); [Ewart 1998](#); [Neumark-Sztainer 2010](#)). The majority of studies reported results for a mixed sample of boys and girls combined, two reported results for boys and girls separately, and three included girls only. Most studies measured impact on physical activity duration immediately post intervention, while one study measured impact at two weeks post intervention, one at five months, one at six months, one at nine months, one at 12 months, and one at four years. The length of the intervention ranged from 12 weeks to six years, with the median being one to two school years. Two studies in the original review ([Ewart 1998](#); [Stone 2003](#)), and six in the update measured duration of physical activity using accelerometers ([Kriemler 2010](#); [Lubans 2009](#); [McManus 2008](#); [Peralta 2009](#); [Webber 2008](#); [Wilson 2011](#)), although the majority still relied on self report.

Among the studies evaluating duration of physical activity among grade school children only, 12 studies reported statistically significant positive effects ([Araujo-Soares 2009](#); [Barbeau 2007](#); [Donnelly 2009](#); [Ewart 1998](#); [Haerens 2006](#); [Kriemler 2010](#); [Luepker 1996](#); [McManus 2008](#); [Salmon 2008](#); [Simon 2004](#); [Stone 2003](#); [Webber 2008](#)), two of which measured duration of physical activity with accelerometers. However, while [Haerens 2006](#) reported a statistically significant effect overall, further subgroup analysis demonstrated a significant effect for boys only. The remaining studies ($n = 5$) did not report a statistically significant effect on physical activity duration among grade school children. Among the two studies including both grade school and secondary school children, one did not report statistically significant effects ([Lubans 2009](#)), while the second reported a statistically significant effect in favor of the control group ([Weeks 2008](#)). One of three studies evaluating impact on adolescent girls reported a statistically significant positive effect ([Ewart 1998](#)) and two did not ([Bayne-Smith 2004](#); [Neumark-Sztainer 2010](#)). The sample size of the studies ranged from 33 participants to 4019. There did not appear to be a trend indicating that studies with smaller sample

sizes reported non-significant (NS) results more often than larger studies. However, it is possible that some studies with smaller sample sizes were underpowered to detect statistically significant changes in physical activity duration.

The magnitude of effect varied across studies reporting statistically significant effects from just under five min to 45 min more per week of MVPA, and the CIs ranged from as little as 1.4 min to approximately 90 min more per week of MVPA. Similar to physical activity rates, these findings generally represent a relatively modest magnitude of effect. In some studies participants in the intervention group engaged in MVPA longer than control group participants at follow-up, while in other studies, those in the intervention group had a smaller decrease in duration of physical activity in comparison to control group participants. Of the 14 studies in total reporting statistically significant positive effects for children and adolescents combined, the intervention was implemented over 18 weeks to several years. Generally, studies reporting statistically significant effects implemented the intervention over a longer period of time in comparison to those not reporting statistically significant effects. While specific combinations of interventions varied there were some similarities across the studies reporting positive effects. The intervention in all studies reporting statistically significant effects included changes to school curricula, and in many studies printed educational materials. Other interventions included education sessions, audio-visual materials, support groups, self contracts, and community-based interventions. The intervention provider in the majority of studies was classroom teachers; however, other intervention providers included PE teachers, research workers, peers, and physical activity instructors. Generally, those studies not reporting statistically significant effects on duration of physical activity implemented similar combinations of interventions (i.e. printed educational materials, school curricula), by classroom teachers, but for a shorter period of time (i.e. 12 weeks to 10 months).

Time spent watching television

The impact of school-based interventions on television viewing was formerly reported by four studies all of which were included in this update ([Burke 1998](#); [Haerens 2006](#); [Robinson 1999](#); [Simon 2004](#)). In this update 12 additional studies were added ([Colin-Ramirez 2010](#); [Gentile 2009](#); [Jones 2008](#); [Kipping 2008](#); [Lubans 2009](#); [Neumark-Sztainer 2009](#); [Neumark-Sztainer 2010](#); [Peralta 2009](#); [Salmon 2008](#); [Singh 2009](#); [Webber 2008](#); [Williamson 2007](#)). In addition four-year follow-up results for [Simon 2004](#) published in 2008 have been included in this update. The results are presented in [Appendix 7](#). In total this update includes 16 studies evaluating the impact of school-based physical activity interventions on television viewing.

Of these, 13 studies focused on grade school children only ([Burke 1998](#); [Colin-Ramirez 2010](#); [Gentile 2009](#); [Haerens 2006](#); [Jones 2008](#); [Kipping 2008](#); [Neumark-Sztainer 2009](#); [Peralta 2009](#); [Robinson 1999](#); [Salmon 2008](#); [Simon 2004](#); [Webber 2008](#); [Williamson 2007](#)), two reported on participants aged 12 to 14 ([Lubans 2009](#); [Singh 2009](#)), and one reported on adolescents only ([Neumark-Sztainer 2010](#)). The results were generally reported for boys and girls combined, with results for girls only being reported in three studies ([Jones 2008](#); [Neumark-Sztainer 2010](#); [Webber 2008](#)), and one for boys only ([Peralta 2009](#)). Just over half of the studies measured television viewing immediately post intervention, with three measuring impact at six months ([Gentile 2009](#); [Peralta 2009](#); [Neumark-Sztainer 2010](#)) and four at 12 months ([Colin-Ramirez 2010](#); [Salmon 2008](#);

Singh 2009; Webber 2008). All studies measured television viewing through self-report. The length of the intervention ranged from 12 weeks to two school years, with half of the studies implementing interventions for 20 weeks or less.

In total seven studies reported statistically significant positive effects on time spent watching television (Burke 1998; Gentile 2009; Jones 2008; Robinson 1999; Simon 2004; Singh 2009; Webber 2008), and one reported a statistically significant effect in favor of the control group (Salmon 2008). For the two studies reporting results for boys and girls separately, one study found a significant effect in grade school boys six months post intervention, but not in girls (Burke 1998), and the second study did not report a statistically significant effect (Haerens 2006). Of the six studies reporting statistically significant positive results, all demonstrated a significant decrease in the amount of time children spent watching television, compared to the control group. The magnitude of effect ranged from as little as five min less per day to as much as 60 min less per day of television viewing. For example Robinson 1999 reported a 50-minute decrease in television viewing per day, compared to 10 min per day in the control group ($P < 0.001$). Simon 2004 reported that participants exposed to the intervention were half as likely (OR 0.49) to spend more than three hours per day watching television compared to those in the control group ($P < 0.0001$); the 95% CI ranged from 0.35 to 0.69. Burke 1998 reported that six months post intervention boys exposed to the intervention watched five min less per day of television compared to those in the control group ($P < 0.01$). Two studies, Singh 2009 and Webber 2008, reported results at one year post intervention (3 hours and 1 hour less per week, respectively), while a third study, Gentile 2009, reported results at six months post intervention (2 hours less per week). Only one study not reporting a statistically significant effect may have been underpowered to detect a significant effect. In studies reporting 95% CIs, reduction in television viewing ranged from approximately one minute less per week to two hours less per week, generally suggesting modest impact on television viewing, and drawing into question whether these reductions would result in reduced risk for the development of chronic diseases.

Among the seven studies reporting statistically significant effects the length of the interventions varied from 12 weeks to four years. Generally, there did not appear to be noteworthy differences in length of the intervention between studies reporting a statistically significant effect and those not. School curriculum was a component in all studies reporting statistically significant effects, with printed education materials, education sessions, and community-based strategies being implemented in almost all studies reporting statistically significant effects. Interventions occurring in only one study included: counseling, teacher training, physical activity sessions, audio-visuals materials, mass media, and support groups. Among studies reporting a statistically significant positive effect the intervention was more likely to be implemented by a member of the research team, followed by classroom teachers. Among studies not reporting a statistically significant effect, the intervention providers were somewhat more likely to be classroom teachers.

Secondary outcomes: physical health status

Mean systolic blood pressure

Ten studies reported results for mean systolic blood pressure in the original review (Alexandrov 1988; Bayne-Smith 2004; Burke

1998; Bush 1989; Ewart 1998; Graf 2005; Lionis 1991; Luepker 1996; Stephens 1998; Walter 1988). However, three were excluded from the update (Alexandrov 1988; Graf 2005; Lionis 1991). In this update eight additional studies have been added to the results presented in Appendix 8 (Angelopoulos 2009; Kriemler 2010; Martinez 2008; McManus 2008; Reed 2008; Walther 2009; Wang 2008; Young 2006). In addition, four-year post intervention results for Simon 2004, published in 2008 have been included for a total of 16 studies evaluating the impact of school-based physical activity interventions on mean systolic blood pressure.

Thirteen of 16 studies reported results for grade school children only (Angelopoulos 2009; Burke 1998; Bush 1989; Kriemler 2010; Luepker 1996; Martinez 2008; McManus 2008; Reed 2008; Simon 2004; Stephens 1998; Walter 1988; Walther 2009; Wang 2008), and three on children attending secondary school (Bayne-Smith 2004; Ewart 1998; Young 2006). All but two of the 13 studies involving grade school children reported results for the whole sample (Burke 1998; Martinez 2008), and all three studies involving students in secondary school included girls only (Bayne-Smith 2004; Ewart 1998; Young 2006). Twelve studies evaluated impact on mean systolic blood pressure immediately post intervention, while two measured the outcome at six months (Burke 1998; McManus 2008) one at nine months post intervention (Angelopoulos 2009) and one 4 years post intervention Simon 2004. Nine of the studies (Angelopoulos 2009; Burke 1998; Kriemler 2010; Luepker 1996; Martinez 2008; Reed 2008; Simon 2004; Wang 2008; Young 2006), measured blood pressure using an automated sphygmomanometer and the remainder were taken manually.

Four of the 16 studies reported statistically significant positive effects on mean systolic blood pressure (Angelopoulos 2009; Bayne-Smith 2004; Ewart 1998; Reed 2008), two of which used an automated sphygmomanometer (Angelopoulos 2009; Reed 2008). Two studies, Angelopoulos 2009 and Reed 2008, reported statistically significant positive effects on grade school children, and two studies, Ewart 1998 and Bayne-Smith 2004, on secondary school girls. On average, the intervention group experienced a 2 to 5 mmHg reduction in systolic blood pressure in comparison to the control group. The sample sizes of the 12 studies not reporting statistically significant effects ranged from 90 to 4019 participants. It is likely that some of these studies were underpowered to detect a statistically significant effect. Furthermore, only one study (Wang 2008) appeared to demonstrate a trend toward a positive effect, while the remaining studies showed little to no difference in systolic blood pressure between the intervention and control groups.

Of the four studies reporting statistically significant positive effects the interventions were implemented for 12 weeks (Bayne-Smith 2004), 18 weeks (Ewart 1998), 11 months (Reed 2008), and 12 months (Angelopoulos 2009). Among studies reporting no effect, interventions ranged from 12 weeks to six years. Changes to the school curriculum were the only consistent component across all four studies reporting a positive effect. Community-based strategies were used in two studies, and printed education materials and education sessions were used in one study each. In three of the four studies reporting a positive effect the intervention was provided by members of the research staff (Angelopoulos 2009; Ewart 1998; Reed 2008), and was not stated in the fourth study (Bayne-Smith 2004). Generally, the studies not reporting a statistically significant effect on mean systolic blood pressure used similar combinations of interventions, but tended to use classroom

and PE teachers more often, and tended to be implemented for longer periods of time, in comparison to studies reporting statistically significant positive effects.

Mean diastolic blood pressure

Nine studies reported results for mean diastolic blood pressure in the original review (Bayne-Smith 2004; Burke 1998; Bush 1989; Ewart 1998; Graf 2005; Lionis 1991; Luepker 1996; Stephens 1998; Walter 1988). However, two were excluded from this update (Graf 2005; Lionis 1991). In this update an additional nine studies have been added to the results in Appendix 9 (Angelopoulos 2009; Kriemler 2010; Martinez 2008; McManus 2008; Reed 2008; Walther 2009; Wang 2008; Young 2006), including four-year post intervention results for Simon 2004 published in 2008.

Thirteen of 16 studies reported results for grade school children only (Angelopoulos 2009; Burke 1998; Bush 1989; Kriemler 2010; Luepker 1996; Martinez 2008; McManus 2008; Reed 2008; Simon 2004; Stephens 1998; Walter 1988; Walther 2009; Wang 2008), and three on children attending secondary school (Bayne-Smith 2004; Ewart 1998; Young 2006). All but two of the 13 studies involving grade school children reported results for the whole sample (Burke 1998; Martinez 2008), and all three studies involving students in secondary school included girls only (Bayne-Smith 2004; Ewart 1998; Young 2006). Twelve studies evaluated impact on mean diastolic blood pressure immediately post intervention, while two measured the outcome at six months (Burke 1998; McManus 2008) one at nine months post intervention (Angelopoulos 2009) and one at four years post intervention (Simon 2004). Nine of the studies (Angelopoulos 2009; Burke 1998; Kriemler 2010; Luepker 1996; Martinez 2008; Reed 2008; Simon 2004; Wang 2008; Young 2006) measured blood pressure using an automated sphygmomanometer and the remainder were taken manually.

Three of the 16 studies reported statistically significant positive effects on mean diastolic blood pressure (Angelopoulos 2009; Bayne-Smith 2004; Bush 1989), one of which used an automated sphygmomanometer (Angelopoulos 2009). Two studies (Angelopoulos 2009; Bush 1989) reported statistically significant positive effects on grade school children, while Martinez 2008 reported a statistically significant negative effect on grade school boys and no effect on girls. Bayne-Smith 2004 reported a significant positive effect on secondary school girls. Among the three studies reporting positive effects, on average the intervention group experienced a 3 to 4 mmHg reduction in mean diastolic blood pressure in comparison to the control group. Martinez 2008 found boys in the control group had a 2 mmHg greater reduction in mean diastolic blood pressure in comparison to boys in the intervention group. The remaining 12 studies did not report statistically significant effects on mean diastolic blood pressure, and no studies showed a trend toward a positive effect. The sample sizes of the studies ranged from 90 to 4019 participants. It is likely that some of the studies were underpowered to detect a statistically significant effect.

Of the three studies reporting statistically significant positive effects the interventions were implemented for 12 weeks (Bayne-Smith 2004), 12 months (Angelopoulos 2009), and four years (Bush 1989). Among studies not reporting a statistically significant effect, interventions ranged from 12 weeks to six years. Changes to the school curriculum were the only consistent component across all three studies reporting statistically significant positive effects.

Printed education materials were used in two of the three studies, and counseling was also used in one study. Intervention providers included members of the research staff (Angelopoulos 2009; Bush 1989; Martinez 2008) for studies showing both statistically significant positive and negative effects. Classroom teachers were also used in one study reporting a positive effect. Generally, the studies not reporting a statistically significant effect on mean diastolic blood pressure used similar combinations of interventions, but tended to use classroom and PE teachers more often, in comparison to studies reporting a statistically significant positive effect.

Mean blood cholesterol level

Seven studies reported results for mean total blood cholesterol level in the original review (Alexandrov 1988; Bayne-Smith 2004; Bush 1989; Lionis 1991; Luepker 1996; Manios 1999; Walter 1988). However, three of them have been excluded from this update (Alexandrov 1988; Lionis 1991; Manios 1999). In this update an additional five studies have been added to the results in Appendix 10 (Martinez 2008; Reed 2008; Walther 2009; Wang 2008; Young 2006). In addition, four-year post intervention results for Simon 2004, published in 2008, have been added. In total 10 studies evaluating the impact of school-based physical activity interventions on mean blood cholesterol (mg/dL) were included in this update.

All but two studies focused on grade school children, with Bayne-Smith 2004 and Young 2006 including girls in secondary school only. One of the eight studies focused on grade school children reported results for boys and girls separately (Martinez 2008), the remainder reported results for boys and girls combined. All of the studies evaluated impact on mean blood cholesterol immediately post intervention. Most studies measured fasting blood cholesterol.

Only one of the 10 studies reported a statistically significant positive effect on mean blood cholesterol (Walter 1988), and in that study only schools in the intervention group from a higher socioeconomic status reported a statistically significant positive effect. No other studies reported statistically significant changes in mean blood cholesterol at the end of the intervention in comparison to controls. Walter 1988 reported a 2 mg/dL decrease in mean blood cholesterol among boys and girls of higher socioeconomic status in comparison to children in the control group. The sample sizes of these studies ranged from 188 to 4019 participants. It is likely that some of these studies were underpowered to detect a statistically significant effect. There also did not appear to be a trend toward a positive effect.

There were no differences between the one study reporting a statistically significant positive effect (Walter 1988) and the remaining studies not reporting a statistically significant effect with respect to intervention strategies or duration. All studies measuring mean blood cholesterol (mg/dL) used school curriculum, and the majority also used printed educational materials. Some also used community-based strategies (Bush 1989; Luepker 1996; Simon 2004; Walter 1988). The duration ranged from 12 weeks to four years.

Body mass index (BMI)

Fourteen studies reported results for BMI in the original review (Alexandrov 1988; Bayne-Smith 2004; Burke 1998; Bush 1989; Carrel

2005a; Ewart 1998; Haerens 2006; Lionis 1991; Luepker 1996; Manios 1999; Robinson 1999; Sallis 1997; Stone 2003; Walter 1988). However, five of these were excluded from this update (Alexandrov 1988; Carrel 2005a; Lionis 1991; Manios 1999; Sallis 1997). In this update an additional 22 studies have been added to the results presented in Appendix 11 (Angelopoulos 2009; Barbeau 2007; Donnelly 2009; Dorgo 2009; Gentile 2009; Kipping 2008; Kriemler 2010; Li 2010; Martinez 2008; McManus 2008; Neumark-Sztainer 2009; Neumark-Sztainer 2010; Peralta 2009; Reed 2008; Salmon 2008; Singh 2009; Singhal 2010; Wang 2008; Webber 2008; Weeks 2008; Williamson 2007; Young 2006). In addition, four year post intervention results for Simon 2004 published in 2008 have been added. In total, this update includes 32 studies evaluating the impact of school-based physical activity interventions on BMI.

Of these, 23 studies focused on grade school children only (Angelopoulos 2009; Barbeau 2007; Burke 1998; Bush 1989; Donnelly 2009; Gentile 2009; Haerens 2006; Kipping 2008; Kriemler 2010; Luepker 1996; Martinez 2008; McManus 2008; Neumark-Sztainer 2009; Peralta 2009; Reed 2008; Robinson 1999; Salmon 2008; Simon 2004; Stone 2003; Walter 1988; Wang 2008; Webber 2008; Williamson 2007), seven on adolescents in secondary school only (Bayne-Smith 2004; Dorgo 2009; Ewart 1998; Li 2010; Neumark-Sztainer 2010; Singhal 2010; Young 2006), and two with both grade school and secondary school children (Singh 2009; Weeks 2008). Twenty-one of the studies reported results for a mixed sample of boys and girls combined, five for boys and girls separately (Burke 1998; Haerens 2006; Martinez 2008; Singh 2009; Weeks 2008), six studies included girls only (Barbeau 2007; Bayne-Smith 2004; Ewart 1998; Neumark-Sztainer 2010; Webber 2008; Young 2006), and one included only boys (Peralta 2009). Twenty-four of the thirty-two studies evaluated impact on BMI immediately post-intervention, three at approximately six months post-intervention (Gentile 2009; Neumark-Sztainer 2010; Peralta 2009), three at 12 months (Li 2010; Salmon 2008; Singh 2009), one at three years post-intervention (Luepker 1996) and one at four years post intervention Simon 2004.

Overall eight of the 32 studies reported statistically significant positive effects on BMI in favor of the intervention (Angelopoulos 2009; Barbeau 2007; Burke 1998; Haerens 2006; Kriemler 2010; Li 2010; Robinson 1999; Salmon 2008), while one study reported a statistically significant effect in favor of the control group (Weeks 2008). One additional study showed a strong trend toward a positive effect following four years of intervention (Simon 2004), while most did not appear to have a trend toward a positive effect. Five studies reported statistically significant positive effects on a mixed sample of boys and girls (Angelopoulos 2009; Kriemler 2010; Li 2010; Robinson 1999; Salmon 2008), one for boys only (Burke 1998), and two for girls only (Barbeau 2007; Haerens 2006). All studies reporting a statistically significant positive effect on BMI, demonstrated a smaller increase in BMI from baseline to follow-up for those in the intervention group compared to those in the control group. On average, the intervention group experienced an increase of 0.1 to 1.0 kg/m² less in comparison to those in the control group. In only one study (Salmon 2008) was a larger effect size noted, with the intervention group gaining 1.5 kg/m² less than the control group, with the 95% CI ranging from -2.8 to -0.2 kg/m². The effect of baseline weight as a moderating variable varied among studies. In one study (Singh 2009), a statistically significant effect on BMI was observed among non-overweight children in the intervention group, but not among those who were overweight or obese at baseline. In contrast, another study found the intervention

was only effective in preventing weight gain (increased BMI) among those children in the intervention group who were overweight or obese at baseline but not among those who were not overweight (Li 2010). The sample sizes of the studies ranged from 32 to 4120 participants. While it is likely that some of the studies not reporting statistically significant effects were underpowered to detect a statistically significant effect, the majority did have sufficient power to see a significant effect.

Of the eight studies reporting statistically significant positive effects, the intervention was implemented for six months in one study (Robinson 1999), nine months in two studies (Burke 1998; Kriemler 2010), 10 months in one study (Barbeau 2007), one year in three studies (Angelopoulos 2009; Li 2010; Salmon 2008), and two years in one study (Haerens 2006). While specific combinations of interventions varied there were some similarities across the eight studies. For example, the intervention in all studies included changes to the school curriculum. All studies used printed education materials, while three studies included community-based strategies (Burke 1998; Haerens 2006; Kriemler 2010), and three included education sessions (Burke 1998; Kriemler 2010; Salmon 2008). Two studies used audio-visual materials (Li 2010; Robinson 1999), and two included physical activity sessions (Barbeau 2007; Li 2010). Other strategies used by only one study included support groups (Haerens 2006), counseling (Burke 1998), and self contracts (Salmon 2008). In four of the studies reporting a statistically significant positive effect the intervention providers were classroom teachers (Barbeau 2007; Burke 1998; Haerens 2006; Robinson 1999), while in two studies PE teachers were primarily responsible for implementing the intervention (Kriemler 2010; Salmon 2008). In two studies the intervention was provided by either members of the research staff or a psychologist,

PE teacher, or a multidisciplinary healthcare team. Generally, the 24 studies not reporting a statistically significant effect on BMI used similar combinations of interventions implemented by similar combinations of providers for similar lengths of time.

Maximal oxygen consumption (VO₂max)

Five studies reported results for VO₂max in the original review (Bayne-Smith 2004; Carrel 2005a; Eliakim 1996; Fardy 1996; Trevino 2004). However, three were excluded from this update (Carrel 2005a; Eliakim 1996; Fardy 1996). In this update four additional studies have been added to the results presented in Appendix 12 (Barbeau 2007; McManus 2008; Walther 2009; Wang 2008). In total six studies evaluating the impact of school-based physical activity interventions on VO₂max were included.

Of these, five studies focused on grade school children (Barbeau 2007; McManus 2008; Trevino 2004; Walther 2009; Wang 2008) and one on those attending secondary school (Bayne-Smith 2004). Four studies reported results for boys and girls combined (McManus 2008; Trevino 2004; Walther 2009; Wang 2008), and two included girls only (Barbeau 2007; Bayne-Smith 2004). All but one study evaluated impact on VO₂max immediately post intervention, with the one study reporting results at six months post intervention (McManus 2008). Two studies measured VO₂max through blood gases after exertion (Barbeau 2007; McManus 2008), and four measured heart rate recovery following exertion as a proxy for VO₂max (Bayne-Smith 2004; Trevino 2004; Walther 2009; Wang 2008).

Four of the six studies reported statistically significant positive effects on VO_2max (Barbeau 2007; Trevino 2004; Walther 2009; Wang 2008). Statistically significant positive effects were observed among grade school children only. The results illustrate a positive improvement in VO_2max across studies ranging from 1.6 to 3.7 mL/kg per min, while a fourth study reported a lower heart rate by 4 beats/min after strenuous exercise following the intervention. Barbeau 2007 found children in the intervention group increased their VO_2max by 1.6 mL/kg per min, while Trevino 2004 reported an increase of 1.9 mL/kg per min, and Walther 2009 reported an increase of 3.7 mL/kg per min. The 95% CIs ranged from 0.2 to 7.2 mL/kg per min. The sample sizes of these two studies ranged from 182 to 1221 participants. It is possible that one of the two studies not reporting a statistically significant effect was underpowered to detect a significant differences.

Studies reporting a positive effect made changes to the school curriculum, two also included printed education materials, and one included education sessions. Classroom teachers implemented the intervention in two of the studies reporting positive effects and were unknown in the remaining studies. Generally, the two studies not reporting statistically significant effects used similar combinations of interventions implemented for similar lengths of time, although the intervention provider is unknown in these studies.

Pulse rate

Five studies reported results for pulse rate in the original review (Bush 1989; Ewart 1998; Luepker 1996; Stephens 1998; Walter 1988). All of these studies were retained in this update. One additional study was added in this update (McManus 2008). In total six studies were included in this update evaluating the impact of school-based physical activity interventions on pulse rate.

Of these, five studies focused on grade school children (Bush 1989; Luepker 1996; McManus 2008; Stephens 1998; Walter 1988), and one on adolescents (Ewart 1998). The results are summarized in Appendix 13. One study included adolescent females in secondary school only (Ewart 1998), and the other five studies reported results for a sample of boys and girls combined. All studies evaluated impact on pulse rate immediately post intervention.

Only one study reported a statistically significant positive effect on pulse rate (Luepker 1996). One other study (Stephens 1998) reported a statistically significant positive effect, but on pulse rate during maximal exercise and recovery ($P < 0.05$), rather than resting pulse rate. Interestingly, Luepker 1996 did not observe a statistically significant effect immediately following the three-year intervention, but rather at three years post intervention ($P < 0.03$). All five remaining studies did not report a statistically significant effect. The sample sizes of the studies ranged from 88 to 4019 participants. It is likely that some of the studies were underpowered to detect a statistically significant effect. Furthermore, of those that provided data on pulse rate, one demonstrated a trend toward a positive effect, and the others did not.

DISCUSSION

Summary of main results

Generally the results of this update are for the most part unchanged from those reported in the original review with two exceptions.

Whereas in the original review we found school-based physical activity interventions had a positive impact on duration of MVPA, television viewing, blood cholesterol, and VO_2max , in this update, the positive effect on blood cholesterol was no longer observed. However, the magnitude of effect for duration of MVPA, television viewing, and VO_2max , remained the same in the update as in the original review. Also, in this review there is some limited evidence to suggest that school-based physical activity interventions may have a positive effect on physical activity rates in children, meaning there was some limited evidence to suggest that school-based interventions were effective in increasing the proportion of children who engaged in MVPA during school hours. This was not observed in the original review. There is also some limited evidence in this update that these positive effects are maintained in the longer term, (i.e. six months to four years), although only a small number of studies measured outcomes beyond the end of the intervention. However, this also demonstrates an improvement from the original review in that evidence now exists, where it did not previously, that positive effects can be maintained in the longer term on outcomes such as duration and rate of physical activity, and VO_2max .

The evidence suggests that school-based physical activity interventions of longer duration may be needed to effect change in duration and rate of physical activity and VO_2max among grade school children. However, the evidence is less convincing for those attending secondary school. The evidence also suggests that effective school-based interventions include some combination of school curricula, printed educational materials, and likely, though there is less evidence to support it, educational sessions, physical activity specific sessions, and community-based initiatives. In order to produce sustainable effects, it may be necessary to widen the scope of the intervention to include the community so as to promote multiple environments that support active living as children move from childhood to adolescence to adulthood. Community-based strategies have been shown to be somewhat effective in promoting healthy behavior among populations (Dobbins 2011). Careful consideration of the similarities between the study population and local populations may be helpful in ascertaining the likelihood of local initiatives achieving a positive effect if the same intervention was implemented. There is only limited evidence that boys and girls respond differently to school-based interventions as well as different components of interventions from the studies included in this review. Given known gender differences in determinants of physical activity (DiLorenzo 1998), future research in this field should test various gender-specific strategies within the school setting.

Given the primary focus of many of the studies was to promote physical activity it was surprising only five studies reported physical activity rates as an outcome. In addition, it is interesting to note that there was no overlap in studies measuring rates of physical activity and those measuring duration. However, in this update significantly more studies measured duration of MVPA ($n = 23$) representing a positive trend toward the measurement of important outcomes when evaluating the effectiveness of physical activity promotion interventions.

In this update there continues to be limited overlap between those studies measuring physical activity rate or duration and VO_2max . For example, there was only one study that measured both physical activity rate and VO_2max in the original review and one other that

measured duration of physical activity and VO_2max . After excluding studies based on the revised inclusion/exclusion criteria, in this update there were no studies measuring both physical activity rate and VO_2max , and only three studies measuring both physical activity duration and VO_2max .

While new evidence suggests some promise with respect to the longer-term impact of school-based physical activity interventions on physical activity duration and rate, and VO_2max , ongoing efforts to evaluate impact in the long term are needed. It is important, especially for those interventions having positive effects, for outcomes to be measured in the long term so that these results can better inform policy and program decision making at multiple levels.

All of the interventions included in this review were multifaceted interventions focused on changing multiple risk behaviors associated with adult-onset CVD. Some of the multiple components addressed in these studies were physical activity, nutrition, and smoking. Although empirical evidence (Thomas 1999) and theoretical frameworks suggest that CVD risk reduction strategies should target multiple high-risk behaviors simultaneously, it is unclear from the results of this update how these multicomponent strategies interact to impact on indicators of physical activity or fitness measures. Given that exposure (dose) to the physical activity interventions was assessed in just a small number of studies, it is conceivable that more emphasis was placed on CVD risk reduction strategies other than physical activity, thereby providing insufficient exposure to physical activity interventions to produce significant behavioral or fitness changes. An alternative hypothesis might be that children and adolescents have a limited capacity at any given time to adopt new behaviors and absorb new knowledge, and interventions simultaneously addressing multiple factors such as nutrition, physical activity, and smoking, may be overwhelming.

At this time there is some limited evidence to suggest that school-based physical activity interventions have a small to moderate impact on behavioral outcomes related to physical activity as well as on one physical health status measure. However, at best the evidence is of moderate risk of bias, and therefore must be used cautiously. Furthermore, adverse effects as a result of the school-based physical activity interventions were generally not reported upon by the studies included in this update. Future studies should seek to determine if there are any adverse effects experienced by children and adolescents as a result of the intervention.

Overall completeness and applicability of evidence

A comprehensive search of RCTs was conducted. While it is possible that some studies were missed by our search strategy, we anticipate that this number would be small, and that the results of our review have not been significantly impacted upon. The studies included in this review are generally applicable to public health practice in developed countries. However, it is not clear if these findings are applicable to low- and middle-income countries particularly among those where the public health sector system or school systems (or both) are different, or when cultural differences are taken into account. Future research should evaluate school-based physical activity interventions in low- and middle-income countries.

Quality of the evidence

As discussed previously there are a number of limitations inherent in the studies included in this review that reduce the overall methodological quality of this evidence. As such the results must be interpreted cautiously and likely overestimate the true treatment effect. Specific limitations include: lack of blinding particularly of outcome assessors, lack of consistency in how outcomes are measured, reliance on self-reported outcomes for most behavioral outcomes, and a lack of description of the process used to randomly allocate participants to intervention and control groups. Furthermore, a number of studies experienced high attrition rates as well as incomplete outcome data. This as well likely contributed to an overestimation of the treatment effect, given those engaging in the intervention may have been more likely to complete the study and data collection, and therefore biasing the results toward a positive effect. However, on a positive note, significant improvements in the quality of the evidence were observed from the original review to this update.

While the majority of outcomes were assessed using measures with at least some degree of demonstrated reliability and validity, most of the behavioral outcomes were measured through self-report (except for a small, albeit growing, number of studies using accelerometers), while the physical health status outcomes were measured through more objective means. In only nine of 25 studies were more objective outcome measurements obtained from pedometers or accelerometers on time spent engaged in physical activity, and only one of 14 studies did not rely on self-report to measure time spent watching television. For physical health status measures such as systolic and diastolic blood pressure and BMI, in almost all studies it is unclear if the outcome assessors were blinded to study allocation. This represents an important risk of bias for this literature and likely resulted in either overestimating the treatment effect or finding a statistically significant positive effect where one did not exist. This alone may explain why a positive impact was observed for the behavioral outcomes, while a positive effect was observed for only one of the six physical health status outcomes.

However, the explanation cannot be so simplistic, at least not for duration of physical activity. For this outcome, 14 of 23 studies demonstrated a positive effect, and of those five studies measured duration of physical activity with an accelerometer. This detracts from the argument that the ways in which the outcomes were measured is responsible for the difference in positive effects observed between the behavioral outcomes versus the physical health status outcomes.

Potential biases in the review process

It is possible that bias was introduced during the review process despite the implementation of strategies to reduce bias. Most notably, it was not possible to conduct searches in databases that are not English. For example articles published in Chinese that were not indexed in English language databases were not eligible for inclusion. However, the review team recognizes a growing body of evidence in physical activity promotion being produced in Chinese. It is likely in subsequent updates that additional search strategies to ensure non-English publications are assessed for eligibility. Given a meta-analysis was not conducted, it is possible that the review team may have overestimated treatment effects when interpreting the results across studies. While efforts were

undertaken to minimize this bias (multiple review authors were involved in interpreting the results and provided comments on drafts of this update) it is still possible that we have interpreted the results to be more positive than they actually are. Consumers of this review are cautioned therefore to examine the results carefully across studies.

The variability in these findings may be indicative of the limitations and difficulties inherent in doing community-based research where randomization to treatment groups, blind assessment, reliable and valid outcome measures, and prevention of co-intervention are difficult to control. It also demonstrates the difficulty in measuring outcomes associated with physical activity, both from a physiologic as well as a behavior perspective. Inconsistent findings in these studies can further be attributed to: a) variability in strategies used and in the frequency, intensity, and duration of interventions; b) the use of various theoretical models to guide the intervention; c) using a variety of instruments with varying reliability and validity to assess physical activity or physical fitness (or both); and d) follow-up periods of different durations. Many of these studies have reported modest change in levels of physical activity, physical fitness rates, or both. Lack of change in leisure time physical activity or physical fitness, in turn, has been attributed most often to issues of: a) inadequate dose (Tolfrey 2000); b) poor compliance (Baranowski 1990); c) inattention to the multiplicity of risk factors for physical inactivity and subsequent overly simplistic, unidimensional interventions; d) methodologic errors in measuring fitness (e.g. assessing heart rate only after, as opposed to during, activity); and e) a failure to control for potentially confounding variables (Tolfrey 2000).

Agreements and disagreements with other studies or reviews

The findings of this update are consistent with the findings of reviews conducted by Flynn 2006, Reilly 2003, Thomas 2004a, and Waters 2011, who reported mixed results regarding the effectiveness of interventions to prevent obesity, promote healthy eating, and promote physical activity in children and adolescents. An additional review by Hillsdon 2005 also reported similar results among adults for interventions to promote physical activity. Furthermore, a review of studies evaluating the impact of physical activity interventions reported increased physical activity among adolescent girls (Brown 2009), and another found a positive effect on fitness measures in children generally (Trudeau 2008). Others have found that while children and adolescents can experience increased levels of MVPA, this does not necessarily translate into reduced BMI (Cawley 2007; Gonzalez-Suarez 2009; Harris 2009). Similar results were reported by Summerbell 2005, who found little to no impact of obesity prevention interventions in children. However, an update to this review by Waters 2011 indicated there is evidence to suggest that obesity prevention strategies are effective in reducing BMI among children aged 6 to 12 years. However, it is important to point out that there was significant heterogeneity of results across studies and that overall, the magnitude of effect reported by Waters 2011 generally was small. Another meta-analysis of school-based obesity prevention interventions found a positive effect on weight, and clearly argued the need for ongoing school-based intervention (Katz 2009). While these additional reviews suggest that school-based interventions may be effective in preventing and reducing obesity in children, the result of our update indicate that focusing on physical activity may be

insufficient to address issues of healthy weight adequately, and that a comprehensive approach focused on physical activity and diet, at a minimum, may be needed to impact weight in children significantly. Furthermore, the results of Waters 2011 illustrate that strategies outside of the school setting in addition to school-based strategies are likely needed. The findings of this update as well as other reviews suggest that schools are an important setting in which to promote physical activity. Almost all recent reviews illustrate that school-based physical activity interventions do result in children and adolescents spending more time engaged in MVPA and in some instances this translates into improved fitness measures. The finding in this review that changes to BMI were not observed, does not suggest that school-based interventions are not effective, but may suggest that a more comprehensive approach (e.g. home, community, policy) is needed and as suggested in the original review, that BMI may not be an appropriate measure to evaluate the effectiveness of interventions to promote physical activity among children. Future reviews should consider additional outcomes such as percentage body fat and abdominal girth.

AUTHORS' CONCLUSIONS

Implications for practice

The implications for public health practice, based on the findings of this update, are not as clear as one might wish. Nonetheless, the following are suggestions for consideration by public health practitioners, decision makers, and policy makers at this time.

1. Since school-based physical activity interventions are associated with some positive effects, such activities should continue and be encouraged by public health to local schools and school boards.
2. School-based physical activity interventions should be focused on fostering positive attitudes toward physical activity and should be geared toward the developmental level of students.
3. Teachers and school staff should encourage children and adolescents to be more physically active during the course of the school day. This may require some dramatic changes within the working environment of teachers and school staff.
4. Parental involvement could be an integral part of school-based interventions.
5. More emphasis should be placed on promoting physical activity within school-based interventions (i.e. making physical activity a priority along with other healthy behaviors).
6. Public health staff should work in collaboration with teachers, schools, and school boards to lobby local and provincial policy makers to increase resources for the promotion of physical activity within the school system.

Implications for research

There are many gaps in the literature that require considerable exploration, and subsequently, systematic reviews.

1. Research must take care to assess the impact of school-based physical activity interventions more often on physical activity rates and duration and intensity of physical activity.
2. More research is needed to assess the validity and appropriateness of outcomes that represent program effectiveness of school-based physical activity interventions for children and adolescents. Additional outcomes that should be

assessed to evaluate intervention effectiveness should include: student satisfaction, health-related quality of life, self-esteem, self-efficacy for physical activity, reduction in alcohol/drug consumption, involvement in extracurricular activities, and cost-effectiveness.

3. Research is needed to assess the impact of physical activity strategies that take into account the known barriers and facilitators of physical activity among children and adolescents, particularly among those of various socioeconomic status and ethnicity and urban/rural location.
4. Additional subgroup analysis including an examination of the differences in physical activity by gender as well as age and ethnicity, and the impact of strategies that take into account the different factors that affect physical activity among males and females and children and adolescents must be examined.
5. All outcomes related to the impact of school-based physical activity interventions require follow-up data so that the long-term impact of these interventions can be determined.

6. To increase the depth of knowledge in this field, national granting agencies need to make research related to physical activity promotion a major priority and recognize the need to fund projects that span multiple years of intervention implementation and evaluation.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Angelopoulos 2009

Methods	Design: cluster randomized controlled trial Theoretical framework: Theory of Planned Behavior Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 321 N (control): 325 Age (mean): 10.3 years Sex: male and female Ethnicity: Greek
Interventions	Country: Greece Setting: school, urban and rural Provider: classroom teachers Duration: 12 months Intervention: 12-month program (January 2005 to January 2006) integrated in the existing school curriculum in combination with physical education (PE) and science and environmental classes, providing the least possible disturbance. Program material included a student's workbook and teacher's manual, which offered activities for use in class in an appendix. The manual covered: self-esteem, body image, nutrition, physical activity, fitness and environmental issues, and materials were used 1 to 2 h per week. Motivational methods and strategies were used to increase knowledge (i.e. discussion, active learning, cues), increase skills and self efficacy (i.e. modeling, guided practice, enactment), achieve better self-monitoring (i.e. problem solving, goal setting), improve attitudes and beliefs (i.e. self re-evaluation, environmental re-evaluation, arguments, modeling, direct experience), and modify social influence (i.e. modeling, mobilizing social support). School teachers trained by the research team delivered the intervention and there was a home component for which parental involvement was required to provide reinforcement Control: not specified
Outcomes	Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) BMI (kg/m ²)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Comment: random digits used to develop allocation sequence
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias)	Unclear risk	Comment: no information given, likely not done

Angelopoulos 2009 (Continued)

All outcomes

Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: cannot determine how many students started the study only know how many finished
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders were controlled for
Data collection methods valid and reliable?	Low risk	Comment: data collection methods valid and reliable

Araujo-Soares 2009

Methods	Design: cluster randomized controlled trial Theoretical framework: Social Cognitive Theory Number of intervention groups: 1 Number of control groups: 1 Follow-up: 9 months post-intervention
Participants	N (intervention): 105 N (control): 90 Age (mean): 12.1 years Sex: male and female Ethnicity: unstated
Interventions	Country: Portugal Setting: school, unstated if urban or rural Provider: research worker, psychologist, physical education teacher Duration: 12 weeks Intervention: 2 classroom-based physical activity sessions of 90 min each, along with homework, delivered by a trained psychologist, assisted by a sports education teacher. The psychologist received workshop training from the research team. A member of the research team served as supervisor to help prepare the sessions. In the week proceeding both physical activity sessions, adolescents were asked to keep a self-monitoring diary as homework, to keep track of daily physical activities in detail. After the intervention they were encouraged to maintain the diary for 2 more weeks. During sessions, worksheets and a 3-min film were used. At the end of the sessions, each student received a pamphlet reinforcing main topics of the session Control: not specified
Outcomes	Duration of physical activity
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported

Araujo-Soares 2009 (Continued)

Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: unsure if intention to treat conducted at 9-month follow-up
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	High risk	Comment: not all relevant confounders accounted for
Data collection methods valid and reliable?	Low risk	Comment: data collection tools reported to be valid and reliable

Barbeau 2007

Methods	Design: randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately following intervention
Participants	N (intervention): 118 N (control): 83 Age (mean): 9.5 years Sex: female Ethnicity: African-American
Interventions	Country: US Setting: school, unstated whether urban or rural Provider: classroom teachers and teaching assistants Duration: 10 months Intervention: 10-month after-school physical activity (PA) program on body composition and cardiovascular fitness in young black girls, offered every school day during the school year with transportation (i.e. school bus service) provided to encourage participation. 30 min of homework time while subjects received a free, healthy snack, and 80 min of PA. Snacks were individually packaged, and every day offered something salty (e.g. crackers and cheese), something sweet (e.g. low-fat cookies), or a fruit or vegetable. Subjects chose 1 snack with the option of another if they wished. The PA included 25 min of skill development, 35 min of moderate to vigorous physical activity (MVPA), with 20 min of toning and stretching. Subjects wore Polar Accurex Plus HR monitors (Port Washington, NY) every day and were instructed to maintain their heart rate above 150 beats/min during the MVPA. MVPA activities included games such as basketball, tag, softball, relay races, etc., modified for activity of all subjects through the 35-min period. Subjects received small weekly prizes for behavior and attitude, and for having no more than 1 unexcused absence. A student of the month in each school received a slightly larger prize with the prizes intended to reward good behavior, participation, and effort. Parents were called when students had 2 consecutive unexcused absences, with reasons discussed and parents encouraged to send their daughter back to the program. Teachers mostly worked the intervention in their own school and in some cases were assigned to work in a different school. Teachers received formal training with background information on childhood obesity, PA, and cardiovascular risk factors, study

Barbeau 2007 (Continued)

goals, and the study protocol and types of activities appropriate for each segment of the intervention. Role playing was a large component of the training; teachers were asked to prepare a lesson plan for 1 day and did a shortened simulation of it, so feedback could be provided. A Manual of Procedures for each school included all information needed to implement the intervention, including several potential activities. Teachers hired after the training received one-on-one training on the theoretical aspects and observed several sessions before their own implementation

Control: not specified

Outcomes	Duration of physical activity BMI (kg/m ²) VO ₂ ax (mL/kg/minute)
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Notes	
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Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: allocation occurred after testing, therefore concealed. It was not known or determined at time of entry to study which group the next participant would go
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data not addressed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	High risk	Comment: important variables like socioeconomic status not assessed or controlled for
Data collection methods valid and reliable?	High risk	Comment: reliability and validity of most outcomes not stated

Bayne-Smith 2004

Methods	Design: randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 310 N (control): 132 Age (mean): 16.1 years Sex: female

Bayne-Smith 2004 (Continued)

Ethnicity: mixed

Interventions	<p>Country: US Setting: urban Provider: unstated Duration: 12 weeks Intervention: the PATH curriculum was taught as a personal wellness course that integrated vigorous exercise, health and nutrition education, and behavior modification. PATH student manuals were developed to provide students with information about the anatomy and physiology of the heart, cardiovascular risk factors, the heart disease process, proper exercise and nutrition, stress management, cigarette smoking avoidance and cessation techniques, and strategies for modifying high-risk health behaviors. PATH teacher manuals were provided to physical education (PE) teachers containing instructions for teaching the program curriculum and assessing outcomes. PE teachers using the PATH curriculum received in-service training from the investigation team before and during the intervention. The PATH program consisted of 30-min classes conducted 5 days per week for 12 weeks. Individual classes began with a 5- to 10-min lecture and discussion featuring a topic on cardiovascular health and fitness and suggestions for modifying health behaviors. In addition, students frequently were given homework assignments designed to enhance or clarify lecture material through use of the PATH manuals. The lecture and discussion were followed by 20 to 25 min of vigorous physical activity in the form of either resistance exercise to improve muscular strength and endurance or aerobic exercise to improve cardiovascular fitness. Students alternated resistance and aerobic training each day. Resistance exercise consisted of a vigorous program of circuit weight training at a variety of isotonic and isokinetic exercise stations. Students performed 90- to 120-second bouts of weight lifting at 50% to 70% of the 1-repetition maximum (the maximum resistance that can be lifted 1 time). Aerobic training included a variety of vigorous exercises, such as stationary bicycling, stair stepping, rope jumping, fast walking, jogging, step aerobics, and aerobic dance. Students were instructed to exercise continuously at 70% to 85% of their age-predicted maximum heart rate. Students were taught how to self-monitor heart rates during or immediately upon cessation of exercise by palpation of the radial or carotid pulse Control: the frequency and duration of traditional PE classes were identical to those of PATH classes. Since PE classes did not have lecture and discussion, they had approximately 5 min more physical activity per class than PATH classes</p>	
Outcomes	<p>Duration of physical activity Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) Mean blood cholesterol level (mg/dL) BMI (kg/m²) VO₂max (mL/kg/minute)</p>	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Comment: incomplete outcome data not addressed

Bayne-Smith 2004 (Continued)

Selective reporting (re-reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	High risk	Comment: while there were no significant differences in most confounders, there were a few small differences which were not accounted for
Data collection methods valid and reliable?	High risk	Comment: reliability and validity of most outcomes not stated

Burke 1998

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 5 Number of control groups: 1 Follow-up: 6 months post-intervention
Participants	N (total): 720 Age (mean): 11 years Sex: male and female Ethnicity: unstated
Interventions	Country: Australia Setting: school, home, unstated if urban or rural Provider: teachers, research staff, parents Duration: 9 months Intervention 1: standard physical activity (PA) and nutrition program (WASPAN) in 6 schools, which consisted of classroom lessons to establish a rationale, plus 20-min fitness sessions daily by means of small group activities that allowed for individual fitness levels and provided a range of options by means of progression through graded activities. Four fitness sessions per week were considered a realistic expectation. The nutrition program aimed to improve children's diets by prompting families to review their diets; reducing consumption of fat, sugar, and salt; increasing fiber intake; and creating links between home and school for health promotion. The nutrition program is built around 4 comic books in which 2 space creatures must discover the dietary habits of humans. It includes a Teachers' Handbook, Home-based Mission Booklet, Class Activities Booklet, Incentives, and a Recipe Booklet that presents recipes written for children by children. Home-based Missions and Class Activities are combined in activities such as planning a week's grocery shopping on the basis of advertised prices and in learning strategies to resist peer pressure. The Incentives Booklet includes a progress chart, stickers, and a completion certificate to encourage participation from children and parents. Duration of nutrition class activities aimed for 1 hour per week. Intervention 2: standard WASPAN program plus a PA-enrichment program for higher-risk children in 7 schools, which consisted of incorporating the teacher-parent-student triad and allowed for PA needs and preferences to be met outside the setting of the whole class. Children kept regular, but not continuous, 7-day PA diaries, which were used by teachers to identify preferred activities and ways these might be increased in duration or frequency. Teachers and students worked together to establish goals and decide on how these might be attained. Parents were asked to monitor completion of the diaries and to encourage increased levels of PA Control: no program in 5 schools
Outcomes	Television viewing (minutes spent watching television) Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) BMI (kg/m ²)
Notes	

Burke 1998 (Continued)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: outcome data complete
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders were accounted for
Data collection methods valid and reliable?	High risk	Comment: reliability and validity of most outcomes not stated

Bush 1989

Methods	Design: cluster randomized controlled trial Theoretical framework: PRECEDE, Social Learning Theory Number of intervention groups: 2 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N: 431 Age (mean): 10.5 years Sex: male and female Ethnicity: African-American
Interventions	Country: US Setting: school, home, community, physician office, mix of urban and rural Provider: teachers, research staff, volunteers, advisory board Duration: 4 years Intervention 1: 'Know Your Body' curriculum. Focus on nutrition, fitness, and the prevention of cigarette smoking. Curriculum to motivate students to attain and maintain life styles that will reduce the students' risk of developing heart disease and cancer. Includes a personalized health screening with each student receiving results on a 'health passport'. Parents are involved through several mechanisms, they are mailed 2 copies of their children's screening results, 1 copy to keep and 1 for the child's physician, copies of a quarterly 'Know Your Body' newsletter, and the program is introduced by staff at parent-teacher association meetings Intervention 2: received the same intervention as Intervention 1, but only their parents received the results of their cholesterol tests and the students were not provided with the results to enter on their 'health passports' with other screening results

Bush 1989 (Continued)

Control: did not receive the 'Know Your Body' curriculum and were not provided with any of their screening results. Only parents of control subjects received the screening results

Outcomes	Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) Mean blood cholesterol level (mg/dL) BMI (kg/m ²) Pulse rate (beats/minute)
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Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: no description of the randomization process given
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk	Quote: "Only 431 (41.4% of participants were rescreened 2 years after forming the cohort. Students who had moved from a control to an intervention school or vice versa were dropped from the analysis" (Bush 1989, p472)
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Quote: Multiple regression analysis was used to adjust the observed difference in scores between the control and intervention groups for these confounders" (Bush 1989, p472)
Data collection methods valid and reliable?	Unclear risk	Comment: insufficient data to determine reliability and validity

Colin-Ramirez 2010

Methods	Design: cluster randomized controlled trial Theoretical framework: not stated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 245 N (control): 253 Age (mean): 9.4 years

Colin-Ramirez 2010 (Continued)

Sex: male and female

Ethnicity: Mexican

Interventions	Country: Mexico Setting: grade school, urban Provider: mixed – a) health teams including a physician, dentist, psychologist, nurse, social worker, b) classroom teachers, physical education (PE) teachers Duration: 2 academic years Intervention: RESCATE program, included physical activity and nutritional components. Physical activity was addressed at 3 levels: individual, school, and family. At the 'individual level', classroom lessons and exercise breaks were implemented. The educational component in the classroom involved weekly 30-min lessons that emphasized the importance of physical activity, delivered by trained health teams (a physician, a dentist, a psychologist, a nurse and a social worker). Exercise breaks in the classroom lasting 2–10 min were designed to increase energy output and promote physical activity in the classroom. The TAKE 10 program of classroom physical activity was adapted for this purpose and included in the procedure manual for the classroom teachers who led the exercises. 'School-level' intervention included PE classes. The aim of this component of the program was to increase the length of time that children participated in moderate to strenuous exercise during PE classes. For 30 min twice a week, there was a substitution of regular exercise during PE classes for new ones that required moderate to vigorous energy output. PE teachers received a manual with the appropriate exercise options. 'Family level' involved family members in support and reinforcement of classroom lessons. Each child received a book of activities to take home with exercises that corresponded to the lessons at school and was implemented with collaboration with his parents. In addition, the parents received recommendations for achieving a more active lifestyle. Recommendations included decreasing time spent on sedentary activities such as watching television, using a computer or playing video games Control: no physical activity/nutrition program	
Outcomes	Physical activity rates (% of sample physically active) Television viewing (minutes spent watching television)	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: no description of the randomization process given
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all schools were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	High risk	Comment: data collected through self report from participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 80% participation rate, no details/reasons given for attrition
Selective reporting (reporting bias)	Unclear risk	Comment: no information given, likely not done

Colin-Ramirez 2010 (Continued)

Confounders controlled?	High risk	Comment: confounders not addressed
Data collection methods valid and reliable?	Unclear risk	Comment: authors state reliability and validity of questionnaire has been reported previously and validated for a Spanish population, but no details provided other than a citation

Dishman 2004

Methods	Design: cluster randomized controlled trial Theoretical framework: Social Cognitive Theory Number of intervention groups: 1 Number of control groups: 1 Followup: immediately post-intervention
Participants	N: 2111 Age (mean): 13.6 years Sex: female Ethnicity: White and African American
Interventions	Country: US Setting: school, community, mixed urban and rural Provider: classroom teachers Duration: 1 year Intervention: Lifestyle Education for Activity Program (LEAP), a comprehensive school-based intervention that emphasized changes in instruction and the school environment. Designed to increase physical activity in high-school girls by creating a school environment that supported the unique physical activity needs and interests of adolescent girls. Aimed to increase girls' self-efficacy for physical activity, via physical education (PE), school environment, health education, school health services, faculty or staff health promotion, and parent and community involvement. The intervention staff assisted teachers to develop curricula designed to help adolescent girls enhance physical activity self-efficacy through successful experiences with physical activity both inside and outside of school and develop physical and behavioral skills necessary to adopt a physically active lifestyle during the teenage years and to maintain it through adulthood. Teachers at each school developed behavioral skill instructional units that emphasized the acquisition and practice of self-regulatory behaviors (e.g. goal setting, time management, identifying and overcoming barriers, and self-reinforcement); the units were implemented in health education, biology, family and consumer science, or PE, depending on how each school provided health education. The PE component developed motor skills in a variety of physical activities that were popular with high-school girls including aerobics, weight training, dance, and self-defence using approaches that favored small groups and cooperative and successful learning experiences. In addition to facilitating noncompetitive mastery of skills, the instruction also used modeling of success, encouragement, and moderately intense exercise directed toward enhancing self-efficacy Control: standard PE as part of school curriculum
Outcomes	Physical activity rates (% of sample physically active)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported

Dishman 2004 (Continued)

Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: missing data for physical activity at follow-up were imputed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: relevant confounders were controlled including age, ethnicity, body mass index
Data collection methods valid and reliable?	Low risk	Comment: data collection tools reported to be valid and reliable

Donnelly 2009

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 792 N (control): 698 Age (mean): 8.2 years Sex: male and female Ethnicity: White
Interventions	Country: US Setting: school, urban Provider: classroom teachers Duration: 3 years Intervention: Physical Activity Across the Curriculum (PAAC), provided training for classroom teachers (6 hour in-service session) to deliver existing academic lessons taught thorough physical activity, using examples from TAKE 10!, a program of the International Life Sciences Institute Research Foundation/Center for Health Promotion. 90 min/week of moderate to vigorous physically active academic lessons were delivered intermittently throughout the school day Control: regular classroom instruction without physically active lessons
Outcomes	Duration of physical activity BMI (kg/m ²)
Notes	

Risk of bias

Donnelly 2009 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: no description of the randomization process given
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Low risk	Comment: blinding was done where possible - research assistants were blind-ed to condition for measurement of the primary and secondary outcomes and for data entry
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: there was 2.5% missing data, not likely to affect results
Selective reporting (re- porting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders taken into account
Data collection methods valid and reliable?	Low risk	Comment: data collection tools reported to be valid and reliable

Dorgo 2009

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 2 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 93 N (control): 129 Age (mean): 15.9 years Sex: male and female Ethnicity: unstated
Interventions	Country: US Setting: school, unstated if urban or rural Provider: research worker, PE teachers Duration: 18 weeks Intervention 1: physical education (PE) program that used manual resistance training (MRT) in every session. 80-min class sessions 3 times per week, plus a 10- to 15-min warm-up segment with light cardiovascular activities and dynamic stretching followed by the MRT-specific segment of approximately 20 to 30 min conducted and supervised by trained research assistants Intervention 2: MRT PE program plus a cardiovascular endurance training segment in every session. 80-min class sessions, 3 times per week, plus a 20- to 30-min MRT segment conducted and supervised by trained research assistants, with an additional 20- to 30-min period devoted to cardiovascular endurance training. Cardiovascular activities included walking, jogging, step aerobics, and aerobic kick-boxing Control: a regular PE program that followed the usual school curriculum. 80-min class sessions 3 times per week. PE classes focused on skill development for various individual physical activities (i.e. bowling, badminton, tennis, table tennis, golf, various track and field events) and team physical activities

Dorgo 2009 (Continued)

(i.e. soccer, basketball, softball/baseball, volleyball, floor hockey), as well as participation in leisure activities (i.e., hiking) and sport tournaments

Outcomes	BMI (kg/m ²)	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk	Quote: "24 subjects failed to attend the post-test data collection and were not included in the data analyses" (Dorgo, 2009, p2291).
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	High risk	Comment: not all relevant confounders taken into account
Data collection methods valid and reliable?	Low risk	Comment: data collection tools reported to be valid and reliable

Ewart 1998

Methods	Design: randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 44 N (control): 44 Age: grade 9 (mean age not provided) Sex: females Ethnicity: White, African American
Interventions	Country: US Setting: school, home, urban Provider: research staff Duration: 18 weeks Intervention: 50-min 'Project Heart' aerobic exercise classes including didactic instruction Control: 50-min standard physical education classes
Outcomes	Duration of physical activity

Ewart 1998 (Continued)

Mean systolic blood pressure (mmHg)
Mean diastolic blood pressure (mmHg)
BMI (kg/m²)
Pulse rate (beats/minute)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Low risk	Comment: technicians taking measurements were reported not aware of girls' experimental status
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: outcome data complete
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Unclear risk	Comment: authors state no differences in behavioral and familial factors were observed, but do not indicate which factors these were
Data collection methods valid and reliable?	Unclear risk	Comment: reliability and validity of data collection tools was not mentioned

Gentile 2009

Methods	Design: cluster randomized controlled trial Theoretical framework: Social Ecological Model Number of intervention groups: 1 Number of control groups: 1 Follow-up: 6 months post-intervention
Participants	N: 1029 Age (mean): 9.6 years Sex: male and female Ethnicity: White
Interventions	Country: US Setting: community, home, school, unstated if urban or rural Provider: research worker, lay person, volunteer, teachers Duration: 8 months Intervention: 'Switch' program, promoted healthy active lifestyles by encouraging students to 'Switch what you Do, Chew, and View', including: be active for 60 min or more per day, limit total screen time to 2 hours or fewer per day, and to eat 5 fruits/vegetables or more per day. <i>Community component</i> : promotion of awareness of healthy lifestyles and the prevention of childhood obesity included: paid adver-

Gentile 2009 (Continued)

tising (e.g. billboards) and unpaid media emphasizing the key messages. *School component*: teachers were provided with materials and ways to integrate key concepts into their existing curricula. *Family component*: provided parents (and children) with materials and resources to facilitate the adoption of the healthy target behaviors. Monthly packets containing behavioral tools were provided to assist parents and children in modifying their behaviors

Control: no intentional exposure to the Switch program. May have been exposed to the community component of the intervention. Did not receive any school materials. Did not receive materials/resources, other than surveys

Outcomes	Television viewing (minutes spent watching television)	
	BMI (kg/m ²)	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data was not adequately addressed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders taken into account
Data collection methods valid and reliable?	Low risk	Comment: data collection tools reported to be valid and reliable although methods could have been stronger for body mass index

Haerens 2006

Methods	Design: cluster randomized controlled trial Theoretical framework: Transtheoretical Model Number of intervention groups: 2 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N: 2434 Age (mean): 13.1 years Sex: male and female Ethnicity: White
Interventions	Country: Belgium

School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18 (Review)

Haerens 2006 (Continued)

Setting: school, urban

Provider: teachers

Duration: 2 years

Intervention 1: physical activity (PA) and nutrition intervention. The PA intervention focused on increasing levels of moderate to vigorous physical activity (MVPA) to at least 60 min per day. Schools received an intervention box with sports materials such as ropes, balls, and beach ball sets and were encouraged to create more noncompetitive opportunities to be physically active during breaks, at noon or during after-school hours, and to vary content of PAs offered. Children received a physical fitness test at the beginning of the second intervention year where all children had to cycle for 10 min on a computerized cycle ergometer, then were given information on their fitness levels and possible ways to improve it. The computer-tailored portion of the intervention was completed once each school year during 1 class hour. Children completed PA questions on a computer screen, which was immediately followed by tailored feedback on the screen (e.g. normative feedback regarding activity levels, PA recommendations). The nutrition intervention focused on 3 behavioral changes: (i) increasing fruit consumption 2+ pieces/day, (ii) reducing soft drink consumption and increasing water consumption, and, (iii) reducing fat intake. Schools were asked to sell fruit at very low prices or for free at least once a week, to offer fruit for dessert at lunch, and to offer free water via drinking fountains

Intervention 2: PA and nutrition intervention (same as Intervention 1 group) plus parental involvement. Schools invited parents for an interactive meeting on healthy food, PA and the relationship with overweight and health. Three times per year, information on healthy food and PA was published in school papers and newsletters for parents, and parents received a free CD with the adult computer-tailored intervention for fat intake and PA (same as the children's computer tailored intervention) for use at home, and asked to discuss results with their child and to give their child support to create a healthier lifestyle

Control: no PA and nutrition intervention

Outcomes	Duration of PA Television viewing (minutes spent watching television) BMI (kg/m ²)	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data was not adequately addressed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders taken into account
Data collection methods valid and reliable?	Low risk	Comment: data collection tools reported to be valid and reliable

Haerens 2009

Methods	Design: cluster randomized controlled trial Theoretical framework: Transtheoretical Model Number of intervention groups: 1 Number of control groups: 1 Follow-up: 3 months post-intervention
Participants	N (intervention 1): 433 N (control): 448 Age (mean): 14.6 years Sex: male and female Ethnicity: : White
Interventions	Country: Belgium Setting: school, urban Provider: N/A (computer-based intervention) Duration: 3 months Intervention: computer tailored physical activity (PA) program consisting of 3 parts: (a) an introduction page, (b) a diagnostic tool, and (c) advice. The questionnaire used in the diagnostic tool could be filled out on the computer screen and consisted of a demographic questionnaire, a PA questionnaire, and a questionnaire on psychosocial determinants. After questionnaires were completed, feedback was selected out of a database with messages for each possible combination of answers (e.g. normative feedback that related students' PA levels to the PA guidelines). Control: 1.5pg advice including information on the benefits of PA, public health recommendations, differences between moderate and vigorous intensity activities, and tips on how to become more active. The information was a selection of the most essential information in the tailored advice, but not tailored to each individual.
Outcomes	Duration of PA
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: no description of the randomization process given
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data was not adequately addressed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders taken into account

Haerens 2009 (Continued)

Data collection methods valid and reliable?	Low risk	Comment: data collection tools reported to be valid and reliable
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Jones 2008

Methods	Design: cluster randomized controlled trial Theoretical framework: Transtheoretical Model, Social Cognitive Theory Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 291 N (control): 315 Age (mean): 11.6 years Sex: female Ethnicity: White
Interventions	Country: US Setting: school, unstated if urban or rural Provider: peer, physical education (PE) teachers and other teachers Duration: 1.5 school years Intervention: the IMPACT intervention included 3 major components: 1) a health curriculum for grades 6 and 7 (classroom lessons and behavioral journalism); 2) a PE program; and 3) a school food service component that emphasized calcium-rich food choices). Peer-based behavioral journalism involved the use of media (e.g. school-based newsletter with role model stories). The intervention used a 6th grade health curriculum, including 16 sessions that were implemented during PE classes, 3 times per week. The lessons in this curriculum promoted increased consumption of calcium-rich foods and increased weight-bearing physical activities. The curriculum also contained behaviorally based and active lessons adapted to the PE environment. Science-based lessons were administered during 7th grade science classes. The PE component of the program (i.e. "IMPACTivities") was implemented in the 6th and 7th grades during PE and athletics classes. The classes contained an initial 10-min warm-up (i.e. high-impact activities - rope-jumping, circuit training, and box-step activities) Control: the control group participated in the usual health program
Outcomes	Duration of physical activity Television viewing (minutes spent watching television)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: a computer-generated random numbers table was used for the randomization process
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	High risk	Comment: no information given, likely not done

Jones 2008 (Continued)

Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data was not adequately addressed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders taken into account
Data collection methods valid and reliable?	Low risk	Comment: data collection tools reported to be valid and reliable

Kipping 2008

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 304 N (control): 300 Age (mean): 9.4 years Sex: male and female Ethnicity: unstated
Interventions	Country: UK Setting: school, unstated whether urban or rural Provider: classroom teachers Duration: 5 months Intervention: the intervention included 16 lessons on healthy eating, increasing physical activity, and reducing television viewing (adapted and abbreviated form of the 'Eat Well Keep Moving' program). The 10 teachers providing the intervention were trained by 2 other teachers familiar with the program and provided with further training/study materials (i.e. lesson plans for 9 physical activity lessons, 6 nutrition lessons and 1 lesson about screen viewing). In the physical activity lessons, the children played games based on the food groups using photographs of food that reinforced the theory taught in the nutrition lessons Control: the control school were provided with the teacher training and materials following study completion
Outcomes	Television viewing (minutes spent watching television) Body mass index (kg/m ²)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "random allocation to intervention or control school was concealed and done by one of the authors" (Kipping 2008, p469)

Kipping 2008 (Continued)

		Comment: not stated exactly how the randomization sequence was generated by this author
Allocation concealment (selection bias)	Low risk	Quote: "random allocation to intervention or control school was concealed and done by one of the authors (DAL). The investigator who did the random allocation had no prior knowledge of characteristics of any of the schools" (Kipping 2008, p471)
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "school health assistants, who were blinded to the allocation of schools, took height and weight measurements" (Kipping 2008, p470) Comment: there was some initiative taken to blind although incomplete blinding could still introduce bias
Incomplete outcome data (attrition bias) All outcomes	High risk	Quote: "all analyses were undertaken using an intention to treat protocol, regardless of the number of lessons taught in intervention schools. However, we only included in the analyses those children with complete data at baseline and outcome" (Kipping 2008, p470) Comment: therefore, intention to treat not done
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders were controlled for
Data collection methods valid and reliable?	High risk	Comment: the physical activity instrument was not shown to be valid or reliable although other measurements were

Kriemler 2010

Methods	Design: cluster randomized controlled trial Theoretical framework: Socio-ecological Conceptual Model Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 297 N (control): 205 Age (mean): 6.9 years Sex: male and female Ethnicity: : White
Interventions	Country: Switzerland Setting: school, urban and rural Provider: physical education (PE) and classroom teachers Duration: 1 school year (9 months) Intervention: all children participated in 3 mandatory, 45-min PE lessons per week; the intervention group participated in 2 additional 45-min PE lessons per week. The mandatory PE lessons were given by the usual classroom teachers according to the specified curriculum; the additional lessons were taught mostly outdoors by PE teachers. Three to five 2 to 5-min activity breaks (motor skill tasks - jumping or balancing on 1 leg, power games, coordinative tasks) were provided each day during academic lessons. The children also received daily physical activity homework (10 min' worth), prepared by the PE teachers, including: aerobic, strength, or motor skill tasks (e.g. brushing their teeth while standing on 1 leg, hopping up and down the stairs, rope jumping, or comparable activities)

Kriemler 2010 (Continued)

Control: the control group continued to participate in the usual, mandatory PE lessons (45-min, 3 times per week); they were not informed that an intervention group existed in the other schools (teachers in the control group were aware but did not know the content of the intervention)

Outcomes	Duration of physical activity
	Mean systolic blood pressure (mmHg)
	Mean diastolic blood pressure (mmHg)
	BMI (kg/m ²)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Comment: randomized using a random numbers table
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	High risk	Quote: "due to the immense personnel used to perform all assessments, only a part of the researchers were blinded to group allocation. Blinded measurements included height and weight assessment, bioelectrical impedance, dual energy x-ray absorptiometry, and some of the fitness tests" (Kriemler 2010, p2) Comment: did not fully implement blinding
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: intention-to-treat principle employed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: relevant confounders taken into account
Data collection methods valid and reliable?	Low risk	Comment: data collection tools reported to be valid and reliable

Li 2010

Methods	Design: cluster randomized controlled trial
	Theoretical framework: not stated
	Number of intervention groups: 1
	Number of control groups: 1
	Follow-up: 1 year post-intervention
Participants	N (intervention): 2092

Li 2010 (Continued)

N (control): 2028

Age (mean): mean 9.4

Sex: mixed

Ethnicity: Chinese

Interventions	Country: China Setting: school Provider: classroom teachers Duration: 1 academic year Intervention: The Happy 10 program (based on the principle of TAKE10! - http://www.take10.net) included 2 daily 10-min physical activity sessions during the break between classes. Teaching materials provided included: activity cards (each activity card introduced 1 exercise and explained how to perform it); video demonstrations (showing students from the pilot study performing the activities; teachers could either demonstrate the activity or show it on a video); and tracking posters and stickers (used to illustrate the progress of each class). Teachers (i.e. classroom tutors, health educators, or both) attended a half-day training session (conducted by the staff of the National Institute for Nutrition and Food Safety, China CDC) to learn how to integrate the program into the school curriculum, and how to perform the activities. The training also included information about childhood obesity, risk factors, health consequences, and prevention. Activities (taken from TAKE 10! Program) included: "invisible jump rope"; "copy cat"; "all about you"; "stories on the move!"; and "stories in space". Students, teachers, and parents were encouraged to develop new activity models along with program staff (and included: "story in zoo"; "story in farm"; "who is wearing yellow today"; "time like a colt"; "happy and health"; and "little frog"). All activities were of moderate to vigorous intensities. Each 10-min session included: 1) the teacher or student selected an activity card(s) - 1 to 3 activities were performed at each session; 2) several children were chosen to model the exercise(s) in the front of the classroom with the other students following along; 3) a cool-down period following the activities; and 4) the students were taught a health message Control: no intervention took place	
Outcomes	Body mass index (kg/m ²)	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: no description of the randomization process given
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Low risk	Comment: outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: approximately 10% of intervention and control groups did not provide follow-up data (either moved away or absent on day outcomes were measured)

Li 2010 (Continued)

Selective reporting (re-reporting bias)	Unclear risk	Comment: no Information given, likely not done
Confounders controlled?	High risk	Comment: did not take any confounders into account
Data collection methods valid and reliable?	Unclear risk	Comment: while blinded outcome assessors measured height and weight in an objective way, reliability across outcome assessors was not reported. Validity not addressed in article

Lubans 2009

Methods	Design: cluster randomized controlled trial Theoretical framework: Social Cognitive Theory Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 53 N (control): 53 Age (mean): 14.1 years Sex: male and female Ethnicity: unstated
Interventions	Country: Australia Setting: school, home, unstated whether urban or rural Provider: teachers Duration: unstated Intervention: the intervention group (Program X intervention, based on the LEAF pilot study) included the same school sport program (as the control), however, with the following additions/alterations: 1) enhanced school sport program, delivered once a week for 10 weeks, focusing on lifetime physical activities that can be continued into adulthood (e.g. aerobics, weight training); 2) information sessions and interactive summary lecture focusing on physical activity and healthy eating; 3) pedometers for physical activity monitoring over the 6-month intervention; 4) physical activity and nutrition handbooks and monthly information newsletters for parents (designed to educate parents on strategies to support the health behaviors taught to their children in Program X); and 5) social support for physical activity and dietary behavior change using e-mail. Teachers introduced 1 of 10 physical activity and nutrition messages (selected because they represent the behaviors commonly associated with lower levels of disease risk and maintaining a healthy weight) at the beginning of each school sport session and delivered an activity reinforcing the message. These messages included: 1) Keep track of your physical activity (using goals/diary); 2) every step counts; 3) reduce your time spent watching television, using the computer, and playing electronic games immediately after school; 4) be active with friends and family; 5) identify excuses for not being active; 6) keep track of fruit and vegetable intake (using goals/diary); 7) aim for 2 pieces of fruit and 5 servings of vegetables each day; 8) drink more water and swap sugary drinks for diet drinks; 9) reduce your portion sizes and eat at the dinner table; and 10) reduce your junk food snacks. A member of the research team delivered an interactive lecture summarizing the 10 messages following the 10-week school sport component of the study. Control: the control group attended a 10-week school sport program and were given instructions (exercise program booklet) on how to complete the school sport sessions. They were not given any of the 'Program X messages' or additional materials or strategies to support behavior change or nutrition behaviors
Outcomes	Duration of physical activity Television viewing (minutes spent watching television)
Notes	

Lubans 2009 (Continued)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: although an envelope was used to attain concealment, having an envelope with the assignment does not tell us how authors generated the randomization sequence
Allocation concealment (selection bias)	Low risk	Quote: "a randomization envelope was prepared by a member of the research team and schools were assigned to one of two treatment conditions" (Lubans 2009, p177) Comment: concealment was attained
Blinding (performance bias and detection bias) All outcomes	Low risk	Comment: blinding implemented
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data not adequately addressed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	High risk	Comment: all relevant confounders were not controlled for
Data collection methods valid and reliable?	Low risk	Comment: tools were shown to be valid and reliable for both pedometers and the method to measure television viewing

Luepker 1996

Methods	Design: cluster randomized controlled trial Theoretical framework: Health Belief Model Number of intervention groups: 2 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 3297 N (control): 722 Age (mean): 8.8 years Sex: male and female Ethnicity: : White, African-American, Hispanic
Interventions	Country: US Setting: school, home, urban Provider: teachers, research staff, cafeteria staff Duration: 3 years <i>Intervention (overview): The CATCH intervention included school-based (school food service, physical education, classroom curricula) and family-based (home curricula, family fun nights) components. The school food service changes and physical education enhancement were ongoing throughout the 3 school years whereas the classroom and home curricula were implemented (by classroom teachers) over a fixed time period during each school year and addressed eating habits (grades 3 through 5), physical activity (grades 4 and 5), and cigarette smoking (grade 5 only). Eat Smart, the food service intervention, provided children with healthy meals that maintained recommended levels of essential nutrients and child partic-</i>

Luepker 1996 (Continued)

ipation in the school meal programs. Food service personnel attended a 1-day training session at the beginning of each school year. They were provided with more information, assistance in planning, and other support during monthly follow-up visits to the schools and booster sessions. The physical education specialists and teachers attended 1 to 1.5 days of training every school year. The classroom curricula included: the Adventures of Hearty Heart and Friends (grade 3 to 15, 30- to 40-min classes during 5 weeks); Go for Healths (grade 4 to 24, 30- to 40-min classes during 12 weeks); and Go for Health-5 (grade 5 to 16, 30- to 40-min classes during 8 weeks) and F.A.C.T.S. for Five (grade 5 - 4-session tobacco use prevention curriculum). The classroom teachers attended 1 to 1.5 days of training every year to learn how to implement the curricula. For the home curriculum, 19 activity packets (over the course of 3 school years) that complemented the classroom curricula were sent home with the students and required adult participation to complete. During grades 3 and 4, students invited their family members to a "family fun night" (dance performances, food booths, recipe distribution, games). The intervention schools were further randomized into 2 equal subgroups

Intervention 1: One group received a school-based program consisting of school food service modifications, physical education interventions, and the CATCH curricula

Intervention 2: One group received the same school-based program plus a family-based program

Control: the control group received the usual health curricula, physical education, and food service programs, but none of the CATCH interventions

Outcomes	Duration of physical activity Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) Mean blood cholesterol level (mg/dL) BMI (kg/m ²) Pulse rate (beats/minute)	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence genera- tion (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: outcome data complete
Selective reporting (re- porting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders were accounted for
Data collection methods valid and reliable?	Low risk	Comment: data collection tools were valid and reliable

Martinez 2008

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 465 N (control): 579 Age (mean): 9.4 years Sex: male and female Ethnicity: : White
Interventions	Country: Spain Setting: school, urban and rural Provider: sports instructors, classroom teachers Duration: 9 months Intervention: the intervention group received: 1) the standard, compulsory physical education curriculum (3 hours per week of low-to-moderate intensity activity); 2) recreational, noncompetitive, after school physical activity program (3 x 90-min sessions per week, for 24 weeks) Control: the control group received the standard, compulsory physical education curriculum: 3 hours per week of physical activity at low-to-moderate intensity
Outcomes	Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) Mean blood cholesterol level (mg/dL) BMI (kg/m ²)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Comment: randomization took place using computer generated random numbers
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	High risk	Quote: "two certified, trained nurses, who were unblinded to school allocation made the anthropometric and blood pressure measurements. The laboratory analysts who determined blood lipids were blinded to school allocation" (Martinez 2008, p14) Comment: only partial blinding implemented
Incomplete outcome data (attrition bias) All outcomes	Low risk	Quote: "analyses were performed according to the intention-to-treat, with children analyzed in their original randomized allocation, regardless of the number of scheduled physical activity sessions attended" (Martinez 2008, p15)
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on

Martinez 2008 (Continued)

Confounders controlled?	High risk	Comment: not all relevant confounders accounted for
Data collection methods valid and reliable?	Low risk	Comment: data collection methods were shown to be valid and reliable

McManus 2008

Methods	Design: cluster randomized controlled trial Theoretical framework: Health Belief Model, Social Cognitive Theory, Diffusion of Innovation Number of intervention groups: 2 Number of control groups: 1 Follow-up: 6 months post-intervention
Participants	N (intervention 1): 64 N (intervention 2): 61 N (control): 68 Age (mean): 10.4 years Sex: male and female Ethnicity: Chinese
Interventions	Country: China Setting: school, urban Provider: unstated Duration: 2 years Intervention 1: educational program group completed a 2-week education program using targeted materials, providing learner guidance and feedback, and promoting retention of the desired behavior. Content included heart rate monitor skills and education about heart health, goal-setting, and role play. Heart rate monitor skills and goal setting included: information about activity targets (light, moderate, vigorous); daily activity accumulation to achieve 30 to 60 min of moderate-to-vigorous intensity activity (MVPA); and how to use a heart rate monitor for feedback about progression to this goal. This content was taught via an active games approach and a take home booklet. Following the educational program, children in the 2 intervention groups completed 2 weeks with heart rate feedback and 2 weeks without heart rate feedback (counterbalanced) Intervention 2: no-education program group completed a 2-week control program (physical education classes without physical activity or heart health education). Following the educational program, children in the 2 intervention groups completed 2 weeks with heart rate feedback and 2 weeks without heart rate feedback (counterbalanced). The No-education Program Group were not given any information about the heart rate signal or its meaning, but were informed of the correct position of the chest belt Control: no intervention took place
Outcomes	Duration of physical activity Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) Body mass index (kg/m ²) VO ₂ max (mL/kg/minute) Pulse rate (beats/min)

Notes

Risk of bias

McManus 2008 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Comment: does not tell us exactly how they generated the sequence but rather how they selected schools from lists and kept allocation concealed
Allocation concealment (selection bias)	Low risk	Comment: opaque envelopes were utilized to maintain allocation concealment
Blinding (performance bias and detection bias) All outcomes	High risk	Comment: partial blinding was implemented only
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data was not adequately addressed
Selective reporting (reporting bias)	High risk	Comment: data collected on other outcomes that were not reported (e.g. secondary outcomes blood pressure and body mass index)
Confounders controlled?	Low risk	Comment: all relevant confounders were controlled for
Data collection methods valid and reliable?	Low risk	Comment: data collection methods were shown to be valid and reliable

Neumark-Sztainer 2009

Methods	Design: cluster randomized controlled trial Theoretical framework: Social Cognitive Theory Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 51 N (control): 45 Age (mean): 10.3 years Sex: male and female Ethnicity: African-American
Interventions	Country: US Setting: school, community, theatre, urban Provider: unstated Duration: approximately 16 weeks Intervention: the intervention included 3 components: 1) 14 x 2-hour after-school theatre sessions; 2) 8 weekly after-school booster sessions; and 3) family outreach to enhance home support for behavioral changes through positive reinforcement of health behaviors, parent-child participation in physical activities, and availability of healthy foods. Each theatre session included: 1) a 'check-in' in which children were given an opportunity to share any behavioral changes they had made over the past week (e.g. eating more fruits and vegetables) and talk about how take-home packages were received by families; 2) easy-to-prepare healthy snacks; 3) a movement component of fun and easy activities requiring minimal resources (e.g. dancing or walking); and 4) theatrical ACTIVities. For the initial sessions, the ACTIVities component included exercises to introduce the children to theatre techniques and to build trust and cooperation. In later sessions, the ACTIVities focused on enhancing knowledge and skills related to physical activity and healthy eating and promoting a positive body image through interactive activities. Children were asked to share their personal experiences related to being active and eating healthfully. The content of the script for the Ready. Set. ACTION! play was developed through these activities. During the final sessions, children were introduced to the script and began to rehearse for the final play

Neumark-Sztainer 2009 (Continued)

performance. The booster sessions included activities such as: creating advertisements for fruits and vegetables; painting positive affirmations (e.g. I am special) on a mirror to take home; brainstorming ways to be active while watching television (e.g. doing jumping jacks during commercials); teaching dance and strength training exercises to their classmates; learning exercises to do at home with their families; and rehearsals for the school performance of the Ready. Set. ACTION! play. For the family outreach component, Weekly Fun and Fitness packs (i.e. a healthy food with a simple recipe or fitness incentives for the family) and a CD of the Ready. Set. ACTION! songs were sent home (each pack also had a parent postcard with information and interactive activities on a topic addressed in the after-school program). There were also 2 family events: 1) the students' performance of the play; and 2) a 'Ready. Set. ACTION! DVD Release Party' (i.e. a family viewing of the DVD recording of the play production, a short performance by the children, and a communal family dinner)
Control: the control group participated in a theater-based intervention involving performing a play focused on environmental health issues using a prepared script

Outcomes	Duration of physical activity	
	Television viewing (minutes spent watching television)	
	Body mass index (kg/m ²)	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: authors should have used intention-to-treat analysis. While they did adjust for baseline differences, they only adjusted for certain characteristics like age and sex, and not for any of the outcome variables
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	High risk	Comment: not all relevant confounders controlled for; only age, gender, and race
Data collection methods valid and reliable?	Unclear risk	Comment: survey tool is cited, but reliability and validity not reported

Neumark-Sztainer 2010

Methods	Design: cluster randomized controlled trial
	Theoretical framework: Social Cognitive Theory, Transtheoretical Model
	Number of intervention groups: 1

Neumark-Sztainer 2010 (Continued)

	Number control groups: 1
	Follow-up: immediately post-intervention
Participants	<p>N (intervention): 177</p> <p>N (control): 159</p> <p>Age (mean): 15.8 years</p> <p>Sex: female</p> <p>Ethnicity: African-American, Causasian, Hispanic, Asian, American-Indian, mixed/other</p>
Interventions	<p>Country: US</p> <p>Setting: school, urban</p> <p>Provider: physical education (PE) teachers, coaches who were trained intervention staff</p> <p>Duration: 16 weeks</p> <p>Intervention: the intervention group continued to participate in the all-girls PE class during the first semester of the school year. They also received the New Moves curriculum during their PE class (approximately 16 weeks) and participated in New Moves activities throughout the rest of the school year (maintenance period). This program included: 1) the New Moves PE class - nutrition and social support/self-empowerment sessions (physical activity (Be Fit) 4 days/week taught by school PE teachers (3 days) and community guest instructors (1 day) and nutrition (Be Fueled) or social support/self-empowerment (Be Fab) classes 1 day/week); 2) individual counseling sessions using motivation interviewing techniques (to set personal goals for behavioral change based on eight New Moves objectives); 3) lunch get-togethers ("lunch bunches") once a week during the maintenance period where participants were served healthy food and engaged in informal discussions on New Moves topics; and 4) minimal parent outreach activities (i.e. 6 postcards sent home to reinforce New Moves messages and a parent-daughter retreat day focused on New Moves messages during the maintenance period). PE teachers attended full-day training before the intervention and half-day training during the intervention. They also received regular, ongoing support from New Moves staff throughout the program. New Moves intervention staff ran all program components aside from the PE class. These staff received training and ongoing support in motivational interviewing techniques</p> <p>Control: the control group continued to participate in the all-girls PE class during the first semester of the school year. Teachers were free to conduct their PE classes as they desired during the study period and did not receive training on New Moves until after the study period</p>
Outcomes	<p>Duration of physical activity</p> <p>Television viewing (minutes spent watching television)</p> <p>Body mass index (kg/m²)</p>

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: no description of the randomization process given
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known

Neumark-Sztainer 2010 (Continued)

Blinding (performance bias and detection bias) All outcomes	High risk	Comment: self-reported; unclear if trained staff taking measurements were blinded to intervention allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: less than 10% drop-out rate in intervention group; no details provided on reasons for drop-outs
Selective reporting (reporting bias)	Unclear risk	Comment: not discussed in report
Confounders controlled?	High risk	Comment: only considered baseline age, weight, and race
Data collection methods valid and reliable?	Unclear risk	Comment: did not provide details on reliability and validity of measures

Peralta 2009

Methods	Design: randomized controlled trial Theoretical framework: Social Cognitive Theory Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 16 N (control): 16 Age (mean): 12.5 years Sex: male Ethnicity: unstated
Interventions	Country: Australia Setting: school, unstated if urban or rural Provider: research worker, lay person, physical education (PE) teacher Duration: 16 weeks Intervention: the intervention program was primarily based on Social Cognitive Theory, with 16 program weeks, with each week comprising 1 x 60-min curriculum session and 2 x 20-min lunchtime physical activity sessions. Each 60-min curriculum session included practical and/or theoretical components focused on promoting physical activity through increasing physical self-esteem and self-efficacy, reducing time spent in small screen recreation on weekends, decreasing sweetened beverage consumption, and increasing fruit consumption and the acquisition and practice of self-regulatory behaviors such as goal setting, time management, and identifying and overcoming barriers. Behavior modification techniques (e.g. group goals converting time spent in physical activity to kilometers to reach a specified destination, and the use of incentives) were used. The practical component included modified games and activities. The researcher primarily facilitated the intervention with staff and parents' involvement. A Program Champion (PE teacher) liaised with School Executive and other staff to promote the program within the school and assist with logistical requirements. Eleventh grade students peer facilitated lunchtime sessions, based on their potential to be positive role models and had one 20-min training session. Parents were emailed 6 newsletters throughout, informing them of the program content, motivating them, and suggesting strategies to engage the family in healthy behaviors, creating a stronger connection between parents and the school Control: participated in 16 x 60-min physical activity curriculum at the same time as the intervention group, with a school PE teacher facilitating the control group
Outcomes	Duration of physical activity

Peralta 2009 (Continued)

Television viewing (minutes spent watching television)

Body mass index (kg/m²)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Comment: participants were randomized, using a computer-based number producing algorithm, to either the intervention or active comparison group
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "trained independent assessors, blind to group allocation, conducted the measurements" (Peralta 2009, p538)
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: outcome data complete
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders were controlled for
Data collection methods valid and reliable?	High risk	Comment: although reliability and validity were discussed with some of the data collection methods, not all were discussed

Petchers 1988

Methods	Design: randomized controlled trial Theoretical framework: Health Behavior Model Number of intervention groups: 2 Number of control groups: 1 Follow-up: 1 year post-intervention
Participants	N: 325 Age (mean): 11.1 years Sex: male and female Ethnicity: unstated
Interventions	Country: US Setting: school, mixed (urban, suburban and residential) Provider: teachers Duration: 1 school year (40 weeks) Intervention: Chicago Heart Health Curriculum Program called "Body Power" is a 1-year-long curriculum with modules on 5 topics: 1) cardiovascular system, anatomy, and physiology; 2) smoking; 3) nutrition; 4) exercise; and 5) risk factors review. Curriculum materials and activities emphasize the inter-relationship between students' feelings, behavior, and relationships and the risk factors of cardiovascular disease. The curriculum was implemented by classroom teachers with each module taught during at least 3 x 45-min sessions per week for 4 to 6 weeks. The Northeast Ohio Affiliate of the American

Petchers 1988 (Continued)

Heart Association provided training for teachers. In total, 14 training covered relevant content and humanistic education teaching techniques. Training was supplemented by a comprehensive teachers' manual with specific objectives for each module, suggested time frames and alternative activities for teachers to select those most compatible with their own teaching styles.

Control: control classes received the traditional curriculum with approximately the same amount of teaching time. Control group teachers were provided an alternative experience to the training sessions for the intervention group in the form of a separate in-service training day (general literature and lectures by a cardiologist and an educator

Outcomes	Physical activity rates (% of sample physically active)	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: no description of the randomization process was given
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data assessment
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	High risk	Comment: all relevant confounders were not accounted for
Data collection methods valid and reliable?	Low risk	Comment: data collection tools shown to be valid and reliable

Reed 2008

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 2 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N: 288 Age (mean): 10 years Sex: male and female Ethnicity: predominately White and Asian
Interventions	Country: Canada Setting: school, community, home, urban Provider: research staff, teachers

Reed 2008 (Continued)

Duration: 11 months

Intervention: the Action Schools! BC model was consistent with the 'active school' framework and emphasized an integrated whole-school approach rather than traditional classroom-based health education, targeting 6 Action Zones: i) School Environment, ii) Scheduled Physical Education, iii) Extracurricular, (iv) School Spirit, v) Family and Community and vi) Classroom Action. Classroom Action was the only prescriptive component of the AS! BC model in which teachers delivered 15 min of moderate to intense physical activity daily to achieve 75 min of extra physical activity per week (in addition to 2 x 40 min physical education (PE) classes). Teachers provided opportunities to 'snack on physical activities' such as skipping, dancing, and resistance exercises throughout the day. A school Action Team – comprised of the school principal, teachers, or both – was convened in each school and an AS! BC facilitator worked with Action Teams to design a program with activities across the 6 Action Zones. A 1-day training workshop was held for INT teachers, who were provided a Classroom Action Bin with resources to support their Action Plan with the goal for each school to provide students with 150 min of physical activity per week (2 x 40 min PE classes and 15 x 5 min per day of Classroom Action)

Control: teachers in usual practice schools continued their regular program of PE and school-based physical activity

Outcomes	Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) Mean blood cholesterol level (mg/dL) Body mass index (kg/m ²)
Notes	
<i>Risk of bias</i>	
Bias	Authors' judgement Support for judgement
Random sequence generation (selection bias)	Unclear risk Quote: "schools were then remotely randomized to either Usual Practice or Intervention by an epidemiologist not involved in the trial" (Reed 2008, p527) Comment: although it is stated who allocated schools, it does not state how schools were randomized
Allocation concealment (selection bias)	High risk Comment: it was reported that it was not possible for schools to be blinded to random assignment and therefore concealment not attained
Blinding (performance bias and detection bias) All outcomes	Unclear risk Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk Comment: incomplete outcome data not adequately addressed
Selective reporting (reporting bias)	Low risk Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk Comment: all relevant confounders controlled for
Data collection methods valid and reliable?	High risk Comment: reliability and validity of the physical activity measure was not discussed

Robinson 1999

Methods	Design: cluster randomized controlled trial
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Robinson 1999 (Continued)

Theoretical framework: Social Cognitive Theory
Number of intervention groups: 1
Number of control groups: 1
Follow-up: immediately post-intervention

Participants	N (intervention): 92 N (control): 100 Age (mean): 9 years Sex: male and female Ethnicity: unstated
Interventions	Country: US Setting: school, unstated if urban or rural Provider: teachers Duration: 6 months Intervention: limited access to television (TV) use and budgeting TV time. Based on Bandura's Social Cognitive Theory it involved 18 lessons of 30 to 50 min as part of standard curriculum, taught by regular classroom teachers trained by research staff. Most lessons occurred in the first 2 months of the year and early lessons included self-monitoring and self-reporting for TV and video game use followed by a 10-day TV turnoff challenge after which students were encouraged to follow a 7-h per week budget. Newsletters designed to help parents motivate students and regulate time spent on TV and video games for the entire family were distributed. Each household received 1 (or more if requested) TV time master to regulate TV and video use Control: not specified
Outcomes	Duration of physical activity TV viewing (minutes spent watching TV) Body mass index (kg/m ²)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "participants and school personal including classroom teachers, were informed of the intervention but were unaware of the primary hypothesis. Measurements were done by trained staff blinded to the experimental design" (Robinson 1999, p1562)
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: outcome data complete
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders were accounted for
Data collection methods valid and reliable?	Low risk	Comment: data collection tools valid and reliable

Salmon 2008

Methods	Design: cluster randomized controlled trial Theoretical framework: Social Marketing Theory, Behavioral Choice Theory Number of intervention groups: 3 Number of control groups: 1 Follow-up: 1 year post-intervention
Participants	N (intervention): 213 N (control): 55 Age (mean): 10 years Sex: male and female Ethnicity: unstated
Interventions	Country: Australia Setting: school, urban Provider: specialist physical education (PE) teacher Duration: 1 school year Intervention: students were assigned to 1 of 4 conditions: a behavioral modification group (BM; N = 69); a fundamental motor skills group (FMS; N = 73); a combined BM and FMS group (N = 90). Components of the intervention program were developed by the study team, with others adapted from previous interventions (SPARK), concepts outlined in Robinson's study, from Planet Health, and from the Victorian Fundamental Motor Skills program. BM condition: included 19 sessions of 40 to 50 min' duration over 3 school terms by the intervention specialist teacher, with different aims for each set of lessons (e.g. increasing awareness of time-use, health benefits of physical activity, self-monitoring time spent in sedentary behaviors and physical activity, raising awareness of the home and community environments in relation to choices and opportunities, decision-making skills, developing their own physical activities and games, 'intelligent viewing', a 'Switch-off Challenge', and intermittent reinforcement schedule with a small reward). FMS condition: 19 sessions of 40 to 50 min over 3 school terms taught by the same intervention specialist teacher who delivered the BM intervention. The FMS intervention focused on 6 skills, including 3 object control skills and 3 locomotor skills. Skills were taught with an emphasis on fun through games and maximum involvement for all the children. Most lessons focused on at least 2 skills, and each skill was a focus lesson in at least 6 or more sessions Control: usual classroom lessons
Outcomes	Duration of physical activity Television viewing (minutes spent watching television) Body mass index (kg/m ²)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Comment: participants selected a ticket from a container which specified group allocation
Allocation concealment (selection bias)	Unclear risk	Comment: it was not stated if allocation was adequately concealed
Blinding (performance bias and detection bias) All outcomes	High risk	Comment: Two trained staff members not blinded to group assignment took measurements

Salmon 2008 (Continued)

Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data was not adequately addressed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders were accounted for
Data collection methods valid and reliable?	Low risk	Comment: data collection tools valid and reliable

Simon 2004

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 475 N (control): 479 Age (mean): 11.7 years Sex: male and female Ethnicity: White
Interventions	Country: France Setting: community, school, urban Provider: teachers, physical activity (PA) instructors, peers, community groups Duration: 4 school years (40 weeks per year) Intervention: the ICAPS program was implemented over 4 academic years to promote PA inside and outside. The intervention includes an educational component focusing on PA and sedentary behaviors, new opportunities for PA during school hours (lunch break, recess), and after-school hours. Activities implemented are either informal or academic with emphasis on fun and pleasure, well-being, noncompetitiveness. Sporting events, bicycle, and on-foot transport are organized, with teachers, parental organizations, and sport associations encouraged to participate in meetings and regular contact. Intervention staff are informed of study objectives and work in collaboration with the different partners. The ICAPS coordinators regularly visit intervention school members to inquire about difficulties and help resolve material or personnel needs Control: not specified
Outcomes	PA rates (% of sample physically active) Duration of physical activity Television viewing (minutes spent watching televisions) Body mass index (kg/m ²) Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) Mean cholesterol level (mg/dL)
Notes	

Simon 2004 (Continued)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: outcome data complete
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders were accounted for
Data collection methods valid and reliable?	Low risk	Comment: data collection tools were shown to be valid and reliable

Singh 2009

Methods	Design: cluster randomized controlled trial Theoretical framework: Intervention Mapping Protocol Number of intervention groups: 1 Number of control groups: 1 Follow-up: 1 year post-intervention
Participants	N: 875 Age (mean): 12.7 years Sex: male and female Ethnicity: : White
Interventions	Country: Netherlands Setting: school, unstated whether urban or rural Provider: teachers although unclear Duration: 8 months Intervention: an interdisciplinary program with adapted curriculum including an individual component (11 lessons in biology and physical education) and environmental change component including encouragement for schools to increase physical education and provision of advice for schools related to cafeteria changes Control: regular curriculum
Outcomes	Body mass index (kg/m ²) Television viewing (minutes spent engaged in inactivity)
Notes	

Singh 2009 (Continued)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	High risk	Quote: "all measurements were performed within a 6-week period according to a standardized protocol by a trained research team, which was not blinded to the group assignment" (Singh 2009, p310)
Incomplete outcome data (attrition bias) All outcomes	Low risk	Quote: "all analyses were performed according to the intention-to-treat principle" (Singh 2009, p311)
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders were accounted for
Data collection methods valid and reliable?	Low risk	Comment: more detail on reliability and validity could be given

Singhal 2010

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 99 N (control): 102 Age (mean): 16 years Sex: male and female Ethnicity: Indian
Interventions	Country: India Setting: school, urban Provider: trained nutritionist, teachers, student volunteers Duration: 42 weeks Intervention: multicomponent intervention with 7 components related to nutrition and lifestyle education, including the following activities: dissemination of health-related information through lectures

Singhal 2010 (Continued)

and focused group discussions (24 weeks (6 months) of nutrition education), promotion of physical activity (encouragement to participate in physical activity periods in school every week for at least 30 min), other promotion of healthy lifestyle (a consecutive 8 weeks (30 min 5 days per week), with meal planning and discussion of healthy alternatives and quizzes), individual counseling (1 h per week per child, in groups of 4 or 5), policy-level changes in schools (school canteen serving offering healthier choices), involvement of teachers and parents (health camp for parents and telephone follow-up with counseling of 5 to 7 min per month), training of student volunteers for program sustainability (1-h session each week with 40 eleventh-grade student volunteers)
Control: no intervention

Outcomes	Body mass index (kg/m ²)	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: no description of the randomization process given
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: not reported if assessors were blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: participant loss minimal, reasons given in Figure 1
Selective reporting (reporting bias)	Unclear risk	Comment: not clear if all a priori outcomes were reported on
Confounders controlled?	High risk	Comment: not all confounders adequately controlled
Data collection methods valid and reliable?	High risk	Comment: do not provide details on how body mass index was measured, only state who measured outcome

Stephens 1998

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 45 N (control): 45 Age (mean): 8 years Sex: male and female Ethnicity: African-American
Interventions	Country: US

Stephens 1998 (Continued)

Setting: school, urban
 Provider: medical students
 Duration: 15 weeks
 Intervention: 18 medical students were assigned to classrooms and given a 2-day orientation session. Each class received 3 activity sessions per week, with the fitness intervention consisting of 5 min of warm-up and stretching, followed by 20 min of aerobic activity. Activities were selected from a roster defined by the Centers for Disease Control and Prevention and incorporated repetitive movements of large muscle groups, designed to elevate the pulse rate 40 to 60 beats over resting level. Sessions ended with a 5- to 10-min cool-down when medical student teams presented educational material about nutrition, exercise, and disease prevention
 Control: students in the control classroom received no additional physical activity beyond regular physical education classes

Outcomes	Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) Pulse rate (beats/minute)
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Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data assessment
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported
Confounders controlled?	Low risk	Comment: all relevant confounders were accounted for
Data collection methods valid and reliable?	Unclear risk	Comment: insufficient data to determine reliability and validity

Stone 2003

Methods	Design: cluster randomized controlled trial Theoretical framework: Social Learning Theory, incorporating Cultural Heritage of American-Indians Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	Intervention: 644 Control: 653

Stone 2003 (Continued)

Age: grade 3 (mean age not provided)
Sex: male and female
Ethnicity: American-Indian

Interventions	Country: US Setting: school, unstated if urban or rural Provider: teacher, nutritionist (for nutritional support) Duration: 3 years (12 weeks per year) Intervention: the intervention program was implemented during third through fifth grades, with 4 components including: food service, skills-based classroom curricula, family, and physical education (PE). The intervention combined Social Learning Theory and principles of American Indian culture and practices with indigenous learning modes (e.g. story telling) incorporated. Classroom component: 2 x 45-min lessons delivered by teachers weekly for 12 weeks during grades 3 and 4, decreased to 8 weeks in grade 5. Food service component: nutrient guidelines and tools for reducing fat content of school meals while meeting nutrient requirements. Food service staff provided skill-building for planning, purchasing, and preparing lower-fat school meals. PE component: a minimum of 3 x 30-min sessions per week of moderate to vigorous physical activity based on SPARK. Family component: assistance creating a supportive environment with an interactive forum to discuss Pathways and additionally, 1) family action packs, and 2) family events at schools Control: not specified
Outcomes	Duration of physical activity Body mass index (kg/m ²)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: outcome data complete
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported
Confounders controlled?	Low risk	Comment: all relevant confounders were accounted for
Data collection methods valid and reliable?	Low risk	Comment: data collection tools shown to be valid and reliable

Trevino 2004

Methods	Design: randomized controlled trial Theoretical framework: Social Cognitive Theory, Social Ecological Theory
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Trevino 2004 (Continued)

Number of intervention groups: 1
Number of control groups: 1
Follow-up: immediately post-intervention

Participants	<p>N (intervention): 619 N (control): 602</p> <p>Age (mean): 9.8 years Sex: male and female Ethnicity: Hispanic</p>
Interventions	<p>Country: US Setting: school, urban Provider: teachers Duration: 7 months Intervention: 50 sessions of health programing across 7 months to transmit to children 3 health behavior messages associated with diabetes mellitus control (decreased dietary saturated fat intake, increase dietary fiber intake, increase physical activity). Taught and reinforced through classroom, home, school cafeteria, and after-school care educational activities. Physical education teachers, parents, school cafeteria staff, and after-school care staff were asked to encourage less dietary saturated fat, more fiber intake and more physical activity, to have less saturated fat and more fiber available, and more physical activity available. Children were asked to set goals aimed at accomplishing the targeted behaviors and to keep records of their accomplishments. Children were also asked to encourage their peers and adult caretakers to practice 3 health behaviors. Children and parents who practiced the 3 health behaviors were rewarded with coupons (worth a \$\$ amount) from a store set up in the school. Students could purchase merchandise with the coupons Control: not specified</p>
Outcomes	VO ₂ max (mL/kg/minute)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Comment: randomization took place using a random number table
Allocation concealment (selection bias)	Low risk	Comment: methods ensured that no one could foresee intervention assignment
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "principals of schools were informed and asked not to inform students, parents or school staff of the intervention assignment" (Trevino 2004, p912)
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: outcome data complete
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant outcomes were accounted for
Data collection methods valid and reliable?	Unclear risk	Comment: reliability and validity of data collection methods not specifically stated

Verstraete 2006

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 122 N (control): 113 Age (mean): 10.8 years Sex: male and female Ethnicity: White
Interventions	Country: Belgium Setting: school, urban Provider: research staff Duration: 3 months Interventions: intervention: classes received a set of game equipment and 'activity cards' including examples of games and activities that can be performed with the equipment. Children were allowed to play outdoors with the equipment during recesses and lunch break. Before providing the game equipment, the different play toys and 'activity cards' were presented to the children of each class group by a research staff member. Teachers were asked to stimulate the children to play with the game equipment and agreed on rules with the children about the use and the loss or damage of the game equipment to assure its endurance. The teachers were advised to divide the game equipment into different sets and to exchange those sets regularly to prevent children losing interest in the equipment. Children were only allowed to play with the equipment of their own class. The set of game equipment for each class group included 2 jump ropes, 2 double Dutch ropes, 2 scoop sets, 2 flying discs, 2 catchballs, 1 poco bal, 1 plastic bal, 2 plastic hoops, 2 super grips, 3 juggling scarves, 6 juggling rings, 6 juggling beanballs, 1 diabolo, 1 angel-stick, 4 spinning plates, 2 sets of badminton racquets and 2 sets of oversized beach paddles. Control: not specified
Outcomes	Physical activity rates (% of sample physically active)
Notes	
Risk of bias	
Bias	Authors' judgement Support for judgement
Random sequence generation (selection bias)	Unclear risk Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk Comment: incomplete outcome data was not adequately addressed

Verstraete 2006 (Continued)

Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	High risk	Comment: not stated therefore likely not done
Data collection methods valid and reliable?	Unclear risk	Comment: reliability and validity of data collection methods not specifically stated

Walter 1988

Methods	Design: cluster randomized controlled trial Theoretical framework: PRECEDE, Health Belief Model, Social Learning Theory Number of intervention groups: 2 Number of control groups: 2 Follow-up: immediately post-intervention
Participants	N (intervention in lower income inner city area): 1590 (14 schools) N (intervention in middle/upper income suburb): 485 (8 schools) N (control in lower income inner city area): 693 (8 schools) N (control in middle/upper income suburb): 620 (7 schools) Age (mean): 9 years Sex: male and female Ethnicity: White, Hispanic, African-American
Interventions	Country: US Setting: school, community, urban Provider: teachers Duration: 6 years Intervention: special curriculum targeting voluntary changes in risk behavior in the area of diet, physical activity, and smoking. Curriculum content was designed to provide the information and motivation necessary for behavioral changes, as well as training in the skills necessary to make such changes. The intervention foci (perceived susceptibility to, and severity of health problems, perceived benefits of and barriers to adopting and maintaining risk-reduction types of behavior) were derived from the Health Belief Model, skills training strategies were derived from Social Learning Theory. Cognitive-development theory provided a framework for the appropriate tailoring of these constructs to the children's changing maturational stages as the study progressed over a 5-year period. The physical activity component of the intervention fostered the adoption of a regular program of endurance exercise. The special curriculum was taught in classrooms by specially trained regular teachers for approximately 2 hours per week throughout each school year. Control: not specified
Outcomes	Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) Mean blood cholesterol level (mg/dL) Body mass index (kg/m ²) Pulse rate (beats/minute)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
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Walter 1988 (Continued)

Random sequence generation (selection bias)	Unclear risk	Comment randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: analyses were done to see if bias would be introduced due to attrition and average values of the risk values were imputed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders controlled for
Data collection methods valid and reliable?	Unclear risk	Comment: reliability and validity of data collection methods not specifically stated

Walther 2009

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 2 Follow-up: immediately post-intervention
Participants	N (intervention): 109 N (control): 73 Age (mean): 11.1 years Sex: male and female Ethnicity: White
Interventions	Country: Germany Setting: school, unstated if urban or rural Provider: unstated Duration: 1 year Intervention: classes assigned to 1 unit of physical exercise (45 min) with at least 15 min of endurance training per school day. In addition, lessons on healthy lifestyle were included in the regular schedule once monthly for all pupils. 2 additional sixth-grade classes from a school focusing on competitive sports and physical education were selected to serve as a reference group. Control: according to German standards, 2 units (each 45 min) of physical education per week are mandatory in all schools. The nonrandomized sport students (reference group) received 12 units (45 min per unit) of high-level endurance exercise training per week and frequently participated in competitive sporting events, thus representing a maximum of physical fitness attainable under reasonable conditions in school-age children
Outcomes	Mean systolic blood pressure (mmHg) Mean diastolic blood pressure (mmHg) Mean blood cholesterol level (mg/dL)

Walther 2009 (Continued)

VO₂max (mL/kg/minute)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data was not adequately addressed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	High risk	Comment: not all relevant confounders controlled for
Data collection methods valid and reliable?	Low risk	Comment: data collection methods were reported to be valid and reliable

Wang 2008

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 168 N (control): 148 Age (mean): 8.5 years Sex: Male and female Ethnicity: African-American
Interventions	Country: US Setting: school, urban Provider: physical education (PE) teachers, classroom teachers, paraprofessionals Duration: 3 school years Intervention: 'FitKid' after-school program was offered 5 days a week (not offered during holidays and vacation periods). Certified school teachers and paraprofessionals implemented the program, following established guidelines that included reinforcement and teaching techniques, safety measures, evaluation procedures, and monthly activity plans that accommodate local weather conditions (i.e. more outdoor-based activities in spring, winter, and late fall and more indoor activities in summer and early fall when it is often too hot and humid to play outside). 2-hour intervention sessions began with a 40-min period during which the youths were provided with a healthy snack and academic enrichment

Wang 2008 (Continued)

activities. The snacks were provided through the US Department of Agriculture's National School Lunch and Child and Adult Care Food Programs in cooperation with the school nutrition service. The academic enrichment activities were incorporated into the program to ensure that participation in the FitKid intervention during the after-school hours would not damage the academic progress of the children. The 80 min of physical activity included a variety of activities designed to improve sport skills, aerobic fitness, strength, and flexibility; 40 min were devoted to vigorous physical activity
Control: not specified

Outcomes	Mean systolic blood pressure (mmHg)
	Mean diastolic blood pressure (mmHg)
	Mean cholesterol level (mg/dL)
	Body mass index (kg/m ²)
	VO ₂ max (mL/kg/minute)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data was not adequately addressed
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant confounders were taken into account
Data collection methods valid and reliable?	High risk	Comment: not all methods were shown to be valid or reliable

Webber 2008

Methods	Design: cluster randomized controlled trial Theoretical framework: Social Cognitive Theory, Diffusion of Innovation, Operant Learning Theory Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 18 schools N (control): 18 schools

Webber 2008 (Continued)

Age (mean): 12 years
Sex: female
Ethnicity: White

Interventions	Country: US Setting: community, school, unstated whether urban or rural Provider: research staff, community groups, teachers Duration: 2 years Intervention: TAAG health education included 6 lessons in each of the 7th and 8th grades designed to enhance behavioral skills known to influence physical activity participation. Activity challenges associated with the lessons reinforced the contents, encouraged self-monitoring, and set goals for behavior change. To meet the varying formats in which health education was taught at the school, TAAG health education was offered in 2 forms: 1 for a traditional classroom setting and 1 for physical education (PE) class. TAAG PE class promoted moderate to vigorous physical activity (MVPA) for at least 50% of class time and encouraged teachers to promote physical activity outside of class. Activities targeted to create (1) environmental and organizational changes supportive of physical activity and (2) cues, messages, and incentives to be more physically active. Specifically, the intervention was designed to establish more opportunities, improve social support and norms, and increase self-efficacy, outcome expectations, and behavioral skills to foster greater MVPA. 35 to 40 girls were the focus of the intervention; however, health and PE classes were part of the usual school curriculum and most included boys as well. An innovative feature of the intervention was linking school and community agencies to develop and promote physical activity programs for girls. These programs were delivered both on and off school property, in most cases either before or after school Control: not specified
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Outcomes	Duration of physical activity Television viewing (minutes spent watching television) Body mass index (kg/m ²)
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Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Low risk	Quote: "TAAG staff was blinded to the study outcomes until the 2006 data collection was complete. Also, separate intervention and measurement staff were employed" (Webber 2008, p174)
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: incomplete outcome data was not addressed adequately. Quote: "in a study such as TAAG, efforts to obtain a complete set of measurements on the girls assigned to each treatment condition would require considerable resources, as it is expensive to track and measure students who have left a school. Furthermore, despite extraordinary efforts, ascertainment of measurements in every girl in the cohort is unlikely" (Stevens 2005, p226)
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on

Webber 2008 (Continued)

Confounders controlled?	High risk	Comment: all relevant confounders were not controlled for
Data collection methods valid and reliable?	Unclear risk	Comment: data collection methods were not discussed or shown to be valid or reliable

Weeks 2008

Methods	Design: randomized controlled trial Theoretical framework: unstated Number of intervention groups: 1 Number of control groups: 1 Follow-up: immediately post-intervention
Participants	N (intervention): 43 N (control): 38 Age (mean): 13.8 years Sex: male and female Ethnicity: unstated
Interventions	Country: Australia Setting: school, unstated whether urban or rural Provider: research staff Duration: 8 months Intervention: 10 min of directed jumping activity at the beginning of every physical education (PE) class (twice per week). Activities designed to apply loads to the skeleton at high strain magnitude, frequency, and rate, and included: jumps, hops, tuck-jumps, jump-squats, stride jumps, star jumps, lunges, side lunges, and skipping. Jumps were occasionally supplemented with upper body strengthening activities, including push-ups and exercises with resistive latex bands (AusBand; Ausmedic Australia). Control: regular PE warm-ups and stretching directed by their usual PE teacher at the beginning of every PE class (twice per week). Activities focused on improving flexibility and general preparedness for physical activity without specifically loading the skeleton at higher rates than normal, including: brisk walking, light jogging, and stretching
Outcomes	Duration of physical activity Body mass index (kg/m ²)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: no description of the randomization process given
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no Information given, likely not done

Weeks 2008 (Continued)

Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: intention-to-treat analysis was not completed on the outcomes of interest
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	Low risk	Comment: all relevant outcomes were accounted for
Data collection methods valid and reliable?	Unclear risk	Comment: reliability and validity were not discussed

Williamson 2007

Methods	Design: cluster randomized controlled trial Theoretical framework: unstated Number of intervention groups: 2 Number of control groups: 0 Follow-up: immediately post-intervention
Participants	N (intervention): 282 N (control): 304 Age (mean): 9.2 years Sex: male and female Ethnicity: White
Interventions	Country: US Setting: school, unstated if urban or rural Provider: classroom teachers Duration: 2 academic years <i>The Healthy Eating and Exercise (HEE) and Alcohol/Tobacco/Drug abuse prevention (ADT) programs were developed as environmental approaches for weight gain. The primary components of the programs were to alter the physical and social environment of the schools. Both programs were rationally linked to a "Wise Mind" concept, which was a central feature of both programs, thus allowing the use of Wise Mind as the name for the program (as a whole), as opposed to just one intervention arm of the study. The Wise Mind concept represents the idea that with knowledge and environmental changes, students can make wise decisions about nutrition, physical activity, and substance use/abuse. The environmental changes were designed to alter the ecology of the school environments, including policy, personal, social, cultural, and physical environmental changes.</i> Intervention: Healthy Eating and Exercise (HEE) program, designed with the goal of preventing inappropriate weight gain by modifying the school environment to improve healthy eating habits, increase physical activity, and decrease sedentary behavior at school and to encourage these same behavioral changes outside the school environment. The goal of the physical activity program was to increase physical activity during the school day and at home. Teachers were provided with containers filled with indoor play supplies (e.g. balloons, bean bags) and outdoor play supplies (e.g. balls, jump ropes) to promote active play during class time and recess. Posters encouraged the use of these physical activity centers (PACs), and brief lesson plans provided academic games that used the supplies contained in the PACs Control: Alcohol/Tobacco/Drug abuse prevention (ADT) program, designed with the goal of modifying children's beliefs and attitudes regarding the use and abuse of tobacco, alcohol, and illicit drugs so that they reflected "healthier" values
Outcomes	Duration of physical activity Television viewing (minutes engaged in inactivity)

Williamson 2007 (Continued)

Body mass index (kg/m²)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: randomization process not reported
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: missing values were replaced with calculated estimates
Selective reporting (reporting bias)	Low risk	Comment: all outcomes identified a priori were reported on
Confounders controlled?	High risk	Comment: more confounders should have been assessed and controlled for
Data collection methods valid and reliable?	Low risk	Comment: data collection methods were shown to be valid and reliable

Wilson 2011

Methods	Design: cluster randomized controlled trial Theoretical framework: Social Cognitive Theory, Self-Determination Theory Number of intervention groups: 1 Number of control groups: 1 Follow-up: 2 weeks post-intervention
Participants	N (intervention): 673 N (control): 635 Age (mean): 11.3 years Sex: male and female Ethnicity: African-American (73%), other
Interventions	Country: US Setting: Grade school, unstated if urban or rural, home Provider: trained team leader

Wilson 2011 (Continued)

Duration: 17 weeks

Intervention: ACT, a 17-week program implemented on Mondays, Tuesdays, and Thursdays for 2 hours after school. On Wednesdays students practiced what they had learned in the after-school program in their home environment. A trained team leader, with expertise in implementing physical activities (PA) in youth, provided the structure for the ACT intervention program implementation. The program had 3 main components: homework/snack (30 min), moderate to vigorous physical activities (MVPA) (60 min) that students selected each week, and a behavioral skills and motivational component (30 min) during which intervention staff worked with participants on developing strategies for increasing their MVPA in their home environment. The ACT intervention specifically targeted development of behavioral skills (communication, reciprocity of social support, group goal setting, and behavioral competence) for increasing PA outside of program days. In addition, the ACT after-school program social environment (autonomy, choice, participation, belongingness, fun, enjoyment, support) was designed to have a positive impact on cognitive mediators (self-confidence, perceived competence) and motivational orientation (intrinsic motivation, commitment, positive self-concept) to promote long-term PA behavior. Control: the General Health Education Program (comparison program) focused on nutrition, stress management, drug prevention, and drop-out prevention (with no PA component). The program consisted of a homework/snack (30 min) and 3 hands-on activities related to general health (30 min each). The comparison program was held on the same days and times as the ACT intervention program.

Outcomes	Duration of PA	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: no description of the randomization process given
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Low risk	Comment: used accelerometers to measure outcome
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: did intention-to-treat analysis, also provided details on drop-outs
Selective reporting (reporting bias)	Unclear risk	Comment: no Information given, likely not done
Confounders controlled?	Low risk	Comment: adjusted for important confounders before randomization
Data collection methods valid and reliable?	Low risk	Comment: data collection tools reliable (accelerometers)

Young 2006

Methods	Design: randomized controlled trial
	Theoretical framework: Social Action Theory

Young 2006 (Continued)

	Number of intervention groups: 1
	Number of control groups: 1
	Follow-up: immediately post-intervention
Participants	<p>N (intervention): 111</p> <p>N (control): 99</p> <p>Age (mean): 13.8 years</p> <p>Sex: female</p> <p>Ethnicity: African-American (83%)</p>
Interventions	<p>Country: US</p> <p>Setting: school, urban</p> <p>Provider: teacher hired by project</p> <p>Duration: 1 year (school year)</p> <p>Intervention: the intervention was taught by a teacher hired by the project. Intervention content included information to make an informed decision about the personal benefits of a physically active lifestyle, develop problem-solving skills, and obtain support from others. Specific strategies that were taught and reinforced included goal setting, problem-solving barriers, communication skills, reinforcement of goal achievement through internal and external rewards, and learning from relevant role models. Skills were taught using class lectures and discussions, small-group discussions, and homework activities. Physical activity self-monitoring was given a strong focus. Students were encouraged to keep weekly exercise logs from which the teacher provided feedback on progress toward goal attainment and reward strategies. All students in class received the intervention, irrespective of whether they were trial participants. The intervention was also designed to maximize physical activity during physical education (PE) class. The format was congruent with the school's PE curriculum - 1 semester of individual sports and 1 semester of team sports - taught 5 days per week. Classes were optimized for physical activity by teaching units that were active in nature (e.g. soccer instead of softball (personal fitness unit)), breaking skills training into small-group activities, and playing games in small groups (e.g. 3-on-3 basketball). Skills training was limited to that needed for competency rather than proficiency. Written tests focused on health-related physical activity and fitness concepts and behavioral skills. The family support component consisted of a family workshop, monthly newsletters, and adult-child homework assignments. A 2-hour family workshop, scheduled shortly after randomization, featured tips on how parents could provide support to their daughters. As an in-class activity, students worked on skits illustrating support strategies that were videotaped and viewed at the workshop. Families who did not attend were mailed copies. Families also received a 2-page family support newsletter each month that contained an article on ways families can support physical activity with their daughter</p> <p>Control: standard PE class was a curriculum in which students were taught skills in individual and team sports. For example, during the basketball unit, students were taught how to dribble, shoot, and pass, and were tested on concepts such as game rules and defense strategies. Similar to the intervention structure, 1 semester focused on individual sports and the other on team sports. Classes were taught by certified PE teachers employed by the school. Parents of participants in the standard PE class also received monthly newsletters. Topics were of general health interests and included an article about PE class content that month</p>
Outcomes	<p>Mean systolic blood pressure (mmHg)</p> <p>Mean diastolic blood pressure (mmHg)</p> <p>Mean blood cholesterol level (mg/dL)</p> <p>Body mass index (BMI) (kg/m²)</p>

Young 2006 (Continued)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: no description of the randomization process given
Allocation concealment (selection bias)	Low risk	Comment: criterion not applicable because all participants were allocated at 1 point in time following recruitment, so at time of recruitment allocation was not known
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Comment: no Information given, likely not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: less than 10% drop-out rate and reasons given (for blood pressure and BMI outcomes)
Selective reporting (reporting bias)	Unclear risk	Comment: no Information given, likely not done
Confounders controlled?	High risk	Comment: while controlled for baseline outcomes and race, they did not account for other important confounders
Data collection methods valid and reliable?	Unclear risk	Comment: reliability and validity of data collection methods were not stated

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Abbott 1989	Weak methodological rating
Aburto 2011	Data on relevant outcomes for children aged 6 to 18 years not reported
Adeniran 1988	Not relevant to public health or health promotion
Aganovic 2002	Not relevant to public health or health promotion
Agron 2002	No control group
Al-Nakeeb 2007	Not a randomized controlled trial
Alexandrov 1988	Not a randomized controlled trial
Alexandrov 1992	Intervention not aimed at promoting physical activity
Alhassan 2007	Data on relevant outcomes for children aged 6 to 18 years not reported
Allensworth 1997	Not relevant to public health or health promotion

Study	Reason for exclusion
Allison 1999	Not relevant to public health or health promotion
Allison 2000	Not a randomized controlled trial
Andersen 1998	No control group
Andersen 2003	Not a randomized controlled trial
Andersen 2006	No control group
Anderson 1999	Not relevant to public health or health promotion
Andreacci 2008	No control group
Annesi 2004	Data on relevant outcomes for children aged 6 to 18 years not reported
Ara 2006	Not a randomized controlled trial
Arau jo-Soares 2009	Not a randomized controlled trial
Arborelius 1988	Intervention not aimed at promoting physical activity. Data on relevant outcomes for children aged 6 to 18 years not reported
Arday 2010	Not a randomized controlled trial
Armstrong 2000	Not a randomized controlled trial
Babin 2001	Data on relevant outcomes for children aged 6 to 18 years not reported
Bal 1990	Intervention not school based. Intervention not aimed at promoting physical activity
Baquet 2001	Weak methodological rating
Baquet 2002	Weak methodological rating
Baranowski 2002	Not a randomized controlled trial
Baranowski 2005	Not a randomized controlled trial
Barthold 1993	Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
Baxter 1997	Intervention not aimed at promoting physical activity
Beighle 2006	No control group
Belansky 2006	Weak methodological rating
Benson 2008	Intervention not school based
Berenson 1993	Not a randomized controlled trial
Berenson 1993a	Data on relevant outcomes for children aged 6 to 18 years not reported
Berenson 2001	Data on relevant outcomes for children aged 6 to 18 years not reported. No control group

Study	Reason for exclusion
Berg-Kelly 1997	Not relevant to public health or health promotion
Bergmann 2010	Not a randomized controlled trial
Biddle 2004	Not a randomized controlled trial
Bindler 2000	Not relevant to public health or health promotion
Bischoff 1987	No control group
Blank Sherman 1992	No control group
Blessing 1994	No control group
Bonhauser 2005	Weak methodological rating
Booth 2001	Not a randomized controlled trial
Boreham 2001	Not a randomized controlled trial
Boyd 1997	Weak methodological rating
Boyle-Holmes 2010	Not a randomized controlled trial
Briancon 2010	Data on relevant outcomes for children aged 6 to 18 years not reported
Brown 2004	Data on relevant outcomes for children aged 6 to 18 years not reported
Brownell 1982	Intervention not aimed at promoting physical activity
Buchan 2011	Intervention duration less than 3 months
Bungum 1997	Not relevant to public health or health promotion
Burgeson 2001	Not a randomized controlled trial
Burgess 2006	Intervention not school based
Bush 2010	Intervention not school based
Butcher 2007	Data on relevant outcomes for children aged 6 to 18 years not reported
Byrd-Williams 2010	Not a randomized controlled trial
Cale 2000	Not a randomized controlled trial
Calfas 1991	Intervention not aimed at promoting physical activity. Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
Calfas 1994	Not relevant to public health or health promotion
Caravella 1996	Not relevant to public health or health promotion
Cardon 2002	Not a randomized controlled trial

Study	Reason for exclusion
Cardon 2004	Not a randomized controlled trial
Carlson 2008	Not a randomized controlled trial
Carrel 2005b	Weak methodological rating
Carrel 2005a	Intervention not aimed at general population (overweight/obese-only sample)
Casazza 2007	Not a randomized controlled trial
Cass 2006	No control group
Castelli 2007	Not a randomized controlled trial
Cawley 2007	No control group
Chad 1999	Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
Challener 1990	Not relevant to public health or health promotion
Chatzisarantis 2009	Intervention duration less than 3 months
Chavarro 2005	Intervention not aimed at general population (only girls not menstruating were included in the study)
Chomitz 2003	Weak methodological rating
Choudhuri 2002	Not relevant to public health or health promotion
Chow 2001	Data on relevant outcomes for children aged 6 to 18 years not reported
Ciccomascolo 2008	Intervention not school based
Cirignano 2010	Intervention duration less than 3 months
Clark 2008	Data on relevant outcomes for children aged 6 to 18 years not reported
Coe 2005	Not relevant to public health or health promotion
Coe 2006	Data on relevant outcomes for children aged 6 to 18 years not reported
Cohen 1991	No control group
Colchico 2000	No control group
Collins 1988	Not relevant to public health or health promotion
Collins 1995	Not relevant to public health or health promotion
Connor 1986	Weak methodological rating
Contento 2010	Intervention duration less than 3 months
Cornelius 1991	Not relevant to public health or health promotion

Study	Reason for exclusion
Cottrell 2005	Weak methodological rating
Cox 2006	Intervention not school based
Crawford 1997	Not relevant to public health or health promotion
Dale 2000	Weak methodological rating
Davis 1995	Weak methodological rating
de Barros 2009	Data on relevant outcomes for children aged 6 to 18 years not reported
De Bourdeaudhuij 2010	Intervention duration less than 3 months
De Meij 2010	Data on relevant outcomes for children aged 6 to 18 years not reported
DeBar 2006	Data on relevant outcomes for children aged 6 to 18 years not reported
Deforche 2004	Not relevant to public health or health promotion
Dehar 1991	Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
Del Ben 1991	No control group
Dellinger 2002	Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
DeMarco 1989	Not relevant to public health or health promotion
Dempsey 1993	Not relevant to public health or health promotion
Dencker 2006	Not a randomized controlled trial
Dennison 2004	Data on relevant outcomes for children aged 6 to 18 years not reported
Derri 2004	Intervention not school based
DeVault 2009	Data on relevant outcomes for children aged 6 to 18 years not reported
Devis 1992	No control group
Diaz 1997	Data on relevant outcomes for children aged 6 to 18 years not reported
Diehl 1998	Data on relevant outcomes for children aged 6 to 18 years not reported. Intervention not school based
Dishman 2005	Weak methodological rating
Dishman 2010	Data on relevant outcomes for children aged 6 to 18 years not reported
Donnelly 1996	Weak methodological rating
Dowda 2001	Not relevant to public health or health promotion
Drews 2009	Data on relevant outcomes for children aged 6 to 18 years not reported

Study	Reason for exclusion
Dudley 2010	Intervention not aimed at general population (only girls who expressed low enjoyment of physical activity were included in the study)
Dunbar 1998	Intervention not school based. Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
Duncan 1983	Study published prior to inclusion date of 1985
Duncan 2004	Not a randomized controlled trial
Duncan 2009	Intervention duration less than 3 months
Duncan 2010	Intervention duration less than 3 months
Dunn 2006	No control group
DuShaw 1984	Study published prior to inclusion date of 1985
Dwyer 1979	Study published prior to inclusion date of 1985
Dwyer 1983	Study published prior to inclusion date of 1985
Dwyer 1991	Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
Dwyer 2003	Not a randomized controlled trial
Dyson 1998	Not relevant to public health or health promotion
Dzewaltowski 2002	Data on relevant outcomes for children aged 6 to 18 years not reported
Dzewaltowski 2007	Not a randomized controlled trial
Dzewaltowski 2009	The type of outcome data collected for physical activity outcomes in this study is too different from how it was measured by included studies, therefore cannot be synthesized with the included
Economos 2007	Not a randomized controlled trial
Edwards 2005	Data on relevant outcomes for children aged 6 to 18 years not reported
Eisenmann 2007	Not a randomized controlled trial
Ekelund 2004	Not a randomized controlled trial
Eliakim 1996	Intervention duration less than 3 months
Eliakim 1997	Data on relevant outcomes for children aged 6 to 18 years not reported
Epstein 2000	Not relevant to public health or health promotion
Ericsson 2011	Data on relevant outcomes for children aged 6 to 18 years not reported
Ernst 1999	Weak methodological rating
Ernst 2003	Weak methodological rating

Study	Reason for exclusion
Errecart 1991	No control group
Erwin 2011	Not a randomized controlled trial
Escobar 2010	Intervention not school based
Everhart 2002	Weak methodological rating
Ewart 1998	Intervention not aimed at promoting physical activity
Ezendam 2007	Data on relevant outcomes for children aged 6 to 18 years not reported
Faigenbaum 1999	Intervention not school based
Faigenbaum 2001	Data on relevant outcomes for children aged 6 to 18 years not reported
Faigenbaum 2003	Data on relevant outcomes for children aged 6 to 18 years not reported
Faigenbaum 2007	Intervention not school based
Faigenbaum 2009	Data on relevant outcomes for children aged 6 to 18 years not reported
Fairclough 2002	Not relevant to public health or health promotion
Fairclough 2005	Intervention duration less than 3 months
Faludi 1999	Data on relevant outcomes for children aged 6 to 18 years not reported
Fardy 1996	Intervention duration less than 3 months
Fisher 2011	Not a randomized controlled trial
Fitzgibbon 2005	Data on relevant outcomes for children aged 6 to 18 years not reported
Fitzgibbon 2011	Data on relevant outcomes for children aged 6 to 18 years not reported
Fleming 2000	Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
Flores 1995	Weak methodological rating
Foster 1985	Not relevant to public health or health promotion
Foster 2008	Data on relevant outcomes for children aged 6 to 18 years not reported
Fox 2004	Not a randomized controlled trial
Francis 2010	Intervention duration less than 3 months
Frauhiger 2002	Weak methodological rating
Frenn 2003	Not a randomized controlled trial
Frenn 2005	Not a randomized controlled trial

Study	Reason for exclusion
Fuchs 2002	Intervention not school based. Intervention not aimed at promoting physical activity. Data on relevant outcomes for children aged 6 to 18 years not reported
Fullerton 2007	Intervention not aimed at general population (overweight/obese-only sample)
Gallotta 2009	Data on relevant outcomes for children aged 6 to 18 years not reported
Giralt 2011	Data on relevant outcomes for children aged 6 to 18 years not reported
Goldfine 1993	Weak methodological rating
Goran 1999	Not relevant to public health or health promotion
Goran 2005	Weak methodological rating
Gore 1996	Intervention not aimed at promoting physical activity. Data on relevant outcomes for children aged 6 to 18 years not reported
Gortmaker 1999a	Weak methodological rating
Gortmaker 1999b	Weak methodological rating
Graf 2005	Not a randomized controlled trial
Graf 2008	Not a randomized controlled trial
Grafner 1987	Weak methodological rating
Graham 2008	Not a randomized controlled trial
Graham 2008a	Data on relevant outcomes for children aged 6 to 18 years not reported
Greene 1995	Intervention not school based
Greening 2011	Not a randomized controlled trial
Grey 2004	Data on relevant outcomes for children aged 6 to 18 years not reported
Grey 2009	Intervention not aimed at general population (overweight/obese-only sample)
Grund 2001	Not relevant to public health or health promotion
Guldbrandsson 2009	Not a randomized controlled trial
Gunter 2008	Data on relevant outcomes for children aged 6 to 18 years not reported
Gutin 1993	Not relevant to public health or health promotion
Gutin 1995	Not relevant to public health or health promotion
Gutin 1999	Not relevant to public health or health promotion
Gutin 2002	Intervention not school based
Gutin 2005	Not a randomized controlled trial

Study	Reason for exclusion
Haerens 2007	Intervention duration less than 3 months
Haines 2006	Not a randomized controlled trial
Halfon 1988	Intervention not aimed at promoting physical activity
Hansen 1991	Weak methodological rating
Hansen 2005	Not relevant to public health or health promotion
Hardman 2011	Weak methodological quality (low participation rate; high drop-out rate; less than half of sample included in the final analysis)
Hardy 2007	Not a randomized controlled trial
Harrell 1998	Weak methodological rating
Harris 1998	No control group
Hart 2003	Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
Hartmann 2010	Data on relevant outcomes for children aged 6 to 18 years not reported
Hasselstrom 2008	Data on relevant outcomes for children aged 6 to 18 years not reported
Hastie 2007	Data on relevant outcomes for children aged 6 to 18 years not reported
Heale 2008	Intervention not school based
HEALTHY Study Group 2010	Intervention not aimed at general population (overweight/obese-only sample)
Henaghan 2008	Intervention not school based
Hipsky 2002	Intervention not school based
Hoelscher 2010	Not a randomized controlled trial
Holcomb 1998	Weak methodological rating
Hollar 2010	Not a randomized controlled trial
Hopper 1992	Data on relevant outcomes for children aged 6 to 18 years not reported
Hopper 1996	Weak methodological rating
Hopper 2001	No control group
Hopper 2005	Weak methodological rating
Howard 1996	Weak methodological rating
Howe 2003	Data on relevant outcomes for children aged 6 to 18 years not reported
Huang 2007	Intervention not aimed at general population (overweight/obese-only sample)

Study	Reason for exclusion
Huberty 2011	Not a randomized controlled trial
Huguet 1997	Data on relevant outcomes for children aged 6 to 18 years not reported
Ingle 2006	Intervention not school based
Irwin 2010	Intervention duration less than 3 months
Jackson 2001	Data on relevant outcomes for children aged 6 to 18 years not reported
Jago 2009	Data on relevant outcomes for children aged 6 to 18 years not reported
James 2007	Intervention not aimed at promoting physical activity
Jamner 2004	Weak methodological rating
Jansen 2008	Data on relevant outcomes for children aged 6 to 18 years not reported
Janz 2002	Not relevant to public health or health promotion
Jekal 2009	Intervention not school based
Jemmott 2011	The type of outcome data collected for physical activity outcomes in this study is too different from how it was measured by included studies, therefore cannot be synthesized with the included
Jiang 2007	Intervention not aimed at general population (overweight/obese-only sample)
Johns 1999	Not a randomized controlled trial
Johnson-Down 1997	Not relevant to public health or health promotion.
Johnston 2007	Intervention not aimed at general population (overweight/obese-only sample)
Jones 1988	Data on relevant outcomes for children aged 6 to 18 years not reported
Jones 2007	Data on relevant outcomes for children aged 6 to 18 years not reported
Jordan 1995	Weak methodological rating
Jurg 2006	Weak methodological rating
Kain 2004	Not a randomized controlled trial
Kain 2008	Not a randomized controlled trial
Kann 2000	Not a randomized controlled trial
Kaplan 1996	Not relevant to public health or health promotion
Karabourniotis 2002	Data on relevant outcomes for children aged 6 to 18 years not reported
Katz 2010	Not a randomized controlled trial
Kawabe 2000	Not relevant to public health or health promotion

Study	Reason for exclusion
Keays 1995	Not relevant to public health or health promotion
Kelder 1995a	Weak methodological rating
Kelder 2004	Not a randomized controlled trial
Kijboonchoo 1999	Not a randomized controlled trial
Killen 1989	Weak methodological rating
Kimm 1997	Not relevant to public health or health promotion
Kimm 2005	Not a randomized controlled trial
Kiran 2010	Data on relevant outcomes for children aged 6 to 18 years not reported
Kirkcaldy 2002	Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
Klein-Platat 2005	Not a randomized controlled trial
Klepp 1994	Not a randomized controlled trial
Knox 2009	Data on relevant outcomes for children aged 6 to 18 years not reported
Kolbe 1995	Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
Kong 2009	No control group
Kouli 2009	Data on relevant outcomes for children aged 6 to 18 years not reported
Koutedakis 2003	Not relevant to public health or health promotion
Kovacs 2009	Data on relevant outcomes for children aged 6 to 18 years not reported
Kremers 2005	Not a randomized controlled trial
Kriemler 2011	Not a randomized controlled trial
Kristensen 2010	Data on relevant outcomes for children aged 6 to 18 years not reported
Kwon 2007	Intervention not aimed at general population (overweight/obese-only sample)
La Torre 2006	Not a randomized controlled trial
Lal 1991	Intervention not aimed at promoting physical activity. Data on relevant outcomes for children aged 6 to 18 years not reported. No control group
Lawman 2011	Data on relevant outcomes for children aged 6 to 18 years not reported
Lazarus 2000	Not a randomized controlled trial
Le Masurier 2005	Not a randomized controlled trial
Lee 2010	Data on relevant outcomes for children aged 6 to 18 years not reported

Study	Reason for exclusion
LeMura 2000	Not relevant to public health or health promotion
Levin 2002	Data on relevant outcomes for children aged 6 to 18 years not reported
Lien 2010	Data on relevant outcomes for children aged 6 to 18 years not reported
Lindstrom 2010	Not a randomized controlled trial
Lionis 1991	Not a randomized controlled trial
Liskova 2002	Not relevant to public health or health promotion
Lubans 2006	Intervention not school based
Lubans 2010a	Intervention duration less than 3 months
Lubans 2010b	Data on relevant outcomes for children aged 6 to 18 years not reported (baseline data only)
Lubans 2011	Intervention not aimed at general population (only low active boys were included in the study)
Ludwig 2004	No control group
Luepker 1999	Not relevant to public health or health promotion
Lungo 1994	Weak methodological rating
Macaulay 1997	Data on relevant outcomes for children aged 6 to 18 years not reported
MacConnie 1991	Data on relevant outcomes for children aged 6 to 18 years not reported
Macdonald 1999	Data on relevant outcomes for children aged 6 to 18 yearsnot reported.
Macdonald 2007	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
MacKelvie 2001	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
MacKelvie 2002	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
MacKelvie 2004	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
MacLean 2003	Data on relevant outcomes for children aged 6 to 18 yearsnot reported.
Mahar 2006	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Mahon 1993	Weak methodological rating
Mandigo 2003	Not relevant to public health or health promotion
Manios 1999	Not a randomized controlled trial
Marcus 1987	Not a randomized controlled trial
Marcus 2009	The type of outcome data collected for physical activity outcomes in this study is too different from how it was measured by included studies, therefore cannot be synthesized with the included

Study	Reason for exclusion
Marks 2006	Intervention not school based
Martin 2010	Not a randomized controlled trial
Matsudo 1999	No control group
Mauriello 2010	Intervention not school based
McAuley 2010	Intervention not school based
McKay 2003	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
McKenzie 1993	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
McKenzie 2002	Weak methodological rating
McManus 1997	Intervention not school based
McManus 2005	Not relevant to public health or health promotion
McManus 2008a	Intervention not school based
McMurray 2002	Weak methodological rating
McMurray 2009	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
McNeil 2009	Intervention not school based
McWhannell 2008	Intervention not school based
Mecredy 1993	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Meininger 2000	Not relevant to public health or health promotion
Mellin 1987	Intervention not school based
Melnyk 1994	Not relevant to public health or health promotion
Melnyk 2007	Intervention not aimed at general population (overweight/obese-only sample)
Melnyk 2009	Intervention not aimed at general population (overweight/obese-only sample)
Meredith 1991	Not relevant to public health or health promotion
Mettler 2000	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Metzker 2000	Weak methodological rating
Meunnich Cowell 1989	No control group
Mier 2002	No control group
Missouri 2003	Not relevant to public health or health promotion
Mo-suwan 1998	Data on relevant outcomes for children aged 6 to 18 yearsnot reported

Study	Reason for exclusion
Moberg 1990	Intervention not aimed at promoting physical activity. Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Monness 2009	Not a randomized controlled trial
Moodie 2011	Intervention not school based.
Moon 1999	Weak methodological rating
Morris 1997	Intervention not aimed at promoting physical activity
Motlagh 2009	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Mott 1991	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Moya 2011	Intervention not school based
Muller 2001	Weak methodological rating
Muller 2005	Not a randomized controlled trial
Muth 2008	Not a randomized controlled trial
Nabipour 2004	Intervention not aimed at promoting physical activity
Nader 1992	Intervention not aimed at promoting physical activity
Nahas 2009	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Naylor 2006	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
NCCDP 1997	Intervention not aimed at promoting physical activity. Data on relevant outcomes for children aged 6 to 18 yearsnot reported. No control group
Nelson 2011	Not a randomized controlled trial
NeumarkSztainer 2003	Weak methodological rating
Newton 2010	Not a randomized controlled trial
Niederer 2009	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Nielsen 2010	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Nyberg 2011	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
O'Loughlin 1999	Data on relevant outcomes for children aged 6 to 18 yearsnot reported. Intervention not school based
Okely 2010	Intervention not aimed at general population (overweight/obese-only sample)
Ostbye 2011	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Owen 1995	No control group

Study	Reason for exclusion
Oxizoglou 2005	Weak methodological rating
Palmer 2005	Weak methodological rating
Pangrazi 2003	Not a randomized controlled trial
Parcel 1989	Weak methodological rating
Park 2007	Intervention not school based.
Parlee-Hirth 2002	Data on relevant outcomes for children aged 6 to 18 yearsnot reported. No control group
Pate 1987	Not relevant to public health or health promotion
Pate 1994	Not relevant to public health or health promotion
Pate 1995a	Not relevant to public health or health promotion
Pate 1995b	Not relevant to public health or health promotion
Pate 1996	Not relevant to public health or health promotion
Pate 1999	Not a randomized controlled trial
Pate 2003	Weak methodological rating
Pate 2006	Not a randomized controlled trial
Pena 2004	Weak methodological rating
Peralta 2009a	Intervention not aimed at general population (overweight/obese-only sample)
Perry 1987	No control group
Petkevicius 1985	Weak methodological rating
Phillipp 1989	Weak methodological rating
Piper 1993	No control group.
Plachta-Danielzik 2007	Not a randomized controlled trial.
Plotnikoff 1999	Not a randomized controlled trial.
Pollatschek 1989	Weak methodological rating
Prochaska 2002	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Prusak 2010	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Racette 2010	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Raitakari 1994a	Intervention not school based
Rakovi 2008	Not a randomized controlled trial

Study	Reason for exclusion
Ramsay 1990	Intervention not school based
Ransdell 2003	Intervention not school based
Reilly 2006	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Reinhardt 2002	No control group
Renaud 1997	Data on relevant outcomes for children aged 6 to 18 yearsnot reported. No control group
Resaland 2011	Not a randomized controlled trial
Resnick 2009	Intervention not school based
Resnicow 1992	Weak methodological rating
Resnicow 1993	Not relevant to public health or health promotion
Resnicow 1996	Not relevant to public health or health promotion
Resnicow 1997	Not relevant to public health or health promotion
Resnicow 2000	Not relevant to public health or health promotion
Resnicow 2002	Data on relevant outcomes for children aged 6 to 18 yearsnot reported. Intervention not school based
Reybrouck 1990	Not relevant to public health or health promotion
Rezvanian 2010	Intervention not aimed at general population (overweight/obese-only sample)
Ridgers 2010	Not a randomized controlled trial (although children from schools were randomly selected to participate in the study, the schools were not randomly allocated to intervention or control: 15 schools from the low SES area were chosen, and then matched to similar schools)
Rimmer 1997	Weak methodological rating
Robbins 2006	Intervention not school based
Robinson 1999	Not relevant to public health or health promotion
Robinson 2003	Intervention not school-based
Robinson 2007	Intervention not school based
Robinson 2008	Intervention not school based
Rodgers 2001	Not a randomized controlled trial
Rosenbaum 2007	Weak methodological rating
Rowland 1991	No control group
Ruiz 2006	Not a randomized controlled trial

Study	Reason for exclusion
Saakslahti 2004	Intervention not school based
Sabet-Sarvestani 2008	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Sacher 2003	Intervention not school based
Sadowsky 1999	Weak methodological rating
Sahota 2001a	Weak methodological rating
Sahota 2001b	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Saksvig 2003	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Sakuragi 2009	Not a randomized controlled trial
Sallis 1993a	Not relevant to public health or health promotion
Sallis 1993b	Not relevant to public health or health promotion
Sallis 1997	Not a randomized controlled trial
Salmon 2005	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Salmon 2010	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Samples 2010	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Santiago 2007	Intervention not aimed at promoting physical activity
Sasaki 1987	Intervention not aimed at promoting physical activity
Schneider 2007	Weak methodological rating
Schneider 2009	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Schofield 2005	Weak methodological rating
Schuldheisz 1998	No control group
Schwarzer 2010	Not a randomized controlled trial
Scott 1988	Intervention not aimed at promoting physical activity. Data on relevant outcomes for children aged 6 to 18 yearsnot reported. No control group
Sharma 2009	Not a randomized controlled trial
Shaw 1989	Data on relevant outcomes for children aged 6 to 18 yearsnot reported. Intervention not school based. Intervention not aimed at promoting physical activity. No control group
Shea 1996	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Shek 2008	Intervention not aimed at promoting physical activity
Shephard 1992	Not relevant to public health or health promotion

Study	Reason for exclusion
Shephard 1996	Weak methodological rating
Shimon 2009	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Shingo 2002	Not relevant to public health or health promotion
Siegel 1984	Intervention not school based
Siegrist 2011	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Simonetti 1986	Intervention not aimed at promoting physical activity
Singh 2007	Weak methodological rating
Skybo 2002	Weak methodological rating
Slawta 2004	No control group
Slootmaker 2010	Intervention not aimed at whole school population (only low active children were included in the study)
Smith 2009	Not a randomized controlled trial
Smith 2011	Intervention not school based
Sobczyk 1995	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Sollerhed 2008	Not a randomized controlled trial
Soong 1997	Not relevant to public health or health promotion
Sothorn 1993	Not relevant to public health or health promotion
Sothorn 1999	Not relevant to public health or health promotion
Sothorn 2001	Not relevant to public health or health promotion
Spence 1997	Not relevant to public health or health promotion
Speroni 2007	Not a randomized controlled trial
Spiegel 2006	Weak methodological rating
Standage 2005	Not a randomized controlled trial
Stergioulas 1998	Not relevant to public health or health promotion
Stewart 1997	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Stewart 2004	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Stock 2007	Not a randomized controlled trial
Stone 1998	Not relevant to public health or health promotion

Study	Reason for exclusion
Stone 1989	Not relevant to public health or health promotion
Stone 1995	Not relevant to public health or health promotion
Stratton 2000	Weak methodological rating
Stratton 2005	Not a randomized controlled trial
Strazzullo 1988	Not relevant to public health or health promotion
Strong 2005	Not a randomized controlled trial
Tak 2007	Intervention not aimed at general population (overweight/obese-only sample)
Tamir 1990	Weak methodological rating
Tavener 1993	No control group
Taylor 2006	Not a randomized controlled trial
Taylor 2007	Not a randomized controlled trial
Taymoori 2008	Intervention not school based
Taymoori 2008a	Intervention not school based.
Teerarungsikul 2009	Not a randomized controlled trial.
Telford 2009	Not a randomized controlled trial
Thakor 2004	Not relevant to public health or health promotion
Theodorakis 2008	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Thomas 2007	Not a randomized controlled trial
Tolfrey 1998	Intervention not school based
Tolfrey 2004	Intervention not school based
Toruner 2010	Not a randomized controlled trial
Trevino 1998	Not a randomized controlled trial
Trost 1997	Not relevant to public health or health promotion
Trost 1999a	Not relevant to public health or health promotion
Trost 1999b	Not relevant to public health or health promotion
Trudeau 1999	Not a randomized controlled trial
Trudeau 2008	Not a randomized controlled trial
Tsai 2009	Not a randomized controlled trial

Study	Reason for exclusion
Tsorbatzoudis 2005	Weak methodological rating
Tuckman 1986	Weak methodological rating
Tudor-Locke 2001	Not relevant to public health or health promotion
Tudor-Locke 2006	Not a randomized controlled trial
Turnbull 2004	Not a randomized controlled trial
Uzunovic 2008	Intervention not school based
Vaccaro 1989	Not relevant to public health or health promotion
Valverde 1998	Not relevant to public health or health promotion
van Beurden 2003	Weak methodological rating.
van Mil 1999	Not relevant to public health or health promotion.
Velez 2010	Outcome data on outcomes relevant to this review not reported
Venditti 2009	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Verderber 2001	Not relevant to public health or health promotion
Verstraete 2007	Weak methodological rating
Verstraete 2007a	The type of outcome data collected for physical activity outcomes in this study is too different from how it was measured by included studies, therefore cannot be synthesized with the included
Veugelaers 2005	Weak methodological rating.
Vissers 2008	Intervention not aimed at general population (overweight/obese-only sample)
Walton 1999	Not relevant to public health or health promotion
Wang 2006	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Wang 2006a	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Warren 2003	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Watts 2004	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Weber 1989	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Weber Cullen 1999	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Wechsler 2000	Not a randomized controlled trial
Weintraub 2008	Intervention not aimed at general population (overweight/obese-only sample)
Wen 2008	Data on relevant outcomes for children aged 6 to 18 yearsnot reported

Study	Reason for exclusion
Werch 2005	Weak methodological rating
Werner 1988	Weak methodological rating
Westcott 1995	Not relevant to public health or health promotion
Wharf Higgins 2001	Intervention not aimed at promoting physical activity. Data on relevant outcomes for children aged 6 to 18 yearsnot reported. No control group
Williden 2006	Not a randomized controlled trial
Wilson 2005	Weak methodological rating
Wilson 2006	Not a randomized controlled trial
Wilson 2008	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Wing 1998	Data on relevant outcomes for children aged 6 to 18 yearsnot reported. Intervention not school based.
Winters 2003	No control group
Wong 2008	Intervention not aimed at general population (overweight/obese-only sample)
Yin 2005	Weak methodological rating
Yopp Cohen 1989	Not relevant to public health or health promotion
Young 2006a	Weak methodological rating
Young 2007	Not a randomized controlled trial
Zahner 2006	Data on relevant outcomes for children aged 6 to 18 yearsnot reported
Zeelie 2010	Intervention duration less than 3 months
Zizzi 2006	Weak methodological rating
Zonderland 1994	Weak methodological rating
Zuckerman 1989	No control group

ADDITIONAL TABLES

Table 1. Overview of study populations

Characteristic Study ID	Intervention(s) and control(s)	[n] randomized	[n] finishing study	[%] of random- ized partici- pants finishing study
Angelopoulos 2009	I: 12-month program integrated into the existing curriculum including: student workbook, teacher	-	I: 321	-

Table 1. Overview of study populations *(Continued)*

	manual; covering themes: self-esteem, body image, nutrition, PA, fitness, environmental issues. Implemented for 1 to 2 hours per week with motivational methods used for increasing knowledge, skills and self-efficacy and improving self-monitoring and social influence. School teachers trained by the research team delivered the intervention. Parental involvement (reinforcement) was required to complete some (unspecified) home activities		C: 325	
			T: 646	
	C: not specified			
Araujo-Soares 2009	I: 2 x 90-min PA sessions with related homework. A trained psychologist delivered the intervention, assisted by a sports education teacher. A research team member supervised preparation for each session, before which each student was asked to keep a diary for a period of 1 week. After the intervention they were asked to keep the diary for an additional 2 weeks. Worksheets and a 3-min film were used, and each student received a leaflet with main topics	I: 157 C: 134 T: 291	I: 105 C: 90 T: 195	I: 67 C: 67 T: 67
	C: not specified			
Barbeau 2007	I: 10-month after-school PA program on body composition and CV fitness in young black girls. The program consisted of 30 min of homework time with a healthy snack, and 80 min of PA (25 min skill development, 35 min MVPA, and 20 min of toning and stretching). Activities during the MVPA included games such as basketball, tag, softball, relay races, etc., all of which were modified to keep all of the subjects active throughout the 35-min period. Subjects received small weekly prizes (e.g. bouncy balls, slinkies, pencils, note pads, lip gloss, play jewelry) for maintaining good behavior and attitude and at most 1 unexcused absence. Absences were discussed with parents. Teachers providing the intervention were trained on childhood obesity, PA, and CV risk factors, the goals of the study, the specific protocol to be followed, and the types of activities appropriate for each segment of the intervention and manuals were provided to schools	-	-	I: 81 C: 84 T: -
	C: not specified			
Bayne-Smith 2004	I: the intervention (PATH program) consisted of 30-min classes conducted 5 days per week for 12 weeks. Classes included: 1) brief lecture/discussion on featured topics (CV health and fitness, health behaviors); and 2) 20 to 25 min of vigorous PA (e.g. resistance exercise, endurance or aerobic exercise, alternated each day)	-	I: 310 C: 132 T: 442	-
	C: the frequency/duration of PE classes were the same as PATH classes (but without lecture/discussion, so 5 extra min of PA each class)			

Table 1. Overview of study populations *(Continued)*

Burke 1998	<p>I1: standard PA and nutrition program (WASPAN). Classroom lessons, 20-min fitness sessions daily (minimum 4/week). Nutrition program built around 4 comic books to teach children and parents how to improve diets, plus 1 h/week nutrition classes</p> <p>I2: standard WASPAN program plus a PA enrichment program for higher-risk children. Incorporated teacher-parent-student triad, moved PA activities outside of the class and focused on the individual. Children kept weekly diaries</p> <p>C: no program</p>	<p>I: - C: - T: 800</p>	<p>I: - C: - T: 720</p>	<p>I: - C: - T: 90</p>
Bush 1989	<p>I1: 'Know Your Body' curriculum focusing on nutrition, fitness, and prevention of smoking. Students also receive a personalized health screening and results on a 'health passport'. Parents are mailed copies of their child's results and kept informed by a quarterly newsletter and an introductory Parent-Teacher meeting</p> <p>I2: 'Know Your Body' curriculum and health screening, but students do not receive the results of their screening, only their parents receive the results</p> <p>C: health screening only, parents only receive results of screening</p>	<p>I:- C: - T: 892</p>	<p>I: - C: - T: 431</p>	<p>I: - C: - T: 48</p>
Colin-Ramirez 2010	<p>I: RESCATE program, included PA and nutritional components. PA addressed at individual (curriculum), school (PE sessions) and family level (home-work and recommendations for parents)</p> <p>C: no PA/nutrition program</p>	<p>I: - C: - T: 619</p>	<p>I: 245 C: 253 T: 498</p>	<p>I: - C: - T: 81</p>
Dishman 2004	<p>I: Lifestyle Education for Activity Program (LEAP). Aimed to increase girls' self efficacy for PA, via: PE, school environment, health education, school health services, faculty or staff health promotion, and parent and community involvement</p> <p>C: standard PE as part of school curriculum</p>	<p>I: 1523 C: 1221 T: 2744</p>	<p>I: - C: - T: 2111</p>	<p>I: - C: - T: 77</p>
Donnelly 2009	<p>I: Physical Activity Across the Curriculum (PAAC), 90 min/week of moderate to vigorous physically active academic lessons delivered intermittently throughout the school day</p> <p>C: regular classroom instruction without physically active lessons</p>	<p>I: 814 C: 713 T: 1527</p>	<p>I: 792 C: 698 T: 1490</p>	<p>I: 97 C: 98 T: 98</p>
Dorgo 2009	<p>I1: PE MRT program. 80-min classes 3 times per week plus 10 to 15 min warm-up and 20 to 30 min of MRT-specific activities conducted by trained research assistants</p>	<p>I: 141 C: 232 T: 373</p>	<p>I: 93 C: 129 T: 222</p>	<p>I: 66 C: 56 T: 60</p>

Table 1. Overview of study populations (Continued)

<p>I2: PE MRT program plus a CV endurance training segment in every session including: walking, jogging, step aerobics, and aerobic kickboxing</p> <p>C: a regular PE program that followed the usual school curriculum. 80-min classes 3 times per week</p>				
Ewart 1998	<p>I: 50-min 'Project Heart' aerobic exercise classes including didactic instruction.</p> <p>C: 50-min standard PE classes</p>	<p>I: 45 C: 54 T: 99</p>	<p>I: 44 C: 44 T: 88</p>	<p>I: 99 C: 82 T: 89</p>
Gentile 2009	<p>I: 'Switch' program, promoted healthy active lifestyles including: being active for 60 min or more per day, limiting total screen time to 2 hours or fewer per day, and eating 5 fruits/vegetables or more per day. Included 3 ecologic levels (family, school, community)</p> <p>C: no intentional exposure to the Switch program</p>	<p>I: 670 C: 653 T: 1323</p>	<p>I: - C: - T: 1029</p>	<p>I: - C: - T: 78</p>
Haerens 2006	<p>I1: PA and nutrition intervention to increase levels of MVPA to at least 60 min a day, increase fruit consumption, increase water consumption, and reduce fat. A computer-tailored intervention assessed children's PA activities and provided tailored feedback</p> <p>I2: PA and nutrition intervention (same as I1 group) plus parental involvement, including: an interactive meeting on healthy food and PA, a newsletter 3 times/year, and a CD with an adult computer-tailored intervention (same as the children's computer-tailored intervention) for use at home</p> <p>C: no PA and nutrition intervention</p>	<p>I: 2105 C: 735 T: 2840</p>	<p>I: - C: - T: 2434</p>	<p>I: - C: - T: 86</p>
Haerens 2009	<p>I: computer-tailored PA program consisting of a demographic questionnaire, a PA questionnaire and a questionnaire on psychosocial determinants followed by tailored feedback that related students' PA levels to the PA guidelines</p> <p>C: generic information on the benefits of PA, public health recommendations, differences between moderate and vigorous intensity activities and tips on how to become more active</p>	<p>I: 563 C: 608 T: 1171</p>	<p>I: 433 C: 448 T: 881</p>	<p>I: 77 C: 74 T: 75</p>
Jones 2008	<p>I: included: 1) a health curriculum (classroom lessons and behavioral journalism - during 6th grade, 16 sessions during PE classes, 3 times per week; during 7th grade, science-based lessons during science class); 2) a PE program; and 3) a school food service component, emphasizing calcium-rich food</p> <p>C: the control group participated in the usual health program</p>	<p>I: 347 C: 371 T: 718</p>	<p>I: 291 C: 315 T: 606</p>	<p>I: 84 C: 85 T: 84</p>

Table 1. Overview of study populations (Continued)

Kipping 2008	I: included: 16 lessons on healthy eating, increasing PA and reducing television viewing taught over 5 months by 10 specifically trained teachers. Materials provided to the schools included: lesson plans for 9 PA lessons, 6 nutrition lessons and 1 lesson about screen viewing C: the control schools were given the materials only after the completion of the study	I: 331 C: 348 T: 679	I: 304 C: 300 T: 604	I: 92 C: 86 T: 89
Kriemler 2010	I: the intervention was a multicomponent PA program that included: 1) 3 existing 45-min PE lessons per week; 2) 2 additional 45-min PE lessons per week; 3) daily short activity breaks; and 4) PA homework C: the control group participated in the usual, mandatory PE lessons (45-min, 3 times/week)	I: 305 C: 235 T: 540	I: 297 C: 205 T: 502	I: 97 C: 87 T: 93
Li 2010	I: the intervention (TAKE 10! Program) included 2 daily 10-min PA sessions: 1) the teacher or student selected 1 to 3 activity cards; 2) several children modeled the exercises, the other students followed along; 3) cool-down period; and 4) the students were taught a health message C: no intervention took place	I: 2371 C: 2329 T: 4700	I: 2092 C: 2028 T: 4210	I: 88 C: 87 T: 88
Lubans 2009	I: included: 1) 10-week school sport program and exercise program booklet; 2) information sessions; 3) PA and dietary monitoring using pedometers and diaries; 4) program X weekly messages and parent information leaflets; and 5) email support C: the control group attended a 10-week school sport program and received an exercise program booklet	I: 58 C: 66 T: 124	I: 53 C: 53 T: 106	I: 91 C: 80 T: 86
Luepker 1996	I1: group received a school-based program consisting of school food service modifications, PE interventions, and the CATCH curricula I2: group received the same school-based program plus a family-based program C: group received the usual health curricula, PE, and food service programs, but none of the CATCH interventions	I: 3651 C: 1455 T: 5106	I: 3297 C: 722 T: 4019	I: 90 C: 50 T: 79
Martinez 2008	I: received: 1) the standard, compulsory PE curriculum (3 hours per week of low-to-moderate intensity activity); 2) recreational, noncompetitive, after school PA program (3 x 90-min sessions per week, for 24 weeks) C: received the standard, compulsory PE curriculum: 3 hours per week of PA at low-to-moderate intensity	I: 691 C: 718 T: 1409	I: 465 C: 579 T: 1044	I: 67 C: 81 T: 74

Table 1. Overview of study populations (Continued)

McManus 2008	I1: Educational Program Group completed a 2-week education program, taught using an active game approach, that included: information about heart health, the use of heart rate feedback to attain an activity target, goal-setting and role-play. They then completed 2-weeks with heart rate feedback and 2-weeks without heart rate feedback	I: 128 C: 69 T: 197	I: 125 C: 68 T: 193	I: 98 C: 99 T: 98
	I2: No-education Program Group completed a 2-week control program of standard PE classes without PA or heart health education. They then completed 2-weeks with heart rate feedback and 2-weeks without heart rate feedback but were not given any information about the heart rate signal or its meaning C: no intervention took place			
Neumark-Sztainer 2009	I: included: (i) 14 x 2-hour after-school theater sessions (which included: check-in, snack, movement component, theatrical activity - the final sessions focused on rehearsing for a play performance (script developed throughout intervention)); (ii) 8 weekly after-school booster sessions (activities related to healthy eating and PA, rehearsals for play); and (iii) family outreach component (to enhance home support for behavioral changes through positive reinforcement of healthy behaviors, parent-child participation in PAs and availability of healthy foods) - take home materials, family events C: a theater-based control condition (i.e. children participated in a play focused on environmental health issues using a prepared script)	I: 56 C: 52 T: 108	I: 51 C: 45 T: 96	I: 91 C: 87 T: 89
Neumark-Sztainer 2010	I: participation in the standard all-girls PE class that was supplemented with the New Moves curriculum (nutrition and self-empowerment components, individual sessions using motivational interviewing, lunch meetings, and parent outreach) C: participation in all-girls PE class (during first semester of school year)	I: 182 C: 174 T: 356	I: 177 C: 159 T: 336	I: 97 C: 91 T: 94
Peralta 2009	I: intervention ran over 16 weeks, with each week including 1 x 60-min curriculum session and 2 x 20-min lunchtime PA sessions. Each 60-min curriculum session included practical or theoretical (or both) components focused on promoting PA and increasing fruit consumption and the acquisition and practice of self-regulatory behaviors. Behavior modification techniques were used. The practical component included modified games and activities. The researcher primarily facilitated the intervention with staff and parents' involvement. Eleventh grade students peer facilitated lunchtime sessions. Parents were emailed 6 newsletters throughout, informing them of the program con-	I: 16 C: 17 T: 33	I: 16 C: 16 T: 32	I: 100 C: 94 T: 97

Table 1. Overview of study populations (Continued)

	tent, motivating them, and suggesting strategies to engage the family in healthy behaviors			
	C: participated in 16 x 60-min PA curriculum at the same time as the intervention group, with a school PE teacher facilitating the control group			
Petchers 1988	I: Chicago Heart Health Curriculum Program called "Body Power": a 1-year-long curriculum with modules on 5 topics: 1) CV system, anatomy, and physiology; 2) smoking; 3) nutrition; 4) exercise; and 5) risk factors review. The curriculum was implemented by classroom teachers during at least 3 x 45-min sessions per week for 4 to 6 weeks, with training provided for teachers and supplemented by a comprehensive teachers' manual C: traditional curriculum with approximately the same amount of teaching time. Control group teachers were provided an alternative experience to the training sessions for the intervention group in the form of a separate in-service	I: - C: - T: 452	I: - C: - T: 325	I: - C: - T: 72
Reed 2008	I: The Action Schools! BC model was consistent with the 'active school' framework and emphasized an integrated whole-school approach rather than traditional classroom-based health education, targeting 6 Action Zones: i) School Environment, ii) Scheduled Physical Education, iii) Extracurricular, (iv) School Spirit, v) Family and Community, and vi) Classroom Action. Classroom Action included 15 min of moderate to intense PA daily (75 min of extra PA per week in addition to 2 x 40 min PE classes). Teachers provided opportunities to 'snack on physical activities' such as skipping, dancing, and resistance exercises throughout the day. A school Action Team was convened in each school with a facilitator who helped to design a program with activities across the 6 Action Zones. INT teachers received a 1-day training workshop and a Classroom Action Bin with resources, with the goal for each school to provide students with 150 min of PA/week (2 x 40 min PE classes + 15 x 5 min/day Classroom Action) C: teachers in usual practice schools continued the regular program of PE and school-based PA	I: 178 C: 90 T: 268	I: 156 C: 81 T: 237	I: 88 C: 90 T: 73
Robinson 1999	I: limited access to television use and budgeting television time and involved 18 lessons of 30 to 50 min as part of standard curriculum, taught by regular classroom teachers trained by research staff. Most lessons occurred in the first 2 months of the year and included self-monitoring and self-reporting for television and video game use followed by a 10-day television turnoff challenge after which students were encouraged to follow a 7-h per week budget. Newsletters designed to help parents motivate students and regulate time spent on television and video games for the entire family were dis-	I: 106 C: 121 T: 227	I: 92 C: 100 T: 192	I: 87 C: 83 T: 85

Table 1. Overview of study populations (Continued)

tributed. Each household received television time master(s) to regulate television and video use

C: not specified

Salmon 2008	I: students were assigned to 1 of 4 conditions: a behavioral modification group (N = 69); a fundamental motor skills group (N = 73); a combined behavioral modification and fundamental motor skills group (N = 90)	I: 233 C: 62 T: 295	I: 213 C: 55 T: 268	I: 91 C: 89 T: 91
	C: usual classroom lessons			
Simon 2004	I: the ICAPS program was implemented over 4 academic years to promote PA inside and outside. The intervention includes an educational component focusing on PA and sedentary behaviors, new opportunities for PA during and after school hours. Activities implemented are either informal or academic with emphasis on fun, well-being, noncompetitiveness. Sporting events, bicycle, and on-foot transport are organized	I: - C: - T: 1046	I: 475 C: 479 T: 954	I: - C: - T: 91
	C: not specified			
Singh 2009	I: an interdisciplinary program with adapted curriculum including an individual component (11 lessons in biology and PE) and environmental change component including encouragement for schools to increase PE and provision of advice for schools related to cafeteria changes	I: - C: - T: 1053	I: - C: - T: 875	I: - C: - T: 83
	C: regular curriculum			
Singhal 2010	I: multicomponent intervention with 7 components related to nutrition and lifestyle education, including the following activities: dissemination of health-related information through lectures and focused group discussions (24 weeks (6 months) of nutrition education), promotion of PA, other promotion of healthy lifestyle, individual counseling, policy-level changes in schools, involvement of teachers and parents, training of student volunteers for program sustainability	I: 101 C: 108 T: 209	I: 99 C: 102 T: 201	I: 98 C: 94 T: 96
	C: no intervention			
Stephens 1998	I: 18 medical students delivered 3 activity sessions per week, consisting of 5 min of warm-up and stretching, plus 20 min of aerobic activity. Activities incorporated repetitive movements of large muscle groups, designed to elevate the pulse rate 40 to 60 beats/min over resting level. Sessions ended with a 5 to 10 min cool-down with presentation of educational material about nutrition, exercise, and disease prevention	I: 45 C: 44 T: 89	-	-
	C: students in the control classroom received no additional PA beyond regular PE classes			

Table 1. Overview of study populations (Continued)

Stone 2003	I: intervention program was implemented during third through fifth grades, with 4 components including: food service, skills-based classroom curricula, family, and PE C: not specified	I: 879 C: 825 T: 1704	I: 644 C: 653 T: 1297	I: 73 C: 79 T: 76
Trevino 2004	I: 50 sessions of health programming re: 3 health behavior messages associated with diabetes mellitus control (decreased dietary saturated fat intake, increase dietary fiber intake, increase PA). Children were asked to set goals and keep records of their accomplishments and were rewarded with coupons from a store set up in the school C: not specified	I: 969 C: 1024 T: 1993	I: 619 C: 602 T: 1221	I: 64 C: 59 T: 61
Verstraete 2006	I: classes were provided game equipment (jump ropes, scoop sets, flying discs, balls, plastic hoops, juggling rings and beanballs, badminton racquets, beach paddles) and 'activity cards' demonstrating use of the equipment for use outdoors during recesses and lunch break C: not specified	-	I: 122 C: 113 T: 235	-
Walter 1988	I: special curriculum targeting voluntary changes in risk behavior in the area of diet, PA, and smoking, taught in classrooms by specially trained regular teachers for ~2 hours per week C: not specified	I: 2075 C: 1313 T: 3388	I: 961 C: 871 T: 1769	I: 46 C: 66 T: 53
Walther 2009	I: 1 unit of PE (45 min) with at least 15 min of endurance training per school day, plus lessons on healthy lifestyle 1 per month C: according to German standards, 2 units (each 45 min) of PE per week are mandatory in all schools. 12 units (45 min per unit) of high-level endurance exercise training per week plus participation in competitive sporting events	I: 112 C: 76 T: 188	I: 109 C: 73 T: 182	I: 97 C: 96 T: 97
Wang 2008	I: 'FitKid' after-school program, 2-h intervention sessions (40-min academic enrichment activities and a healthy snack provided; 80 min of PA designed to improve sport skills, aerobic fitness, strength, and flexibility with a minimum of 40 min were devoted to vigorous PA), offered 5 days a week, instructed by certified school teachers and paraprofessionals C: not specified	I: 603 C: 584 T: 1187	I: 260 C: 265 T: 525	I: 43 C: 45 T: 44
Webber 2008	I: six TAAG health education lessons per school year to enhance behavioral skills known to influence PA participation (self-monitoring, setting goals for behavior change). Offered in 2 forms: 1 for a traditional classroom setting and 1 for PE class. Girls were	I: - C: - T: 3502	I: - C: - T: 3378	I: - C: - T: 97

Table 1. Overview of study populations *(Continued)*

the focus of the intervention; however, health and PE classes were part of the usual school curriculum and most included boys as well

C: not specified

Weeks 2008	I: 10 min of directed jumping activity at the beginning of every PE class (twice per week), designed to apply loads to the skeleton at high strain magnitude, frequency, and rate, including: jumps, hops, tuck-jumps, jump-squats, stride jumps, star jumps, lunges, side lunges, and skipping C: regular PE warm-ups and stretching at the beginning of every PE class (twice per week), including: brisk walking, light jogging, and stretching	I: 52 C: 47 T: 99	I: 43 C: 38 T: 81	I: 83 C: 81 T: 82
Williamson 2007	I: Healthy Eating and Exercise (HEE) program; goal was to increase PA during the school day and at home. Teachers were provided with containers filled with indoor play supplies (e.g. balloons, bean bags) and outdoor play supplies (e.g. balls, jump ropes) to promote active play during class time and recess. Posters encouraged the use of these PACs, and brief lesson plans provided academic games that used the supplies contained in the PACs C: Alcohol/Drug/Tobacco abuse prevention (ADT) program, designed with the goal of modifying children's beliefs and attitudes regarding the use and abuse of tobacco, alcohol, and illicit drugs so that they reflected "healthier" values	I: 313 C: 348 T: 661	I: 282 C: 304 T: 586	I: 90 C: 87 T: 89
Wilson 2011	I: ACT, a 17-week program implemented for 2 hours, 3 days/week by a trained instructor. Three main components: homework/snack (30 min), MV-PA activities (60 min) that students selected each week, and a behavioral skills and motivational component (30 min) C: The General Health Education Program (comparison program) focused on nutrition, stress management, drug prevention, and drop-out prevention (with no PA component), and consisted of a homework/snack (30 min) and 3 hands-on activities related to general health (30 min each). The comparison program was held on the same days and times as the ACT intervention program	I: 729 C: 693 T: 1422	I: 673 C: 635 T: 1308	I: 92 C: 94 T: 92
Young 2006	I: included information to make an informed decision about the personal benefits of a physically active lifestyle, develop problem-solving skills, and obtain support from others. Specific strategies taught by a trained teacher included: goal setting, problem-solving barriers, communication skills, reinforcement of goal achievement through internal and external rewards, and learning from relevant role models. The PA portion of the intervention was congruent with the school's PE curriculum - 1 semester of individual sports and 1 semester of team	I: 116 C: 105 T: 221	I: 111 C: 99 T: 210	I: 96 C: 94 T: 95

Table 1. Overview of study populations (Continued)

sports - taught 5 days per week. The family support component consisted of a family workshop, monthly newsletters, and adult-child homework assignments

C: standard PE class in which students were taught skills in individual and team sports. Similar to the intervention structure, 1 semester focused on individual sports and the other on team sports. Classes were taught by certified PE teachers employed by the school. Parents of participants in the standard PE class also received monthly newsletters

Total	I: 20,930	I: 13,358
	C: 15,897	C: 10,163
	T*: 45,191	T*: 36,593

C: control; CV: cardiovascular; I: intervention; MRT: manual resistance training; MVPA: moderate to vigorous physical activity; PA: physical activity; PAC: physical activity center; PE: physical education; T: total.

"-" denotes not reported.

*T does not equal the sum of I and C as some studies did not report the breakdown of participants in each group.

APPENDICES

Appendix 1. Search strategies

Search terms and databases

Unless otherwise stated, search terms are free text terms.

Abbreviations:

'\$': stands for any character; '?': substitutes one or no character; adj: adjacent (i.e. number of words within range of search term); exp: exploded MeSH; MeSH: medical subject heading (MEDLINE medical index term); pt: publication type; sh: MeSH; tw: text word.

The Cochrane Library

Update search, via Wiley InterScience: January 1 2007 to October 21 2011 (search conducted 21 October 2011)

Original search: Issue 3, 2007 (search conducted 16 May 2007)

Random* control* trial* OR double blind OR single blind OR clinical trial* OR placebo* OR random* allocat* OR intervention

AND

Exercise OR physical education OR physical training OR physical activity OR physical inactivity OR physical fitness OR fitness OR sedentary OR lifestyle OR sport* OR walk* OR danc*

AND

child* OR adolescen*

AND

school

(Continued)

MEDLINE

Update search, via Ovid: May Week 1 2007 to October Week 2 2011 (search conducted 21 October 2011)

Original search via Ovid: 1950 to June Week 3 2007 (search conducted 27 June 2007)

1. Randomized controlled trials/
2. Randomized controlled trial.pt
3. Random allocation/
4. Double blind method/
5. Single blind method/
6. Clinical trial.pt. or clinical trial.sh. or clinical trials.jn. or clinical trials.kw.

7. or/1-6
8. (clinic\$ adj trial\$1).tw.
9. ((singl\$ or doubl\$ or treb\$ or tripl\$) adj (blind\$3 or mask\$3)).tw.
10. Placebos/
11. Placebo\$.tw.
12. Randomly allocated.tw.
13. (allocated adj2 random).tw.
14. or/8-13

15. 7 or 14
16. Case report.tw.
17. Letter.pt.
18. Historical article.pt.
19. or/16-18
20. 15 not 19
21. exp exercise/
22. physical inactivity.mp.
23. physical activity.mp.
24. exp motor activity/
25. (physical education and training).mp.
26. exp "Physical Education and Training"/
27. exp physical fitness/
28. sedentary.ab. or sedentary.ti.

29. exp life style/
30. exp leisure activities/
31. exp walking/
32. exp sports/
33. exp dancing/
34. dancing.mp.

35. exp exercise therapy/
36. (exercise\$ adj aerobic\$).tw.
37. (physical\$ adj5 (fit\$ or train\$ or activ\$ or endur\$)).tw.
38. (exercis\$ adj5 (train\$ or physical\$ or activ\$)).tw.
39. sport\$.tw.
40. walk\$.tw.
41. cycle\$.tw.
42. (("lifestyle" or life-style) adj5 activ\$).tw.

43. (("lifestyle" or life-style) adj5 physical\$).tw.
44. or/21-43
45. limit 44 to ("child (6 to 12 years)" or "adolescent (13 to 18 years)")
46. 20 and 45
47. school.tw.
48. 46 and 47

49. limit 48 to ed=20070501-20111021
-

(Continued)

EMBASE

Update search, via Ovid Week 18 2007 to Week 41 2011 (search conducted 21 October 2011)

Original search, via Ovid: 1985 to June 2007, week 26 (search conducted 27 June 2007)

1. Randomized controlled trials/
2. Random allocation/
3. Double blind method/
4. Single blind method/
5. clinical trial/
6. (clinic\$ adj trial\$1).tw.
7. ((singl\$ or doubl\$ or treb\$ or tripl\$) adj (blind\$3 or mask\$3)).tw.
8. Placebos/
9. Placebo\$.tw.
10. Randomly allocated.tw.
11. (allocated adj2 random).tw.
12. or/1-11
13. Case report.tw.
14. Letter.pt.
15. 13 or 14
16. 12 not 15
17. exp physical activity/
18. physical inactivity.mp.
19. exp exercise/
20. exp fitness/
21. exp physical education/
22. exp sport/
23. exp exertion/
24. exp leisure/
25. exp lifestyle/
26. exercis\$.tw.
27. (physical\$ adj5 activ\$).tw.
28. (physical\$ adj5 fit\$).tw.
29. (physical\$ adj5 lifestyle\$).tw.
30. (physical\$ adj5 train\$).tw.
31. exp dancing/

(Continued)

32. walk.tw.
33. exp kinesiotherapy/
34. exp Exercise Therapy/
35. exercis\$.af.
36. (aerobics or physical therapy or physical activity or physical inactivity).af.
37. (fitness adj (class\$ or regime\$ or program\$)).af.
38. (aerobics or physical therapy or physical training or physical education).af.
39. dance therapy.af.
40. sedentary behavior?.af.
41. or/17-40
42. limit 41 to (school child <7 to 12 years> or adolescent <13 to 17 years>)
43. 16 and 42
44. school.tw.
45. 43 and 44
46. limit 45 to em=200718-201141

BIOSIS

Update search, via Web of Science: January 2007 to October 2011 (search conducted October 21, 2011)

Original search, via Web of Science: 1995 to June 2007 (search conducted June 27, 2007)

1. TS=(physical activity OR exercise)
2. TS=(obesity OR overweight)
3. TS=(physical fitness OR fitness)
4. TS=(school OR school-based intervention OR physical education OR student*)
5. TS=(child* OR adolescent*)
6. TS=(randomized controlled trial OR random trial OR control trial)
7. 1 OR 2 OR 3
8. 4 AND 5 AND 6 AND 7

CINAHL

Update search, via EBSCO Host Research Databases: January 2007 to October 2011 (search conducted 21 October 2011)

Original search, via Ovid: 1982 to June Week 4 2007 (search conducted 28 June 2007)

- S1. (MH "Clinical Trials+")
- S2. (MH "Clinical Effectiveness")
- S3. (MH "Single-Blind Studies") or (MH "Double-Blind Studies")
- S4. (MH "Random Assignment")

(Continued)

S5. (MH "Placebos")

S6. (MH "Quantitative Studies")

S7. S1 or S2 or S3 or S4 or S5 or S6

S8. (MH "Exercise+") or (MH "Aerobic Exercises+")

S9. "physical inactivity"

S10. (MH "Life Style, Sedentary")

S11. ("physical education") or (MH "Physical Education and Training+")

S12. ("physical activity") or (MH "Physical Activity")

S13. ("physical fitness") or (MH "Physical Fitness+") or ("fitness")

S14. ("walk") or (MH "Walking") or (MH "Sports")

S15. "sport*"

S16. S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15

S17. ((MH "Schools+") or (MH "Schools, Elementary") or (MH "Schools, Middle") or ("school*"))

S18. S7 and S16 and S17 ? *Limiters - Publication Year from: 2007-2011; Age Groups: Child, 6-12 years, Adolescence, 13-18 years*

SPORTDiscus

Update search, via EBSCO Host Research Databases: January 1 2007 to October 2011 (search conducted 21 October 2011)

Original search, via EBSCO Host Research Databases: 1985 to June 2007 (search conducted 13 July 2007)

Control group OR randomi* control* trial OR effect* OR random sample* OR control subject*

AND

Physical activity OR physical inactivity OR exercise OR physical fitness OR fitness OR sport* OR danc* OR walk* OR physical education
OR obesity OR body weight

AND

Child OR adolescent

AND

School

PsycINFO

Update search, via Ovid: May Week 1 2007 to October Week 3 2011 (search conducted 21 October 2011)

Original search, via Ovid: 1985 to June 2007 (search conducted 13 July 2007)

1. Randomized controlled trial.mp.

2. Random allocation.mp.

3. Double blind method.mp.

4. Single blind method.mp.

5. clinical trial.mp.

6. (clinic\$ adj trial\$1).tw.

(Continued)

7. ((singl\$ or doubl\$ or treb\$ or tripl\$) adj (blind\$3 or mask\$3)).tw.
8. Placebo\$.tw.
9. Randomly allocated.tw.
10. (allocated adj2 random).tw.
11. Case report.tw.
12. Letter.mp.
13. Historical article.mp.
14. or/1-10
15. or/11-13
16. 14 not 15
17. exp exercise/
18. physical inactivity.mp.
19. physical activity.mp.
20. (physical education and training).mp.
21. exp physical fitness/
22. sedentary.ab. or sedentary.ti.
23. exp walking/
24. exp sports/
25. dancing.mp.
26. (exercise\$ adj aerobic\$).tw.
27. (physical\$ adj5 (fit\$ or train\$ or activ\$ or endur\$)).tw.
28. (exercis\$ adj5 (train\$ or physical\$ or activ\$)).tw.
29. sport\$.tw.
30. walk\$.tw.
31. cycle\$.tw.
32. (("lifestyle" or life-style) adj5 activ\$).tw.
33. (("lifestyle" or life-style) adj5 physical\$).tw.
34. lifestyle.mp.
35. leisure.mp.
36. or/17-35
37. 16 and 36
38. school.tw.
39. 37 and 38
40. limit 39 to (180 school age <age 6 to 12 yrs> or 200 adolescence <age 13 to 17 yrs>)

(Continued)

41. limit 40 to up=20070501-20111021

Sociological Abstracts

Update search, via Scholars Portal: January 1 2007 to October 21 2011 (search conducted 21 October 2011)

Original search, via Scholars Portal: 1985 to June 2007 (search conducted 27 June 2007)

Control group OR randomi* control* trial OR effect* OR random sample* OR control subject*

AND

Physical activity OR physical inactivity OR exercise OR physical fitness OR fitness OR sport* OR danc* OR walk* OR physical education OR obesity OR body weight

AND

Child OR adolescent

AND

School

Appendix 2. Description of interventions

Characteristic Study ID	Design	Intervention(s) and control(s)	Theoretical frame- work
Angelopoulos 2009	Cluster RCT	I: 12-month program integrated into the existing curriculum including: student workbook, teacher manual; covering themes: self-esteem, body image, nutrition, PA, fitness, environmental issues. Implemented for 1 to 2 hours per week with motivational methods used for increasing knowledge, skills, and self-efficacy and improving self-monitoring and social influence. School teachers trained by the research team delivered the intervention. Parental involvement (reinforcement) was required to complete some (unspecified) home activities C: not specified	Theory of Planned Behavior
Araujo-Soares 2009	Cluster RCT	I: 2 x 90-min PA sessions with related homework. A trained psychologist delivered the intervention, assisted by a sports education teacher. A research team member supervised preparation for each session, before which each student was asked to keep a diary for a period of 1 week. After the intervention they were asked to keep the diary for an additional 2 weeks. Worksheets and a 3-min film were used, and each student received a leaflet with main topics C: not specified	Social Cognitive Theory
Barbeau 2007	RCT	I: 10-month after-school PA program on body composition and CV fitness in young black girls. The program consisted of 30 min of homework time with a healthy snack, and 80 min of PA (25 min skill development, 35 min MVPA, and 20 min of toning and stretching). Activities during the MVPA included games such as basketball, tag, softball, relay races, etc., all of which were	-

(Continued)

modified to keep all of the subjects active throughout the 35-min period. Subjects received small weekly prizes (e.g. bouncy balls, slinkies, pencils, note pads, lip gloss, play jewelry) for maintaining good behavior and attitude and at most 1 unexcused absence. Absences were discussed with parents. Teachers providing the intervention were trained on childhood obesity, PA, and CV risk factors, the goals of the study, the specific protocol to be followed, and the types of activities appropriate for each segment of the intervention and manuals were provided to schools

C: not specified

Bayne-Smith 2004	RCT	<p>I: the intervention (PATH program) consisted of 30-min classes conducted 5 days per week for 12 weeks. Classes included: 1) brief lecture/discussion on featured topics (CV health and fitness, health behaviors); and 2) 20 to 25 min of vigorous PA (e.g. resistance exercise, endurance or aerobic exercise, alternated each day)</p> <p>C: the frequency/duration of PE classes were the same as PATH classes (but without lecture/discussion, so 5 extra min of PA each class)</p>	-
Burke 1998	Cluster RCT	<p>I1: standard PA and nutrition program (WASPAN). Classroom lessons, 20-min fitness sessions daily (min 4/week). Nutrition program built around 4 comic books to teach children and parents how to improve diets, plus 1 h/week nutrition classes</p> <p>I2: standard WASPAN program plus a PA enrichment program for higher-risk children. Incorporated teacher-parent-student triad, moved PA activities outside of the class and focused on the individual. Children kept weekly diaries</p> <p>C: no program</p>	-
Bush 1989	Cluster RCT	<p>I1: 'Know Your Body' curriculum focusing on nutrition, fitness and prevention of smoking. Students also receive a personalized health screening and results on a 'health passport'. Parents are mailed copies of their child's results and kept informed by a quarterly newsletter and an introductory Parent-Teacher meeting</p> <p>I2: 'Know Your Body' curriculum and health screening, but students do not receive the results of their screening, only their parents receive the results</p> <p>C: health screening only, parents only receive results of screening</p>	PRECEDE, Social Learning Theory
Colin-Ramirez 2010	Cluster RCT	<p>I: RESCATE program, included PA and nutritional components. PA addressed at individual (curriculum), school (PE sessions) and family level (homework and recommendations for parents)</p> <p>C: no PA/nutrition program</p>	-
Dishman 2004	Cluster RCT	<p>I: lifestyle Education for Activity Program (LEAP). Aimed to increase girls' self efficacy for physical activity, via: physical education, school environment, health education, school health</p>	Social Cognitive Theory

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		services, faculty or staff health promotion, and parent and community involvement	
		C: standard physical education as part of school curriculum	
Donnelly 2009	Cluster RCT	<p>I: physical Activity Across the Curriculum (PAAC), 90 min/wk of moderate to vigorous physically active academic lessons delivered intermittently throughout the school day</p> <p>C: regular classroom instruction without physically active lessons</p>	-
Dorgo 2009	Cluster RCT	<p>I1: PE manual resistance training (MRT) program. 80-min classes 3 times per week plus 10 to 15 min warm-up and 20 to 30 min of MRT-specific activities conducted by trained research assistants</p> <p>Intervention 2: PE MRT program plus a cardiovascular endurance training segment in every session including: walking, jogging, step aerobics, and aerobic kickboxing</p> <p>Control: a regular PE program that followed the usual school curriculum. 80-min classes 3 times per week</p>	-
Ewart 1998	RCT	<p>I: 50-min 'Project Heart' aerobic exercise classes including didactic instruction</p> <p>C: 50-min standard physical education classes</p>	-
Gentile 2009	Cluster RCT	<p>I: 'Switch' program, promoted healthy active lifestyles including: being active for 60 min or more per day, limiting total screen time to 2 hours or fewer per day, and eating 5 fruits/vegetables or more per day. Included 3 ecological levels (family, school, community)</p> <p>C: No intentional exposure to the Switch program</p>	Social Ecological Model
Haerens 2006	Cluster RCT	<p>I1: PA and nutrition intervention to increase levels of MVPA to at least 60 min a day, increase fruit consumption, increase water consumption, and reduce fat. A computer-tailored intervention assessed children's PA activities and provided tailored feedback</p> <p>I2: PA and nutrition intervention (same as Intervention 1 group) plus parental involvement, including: an interactive meeting on healthy food and PA, a newsletter 3 times/year, and a CD with an adult computer-tailored intervention (same as the children's computer tailored intervention) for use at home</p> <p>C: no PA and nutrition intervention</p>	Transtheoretical Model
Haerens 2009	Cluster RCT	<p>I: computer tailored PA program consisting of a demographic questionnaire, a PA questionnaire and a questionnaire on psychosocial determinants followed by tailored feedback that related students' PA levels to the PA guidelines</p> <p>C: generic information on the benefits of PA, public health recommendations, differences between moderate and vigorous intensity activities and tips on how to become more active</p>	Transtheoretical Model

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Jones 2008	Cluster RCT	<p>I: the intervention included: 1) a health curriculum (classroom lessons and behavioral journalism - during 6th grade, 16 sessions during physical education classes, 3 times per week; during 7th grade, science-based lessons during science class); 2) a physical education program; and 3) a school food service component, emphasizing calcium-rich food</p> <p>C: the control group participated in the usual health program</p>	Transtheoretical, Social Cognitive Theory
Kipping 2008	Cluster RCT	<p>I: the intervention included: 16 lessons on healthy eating, increasing physical activity, and reducing television viewing taught over 5 months by 10 specifically trained teachers. Materials provided to the schools included: lesson plans for 9 physical activity lessons, 6 nutrition lessons and 1 lesson about screen viewing</p> <p>C: the control schools were given the materials only after the completion of the study</p>	-
Kriemler 2010	Cluster RCT	<p>I: the intervention was a multicomponent PA program that included: 1) 3 existing 45-min physical education lessons per week; 2) 2 additional 45-min physical education lessons per week; 3) daily short activity breaks; and 4) physical activity homework</p> <p>C: the control group participated in the usual, mandatory physical education lessons (45-min, 3 times/week)</p>	Socio-Ecological Conceptual Model
Li 2010	Cluster RCT	<p>I: the intervention (TAKE 10! Program) included 2 daily 10-min physical activity sessions: 1) the teacher or student selected 1 to 3 activity cards; 2) several children modelled the exercises, the other students followed along; 3) cool-down period; and 4) the students were taught a health message</p> <p>C: no intervention took place</p>	-
Lubans 2009	Cluster RCT	<p>I: the intervention included: 1) 10-week school sport program and exercise program booklet; 2) information sessions; 3) physical activity and dietary monitoring using pedometers and diaries; 4) Program X weekly messages and parent information leaflets; and 5) email support</p> <p>C: the control group attended a 10-week school sport program and received an exercise program booklet</p>	Social Cognitive Theory
Luepker 1996	Cluster RCT	<p>I1: One group received a school-based program consisting of school food service modifications, physical education interventions, and the CATCH curricula</p> <p>I2: One group received the same school-based program plus a family-based program</p> <p>C: The control group received the usual health curricula, PE, and food service programs, but none of the CATCH interventions</p>	Health Belief Model
Martinez 2008	Cluster RCT	<p>I: the intervention group received: 1) the standard, compulsory PE curriculum (3 hours per week of low-to-moderate intensity</p>	-

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		activity); 2) recreational, noncompetitive, after school PA program (3 x 90-min sessions per week, for 24 weeks)	
		C: the control group received the standard, compulsory physical education curriculum: 3 hours per week of physical activity at low-to-moderate intensity	
McManus 2008	Cluster RCT	<p>I1: the Educational Program Group completed a 2-week education program, taught using an active game approach, that included: information about heart health, the use of heart rate feedback to attain an activity target, goal-setting, and role-play. They then completed 2-weeks with heart rate feedback and 2-weeks without heart rate feedback</p> <p>I2: the No-education Program Group completed a 2-week control program of standard PE classes without PA or heart health education. They then completed 2-weeks with heart rate feedback and 2-weeks without heart rate feedback but were not given any information about the heart rate signal or its meaning</p> <p>C: no intervention took place</p>	Health Belief Model, Social Cognitive Theory, Diffusion of Innovation
Neumark-Sztainer 2009	Cluster RCT	<p>I: the intervention included: (i) 14 x 2-hour after-school theatre sessions (which included: check-in, snack, movement component, theatrical activity - the final sessions focused on rehearsing for a play performance (script developed throughout intervention)); (ii) 8 weekly after-school booster sessions (activities related to healthy eating and physical activity, rehearsals for play); and (iii) family outreach component (to enhance home support for behavioral changes through positive reinforcement of healthy behaviors, parent-child participation in physical activities and availability of healthy foods) - take home materials, family events</p> <p>C: there was a theatre-based control condition (i.e. children participated in a play focused on environmental health issues using a prepared script)</p>	Social Cognitive Theory
Neumark-Sztainer 2010	Cluster RCT	<p>I: the intervention group participated in the standard all-girls PE class that was supplemented with the New Moves curriculum (nutrition and self-empowerment components, individual sessions using motivational interviewing, lunch meetings, and parent outreach)</p> <p>C: participation in all-girls PE class (during first semester of school year)</p>	Social Cognitive Theory, Transtheoretical Model
Peralta 2009	RCT	<p>I: the intervention ran over 16 weeks, with each week including 1 x 60-min curriculum session and 2 x 20-min lunchtime PA sessions. Each 60-min curriculum session included practical or theoretical (or both) components focused on promoting physical activity and increasing fruit consumption and the acquisition and practice of self-regulatory behaviors. Behavior modification techniques were used. The practical component included modified games and activities. The researcher primarily facilitated the intervention with staff and parents' involvement. Eleventh grade students peer facilitated lunchtime sessions. Parents were emailed 6 newsletters throughout, informing them of the program content, motivating them, and suggesting strategies to engage the family in healthy behaviors</p>	Social Cognitive Theory

(Continued)

		C: participated in 16 x 60-min physical activity curriculum at the same time as the intervention group, with a school PE teacher facilitating the control group	
Petchers 1988	RCT	<p>I: Chicago Heart Health Curriculum Program called "Body Power": a year-long curriculum with modules on 5 topics: 1) CV system, anatomy, and physiology; 2) smoking; 3) nutrition; 4) exercise; and 5) risk factors review. The curriculum was implemented by classroom teachers during at least 3 x 45-min sessions per week for 4 to 6 weeks, with training provided for teachers and supplemented by a comprehensive teachers' manual</p> <p>C: traditional curriculum with approximately the same amount of teaching time. Control group teachers were provided an alternative experience to the training sessions for the intervention group in the form of a separate in-service</p>	Health Behavior Model
Reed 2008	Cluster RCT	<p>I: the Action Schools! BC model was consistent with the 'active school' framework and emphasized an integrated whole-school approach rather than traditional classroom-based health education, targeting 6 Action Zones: i) School Environment, ii) Scheduled Physical Education, iii) Extra-curricular, (iv) School Spirit, v) Family and Community and vi) Classroom Action. Classroom Action included 15 min of moderate to intense physical activity daily (75 min of extra PA per week in addition to 2 x 40 min PE classes). Teachers provided opportunities to 'snack on physical activities' such as skipping, dancing, and resistance exercises throughout the day. A school Action Team was convened in each school with a facilitator who helped to design a program with activities across the 6 Action Zones. INT teachers received a 1-day training workshop and a Classroom Action Bin with resources, with the goal for each school to provide students with 150 min of PA/week (2 x 40 min PE classes + 15 x 5 min/day Classroom Action)</p> <p>C: teachers in UP schools continued the regular program of physical education and school-based PA</p>	-
Robinson 1999	Cluster RCT	<p>I: limited access to television use and budgeting television time and involved 18 lessons of 30 to 50 min as part of standard curriculum, taught by regular classroom teachers trained by research staff. Most lessons occurred in the first 2 months of the year and included self-monitoring and self-reporting for television and video game use followed by a 10-day television turnoff challenge after which students were encouraged to follow a 7-h per week budget. Newsletters designed to help parents motivate students and regulate time spent on television and video games for the entire family were distributed. Each household received television time master(s) to regulate television and video use</p> <p>C: not specified</p>	Social Cognitive Theory
Salmon 2008	Cluster RCT	<p>I: students were assigned to 1 of 4 conditions: a behavioral modification group (N = 69); a fundamental motor skills group (N = 73); a combined behavioral modification and fundamental motor skills group (N = 90)</p> <p>C: usual classroom lessons</p>	Social Marketing Theory, Behavioral Choice Theory

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Simon 2004	Cluster RCT	<p>I: the ICAPS program was implemented over 4 academic years to promote PA inside and outside. The intervention includes an educational component focusing on PA and sedentary behaviors, new opportunities for PA during and after school hours. Activities implemented are either informal or academic with emphasis on fun, well-being, non-competitiveness. Sporting events, bicycle, and on-foot transport are organized</p> <p>C: not specified</p>	-
Singh 2009	Cluster RCT	<p>I: an interdisciplinary program with adapted curriculum including an individual component (11 lessons in biology and physical education) and environmental change component including encouragement for schools to increase physical education and provision of advice for schools related to cafeteria changes</p> <p>C: regular curriculum</p>	Intervention Mapping Protocol
Singhal 2010	Cluster RCT	<p>I: multicomponent intervention with 7 components related to nutrition and lifestyle education, including the following activities: dissemination of health-related information through lectures and focused group discussions (24 weeks (6 months) of nutrition education), promotion of physical activity, other promotion of healthy lifestyle, individual counseling, policy-level changes in schools, involvement of teachers and parents, training of student volunteers for program sustainability</p> <p>C: no intervention</p>	-
Stephens 1998	Cluster RCT	<p>I: 18 medical students delivered 3 activity sessions per week, consisting of 5 min of warm-up and stretching, plus 20 min of aerobic activity. Activities incorporated repetitive movements of large muscle groups, designed to elevate the pulse rate 40–60 beats over resting level. Sessions ended with a 5–10 min cool-down with presentation of educational material about nutrition, exercise, and disease prevention</p> <p>C: students in the control classroom received no additional PA beyond regular PE classes</p>	-
Stone 2003	Cluster RCT	<p>I: the intervention program was implemented during third through fifth grades, with 4 components including: food service, skills-based classroom curricula, family, and PE</p> <p>C: not specified</p>	Social Learning Theory, incorporating cultural heritage of American Indians
Trevino 2004	RCT	<p>I: 50 sessions of health programming re: 3 health behavior messages associated with diabetes mellitus control (decreased dietary saturated fat intake, increase dietary fiber intake, increase physical activity). Children were asked to set goals and keep records of their accomplishments and were rewarded with coupons (worth a \$\$ amount) from a store set up in the school</p> <p>C: not specified</p>	Social Cognitive Theory, Social Ecological Theory
Verstraete 2006	Cluster RCT	<p>I: classes were provided game equipment (jump ropes, scoop sets, flying discs, balls, plastic hoops, juggling rings and bean-balls, badminton racquets, beach paddles) and 'activity cards'</p>	-

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		demonstrating use of the equipment for use outdoors during recesses and lunch break	
		C: not specified	
Walter 1988	Cluster RCT	I: special curriculum targeting voluntary changes in risk behavior in the area of diet, physical activity and smoking, taught in classrooms by specially trained regular teachers for ~2 hours per week C: not specified	PRECEDE, Health Belief Model, Social Learning Theory
Walther 2009	Cluster RCT	I: 1 unit of physical exercise (45 min) with at least 15 min of endurance training per school day, plus lessons on healthy lifestyle 1 per month C: according to German standards, 2 units (each 45 min) of PE per week are mandatory in all schools. 12 units (45 min per unit) of high-level endurance exercise training per week plus participation in competitive sporting events	-
Wang 2008	Cluster RCT	I: 'FitKid' after-school program, 2-hour intervention sessions (40 min academic enrichment activities and a healthy snack provided; 80 min of PA designed to improve sport skills, aerobic fitness, strength, and flexibility with a minimum of 40 min were devoted to vigorous PA), offered 5 days a week, instructed by certified school teachers and paraprofessionals C: not specified	-
Webber 2008	Cluster RCT	I: 6 TAAG health education lessons per school year to enhance behavioral skills known to influence PA participation (self-monitoring, setting goals for behavior change). Offered in 2 forms: 1 for a traditional classroom setting and 1 for PE class. Girls were the focus of the intervention; however, health and PE classes were part of the usual school curriculum and most included boys as well C: not specified	Social Cognitive Theory, Diffusion of Innovation, Operant Learning Theory
Weeks 2008	RCT	I: 10 min of directed jumping activity at the beginning of every PE class (twice per week), designed to apply loads to the skeleton at high-strain magnitude, frequency, and rate, including: jumps; hops; tuck-jumps; jump-squats; stride jumps; star jumps; lunges; side lunges; and skipping C: regular PE warm-ups and stretching at the beginning of every PE class (twice per week), including: brisk walking, light jogging, and stretching	-
Williamson 2007	Cluster RCT	I: Healthy Eating and Exercise (HEE) program; goal was to increase PA during the school day and at home. Teachers were provided with containers filled with indoor play supplies (e.g. balloons, bean bags) and outdoor play supplies (e.g. balls, jump ropes) to promote active play during class time and recess. Posters encouraged the use of these physical activity centers (PACs), and brief lesson plans provided academic games that used the supplies contained in the PACs	-

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		C: Alcohol/Tobacco/Drug abuse prevention (ADT) program, designed with the goal of modifying children's beliefs and attitudes regarding the use and abuse of tobacco, alcohol, and illicit drugs so that they reflected "healthier" values	
Wilson 2011	Cluster RCT	<p>I: ACT, a 17-week program implemented for 2 hours, 3 days/week by a trained instructor. Three main components: homework/snack (30 min), MVPA activities (60 min) that students selected each week, and a behavioral skills and motivational component (30 min)</p> <p>C: the General Health Education Program (comparison program) focused on nutrition, stress management, drug prevention, and drop-out prevention (with no PA component), and consisted of a homework/snack (30 min) and 3 hands-on activities related to general health (30 min each). The comparison program was held on the same days and times as the ACT intervention program</p>	Social Cognitive Theory, Self-Determination Theory
Young 2006	RCT	<p>I: included information to make an informed decision about the personal benefits of a physically active lifestyle, develop problem-solving skills, and obtain support from others. Specific strategies taught by a trained teacher included: goal setting, problem-solving barriers, communication skills, reinforcement of goal achievement through internal and external rewards, and learning from relevant role models. The PA portion of the intervention was congruent with the school's PE curriculum (1 semester of individual sports and 1 semester of team sports) taught 5 days per week. The family support component consisted of a family workshop, monthly newsletters, and adult-child homework assignments</p> <p>C: standard PE class in which students were taught skills in individual and team sports. Similar to the intervention structure, 1 semester focused on individual sports and the other on team sports. Classes were taught by qualified PE teachers employed by the school. Parents of participants in the standard PE class also received monthly newsletters</p>	Social Action Theory

"-" denotes not reported.

C: control; CV: cardiovascular; I: intervention; MVPA: moderate to vigorous physical activity; PA: physical activity; PE: physical education; RCT: randomized controlled trial.

Appendix 3. Baseline characteristics

Characteris- tic Study ID	Country	Setting	Age [mean years (SD)]	Sex [female %]	Ethnicity	Duration of intervention	Follow-up
Angelopoulos 2009	Greece	School; urban and rural	I: 10.25 C: 10.29	I: 57.3 C: 54.2	White	12 mo	Immediately post-intervention
Araujo-Soares 2009	Portugal	School	I: 12.19 C: 12.05	I: 53 C: 52	-	12 wk	9 months post-intervention
Barbeau 2007	USA	School	I: 9.5 C: 9.5	I: 100 C: 100	African-Amer- ican	10 mo	Immediately post-intervention
Bayne-Smith 2004	USA	Urban	I: 16.2 C: 15.9	I: 100% C: 100%	Mixed	12 wk	Immediately post-intervention
Burke 1998	Australia	School, home	I: NA C: NA T: 11.0	I: NA C: NA T: 49	-	9 mo	6 months post-intervention
Bush 1989	USA	School, home, community, physician office; mix of urban and rural	I: NA C: NA T: 10.5	I: NA C: NA T: 54	African-Amer- ican	4 yr	Immediately post-intervention
Colin-Ramirez 2010	Mexico	Grade school; ur- ban	I: 9.4 C: 9.4	I: 44 C: 53	Mexican	2 yr	Immediately post-intervention
Dishman 2004	USA	School, commu- nity; mixed urban and rural	I: NA C: NA T: 13.6	I: 100 C: 100	African Amer- ican White	1 yr	Immediately post-intervention

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Donnelly 2009	USA	School; urban	Grade 2 I: 7.7 C: 7.8 Grade 3 I: 8.7 C: 8.7	I: NA C: NA T: 57.1	White	3 yr	Immediately post-intervention
Dorgo 2009	USA	School	I: 15.9 C: 15.8	I: NA C: NA T: 57.2	-	18 wk	Immediately post-intervention
Ewart 1998	USA	School, community	Grade 9 (age not provided)	I: 100 C: 100	African-American White	18 wk	Immediately post-intervention
Gentile 2009	USA	School, community, home	I: 9.6 C: 9.6	I: 53 C: 49.6	White	8 mo	6 months post-intervention
Haerens 2006	Belgium	School; urban	I: NA C: NA T: 13.1	I: NA C: NA T: 36.6	White	2 yr	Immediately post-intervention
Haerens 2009	Belgium	School; urban	I: NA C: NA T: 14.6	I: NA C: NA T: 55.1	White	3 mo	3 months post-intervention
Jones 2008	USA	School	I: NA C: NA T: 11.6	I: 100 C: 100	White	1.5 yr	Immediately post-intervention
Kipping 2008	UK	School	I: 9.43 C: 9.4	I: 49.6 C: 54.7	-	5 mo	Immediately post-intervention

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Kriemler 2010	Switzerland	School; urban and rural	First grade I: 6.9 C: 6.9 Fifth grade I: 11 C: 11.3	First grade I: 49 C: 55 Fifth grade I: 55 C: 46	White	9 mo	Immediately post-intervention
Li 2010	China	School	I: NA C: NA T: 9.3	I: 45.7 C: 49.6	Chinese	1 yr	1 year post-intervention
Lubans 2009	Australia	School, home	I: NA C: NA T: 14.1	I: 48.3 C: 65.2	-	-	Immediately post-intervention
Luepker 1996	USA	School, home; urban	I: NA C: NA T: 8.8	I: NA C: NA	African-American White Hispanic	3 yr	Immediately post-intervention
Martinez 2008	Spain	School; urban and rural	Girls I: 9.4 C: 9.4 Boys I: 9.4 C: 9.5	I: 48.9 C: 49.6	White	9 mo	Immediately post-intervention
McManus 2008	China	School; urban	I: NA C: NA T: 10.4	I: NA C: NA T: 50	Chinese	2 yr	6 months post-intervention

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Neumark-Sztainer 2009	USA	School, community, theater; urban	I: NA C: NA T: 10.3	I: NA C: NA T: NA	African-American	16 wk	Immediately post-intervention
Neumark-Sztainer 2010	USA	School; urban	I: 15.7 C: 15.8	I: 100 C: 100	African-American American-Indian Asian White Hispanic Mixed/other	16 wk	Immediately post-intervention
Peralta 2009	Australia	School	I: NA C: NA T: 12.5	I: 0 C: 0	-	16 wk	Immediately post-intervention
Petchers 1988	USA	School; mixed (urban, suburban and residential)	I: NA C: NA T: 11.1	I: NA C: NA T: 52.6	-	40 wk	1 year post-intervention
Reed 2008	Canada	School, community, home; urban	Liaison (int 1) I1: 10.2 I2: 10.1 C: 10.3	I1: 44.8 I2: 50 C: 50.3	Predominately White and Asian	11 mo	Immediately post-intervention
Robinson 1999	USA	School	I: 8.95 C: 8.92	I: 44.6 C: 48.6	-	6 mo	Immediately post-intervention
Salmon 2008	Australia	School; urban	I1: NA I2: NA I3: NA C: NA	I1: 50.7 I2: 52.6 I3: 51.1 C: 50.8	-	1 yr	1 year post-intervention

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Simon 2004	France	School, community; urban	I: 11.6 C: 11.7	I: 53.7 C: 48.2	White	4 yr	Immediately post-intervention
Singh 2009	Netherlands	School	Girls I: 12.8 C: 12.9 Boys I: 12.6 C: 12.7	I: 53.3 C: 53.3	White	8 mo	1 year post-intervention
Singhal 2010	India	School; urban	I: 16 C: 16	I: 39.4 C: 40.2	Indian	42 wk	Immediately post-intervention
Stephens 1998	USA	School; urban	I: 8.4 C: 8.4	I: 44 C: 57	African-American	15 wk	Immediately post-intervention
Stone 2003	USA	School	I: NA C: NA T: 7.6	I: NA C: NA T: NA	American-Indian	3 yr (12 wks per yr)	Immediately post-intervention
Trevino 2004	USA	School; urban	I: 9.8 C: 9.8	I: 50 C: 49	Hispanic	7 mo	Immediately post-intervention
Verstraete 2006	Belgium	School; urban	I: 10.8 C: 10.9	I: 38.5 C: 59.3	White	3 mo	Immediately post-intervention
Walter 1988	USA	School, community; urban	Bronx I: 9 C: 9 Westchester	Bronx I: 48.9 C: 46.2 Westchester	African-American White Hispanic	6 yr	Immediately post-intervention

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			I: 8.9 C: 8.9	I: 45.9 C: 53.1			
Walther 2009	Germany	School	I: 11.1 C: 11.1	I: 47 C: 42	White	1 yr	Immediately post-intervention
Wang 2008	USA	School; urban	I: NA C: NA T: 8.5	I: NA C: NA	African-American	3 yr	Immediately post-intervention
Webber 2008	USA	School, community	I: NA C: NA T: 12.0	I: 100 C: 100	White	2 yr	Immediately post-intervention
Weeks 2008	Australia	School	Girls I: 13.7 C: 13.7 Boys I: 13.8 C: 13.8	I: 58 C: 49	-	8 mo	Immediately post-intervention
Williamson 2007	USA	School	I: NA C: NA T: 9.2	I: NA C: NA	White	2 yr	Immediately post-intervention
Wilson 2011	USA	School	I: 11.3 C: 11.4	I: 55.8 C: 52.4	African-American Other	17 wk	2 weeks post-intervention
Young 2006	USA	School; urban	I: NA C: NA T: 13.8	I: 100 C: 100	African-American	1 yr	Immediately post-intervention

(Continued)

"-" denotes not reported

C: control; I: intervention; mo: month(s); NA: not available; T: total; wk: week(s); yr: year(s).

Appendix 4. Matrix of study endpoints

Characteristic Study ID	Endpoint(s)	Author statements of primary and secondary endpoint(s)
Angelopoulos 2009	Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²)	Primary and secondary endpoints not specified, outcomes included: certain physiological and behavioural indices, such as anthropometric, dietary, and PA indices
Araujo-Soares 2009	PA duration	Primary outcome was "moderate to vigorous physical activity" (International Physical Activity Questionnaire).... [social cognitive theory], [self-regulation theory] and planning variables were secondary outcomes...."
Barbeau 2007	BMI (kg/m ²) Duration of PA VO ₂ max (mL/kg/minute)	Primary and secondary endpoints not specified, outcomes included: PA; fat mass; fat-free soft tissue; percentage body fat; bone mineral content; bone mineral density; visceral adipose tissue; subcutaneous abdominal adipose tissue; cardiovascular; moderate to vigorous PA
Bayne-Smith 2004	Blood cholesterol level (mg/dL) Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²) PA duration VO ₂ max (mL/kg/minute)	Primary and secondary endpoints not specified; outcomes included: age, height, weight, BMI, percentage body fat, resting systolic and diastolic blood pressure, total serum cholesterol, and estimated VO ₂ max
Burke 1998	Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²) TV viewing (minutes spent watching TV)	Primary and secondary endpoints not specified, outcomes included: BMI, systolic blood pressure, diastolic blood pressure, heart rate, cholesterol
Bush 1989	Blood cholesterol level (mg/dL) Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²) Pulse rate (beats/minute)	Primary and secondary endpoints not specified, outcomes included: systolic blood pressure, diastolic blood pressure, postexercise pulse recovery rate, serum total and high-density lipoprotein cholesterol
Colin-Ramirez 2010	PA rates (% of sample physically active) TV viewing (minutes spent watching TV)	Primary and secondary endpoints not specified, outcomes included: moderate to vigorous PA rates, tTV viewing
Dishman 2004	PA rates (% of sample physically active)	Primary outcomes were "self-efficacy, outcome-expectancy value, goal setting, satisfaction, and physical activity"
Donnelly 2009	BMI (kg/m ²) Duration of PA	BMI was the primary outcome, daily PA (duration) and academic achievement were secondary outcomes"
Dorgo 2009	BMI (kg/m ²)	Primary and secondary endpoints not specified, outcomes included: BMI
Ewart 1998	Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²) PA duration	Primary and secondary endpoints not specified, outcomes included: blood pressure, cardiorespiratory fitness, and BMI

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	Pulse rate (beats/minute)	
Gentile 2009	BMI (kg/m ²) TV viewing (minutes spent watching TV)	Primary and secondary endpoints not specified, outcomes included: PA duration, TV viewing, BMI
Haerens 2006	BMI (kg/m ²) PA duration TV viewing (minutes spent watching TV)	Primary and secondary endpoints not specified, outcomes included: duration of moderate to vigorous PA, TV viewing, BMI
Haerens 2009	PA duration	Primary endpoint: PA levels
Jones 2008	PA duration TV viewing (minutes spent watching TV)	Primary and secondary endpoints not specified, but: outcomes included weight bearing physical activity; moderate to vigorous PA; vigorous PA; metabolic equivalent; sedentary activity; before/after-school PA; and weekend PA
Kipping 2008	BMI (kg/m ²) TV viewing (minutes spent watching TV)	The primary outcome was reduction in time spent doing screen-based activities (watching TV, videos, computer games). Other outcomes mentioned (but not necessarily classified as secondary): were hours of screen activities, BMI, mode of transport to school and teachers' views of the intervention.
Kriemler 2010	Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²) PA duration	Primary outcome measures included body fat (sum of 4 skinfolds), aerobic fitness (shuttle run test), PA (accelerometry), and quality of life. Secondary outcome measures included BMI and cardiovascular risk score (average Z score of waist circumference, mean blood pressure, blood glucose, inverted high density lipoprotein cholesterol, and triglycerides)
Li 2010	BMI (kg/m ²)	Primary and secondary endpoints not specified; outcomes included: height, fasting body weight, BMI, body composition, body impedance, fat free mass, fat mass, percent body fat
Lubans 2009	PA duration TV viewing (minutes spent watching TV)	The primary outcome measured was mean steps/day as determined by 4 days of pedometer monitoring. Time spent in non-organized PA and sedentary behavior were also measured
Luepker 1996	Blood cholesterol level (mg/dL) Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²) PA duration Pulse rate (beats/minute)	At the school level, the 2 primary end points were changes in the fat content of food service lunch offerings and the amount of moderate to vigorous PA in the physical education programs. At the individual student level, serum cholesterol change was the primary end point and was used for power calculations for the study. Individual level secondary end points included psychosocial factors, recall measures of eating and PA patterns, and other physiologic measures
Martinez 2008	Blood cholesterol level (mg/dL) Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²)	Main outcome measures: BMI, triceps skin-fold thickness and percentage body fat. Secondary measures were blood lipids and blood pressure
McManus 2008	Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²) PA duration Pulse rate (beats/minute)	Main outcome measures: PA and changes in attraction to PA

(Continued)

V_O₂ max (mL/kg/minute)

Neumark-Sztainer 2009	BMI (kg/m ²) Physical activity duration TV viewing (minutes spent watching TV)	Primary and secondary endpoints were not specified; but outcomes measured included: assessment of program participation (sign-in sheets, attendance records, surveys), satisfaction and perceived impact among children and parents in the intervention condition (process surveys)
Neumark-Sztainer 2010	BMI (kg/m ²) PA duration TV viewing (minutes spent watching TV)	Main outcome measures: percentage body fat, BMI, PA, sedentary activity, dietary intake, eating patterns, unhealthy weight control behaviors, and body/self-image. Other outcomes included perceived changes in the social environments of the participating girls, given the importance placed on providing a supportive environment within New Moves. Finally, program satisfaction among participating girls and their parents were examined
Peralta 2009	BMI (kg/m ²) PA duration TV viewing (minutes spent watching TV)	Primary outcome: BMI; secondary outcomes: waist circumference, percentage body fat, cardiorespiratory fitness, PA and small screen recreation time
Petchers 1988	PA rates (% of sample physically active)	Primary and secondary endpoints not specified; outcomes included: knowledge, attitudes and behaviors reported on the knowledge scale
Reed 2008	Blood cholesterol level (mg/dL) Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²)	Primary and secondary endpoints not specified; outcomes included: cardiovascular fitness (20-m shuttle run), blood pressure, BMI, total cholesterol, total to high-density cholesterol, low-density lipoprotein, apolipoprotein B, C-reactive protein and fibrinogen, academic performance, amounts of physical activity (questionnaire) and PA counts (pedometer). (Power calculation was based on cardiovascular outcome, but data were not extracted for this outcome)
Robinson 1999	BMI (kg/m ²) PA duration TV viewing (minutes spent watching TV)	The primary outcome was BMI; other end points were triceps skinfolds, waist and hip circumference, PA, dietary behaviors, parental and child behaviors
Salmon 2008	BMI (kg/m ²) PA duration TV viewing (minutes spent watching TV)	Primary outcome: BMI; secondary outcomes: sedentary behaviors, PA, and enjoyment of PA
Simon 2004	Blood cholesterol level (mg/dL) Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²) PA duration PA rates (% of sample PA) TV viewing (minutes spent watching TV)	Primary and secondary endpoints not specified; outcomes included: participation in leisure organized PA, high sedentary behavior (43h/day), self-efficacy, and intention toward PA
Singh 2009	BMI (kg/m ²) TV viewing (minutes spent engaged in inactivity)	Primary outcome measures: body composition (i.e., waist circumference, skinfold thickness, and BMI). Secondary outcome measures: dietary and PA behavior (i.e., energy balance related behaviors)
Singhal 2010	BMI (kg/m ²)	Primary outcomes: waist circumference, hip circumference, triceps and biceps skinfolds, mid-thigh circumference, mid-upper arm circumfer-

(Continued)

		ence, sagittal abdominal diameter, BMI, waist-to-hip ratio, waist-to thigh ratio and waist-to-height ratio
		Secondary outcomes: body composition, knowledge, attitude and practices, body image satisfaction, biochemical measures related to diagnosing metabolic syndrome
Stephens 1998	Blood pressure, diastolic and systolic (mm Hg) Pulse rate (beats/minute)	Primary and secondary endpoints not specified; outcomes included: skinfold thickness, heart rate response to submaximal exercise, and sit and reach flexibility
Stone 2003	BMI (kg/m ²) PA duration	Primary and secondary endpoints not specified; outcomes included: percentage body fat, physical activity levels, knowledge of healthy behaviors
Trevino 2004	VO ₂ max (mL/kg/minute)	The primary end point was fasting capillary glucose, however this outcome was not included in this review therefore data was not extracted on this outcome. A secondary outcome was fitness level
Verstraete 2006	PA rates (% of sample physically active)	Primary end point was PA level
Walter 1988	Blood cholesterol level (mg/dL) Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²) Pulse rate (beats/minute)	Primary and secondary endpoints not specified; outcomes included: levels of risk factors and health knowledge, systolic and diastolic blood pressures, nonfasting plasma levels of total cholesterol, height and weight
Walther 2009	Blood cholesterol level (mg/dL) Blood pressure, diastolic and systolic (mm Hg) VO ₂ max (mL/kg/minute)	Primary endpoint was VO ₂ max Secondary outcomes included: blood pressure, heart rate, total cholesterol
Wang 2008	Blood cholesterol level (mg/dL) Blood pressure, diastolic and systolic (mm Hg) BMI (kg/m ²) VO ₂ max (mL/kg/minute)	Primary end point was percentage body fat; however, this outcome was not included in this review, therefore data on this outcome was not extracted Secondary outcome was fitness level
Webber 2008	BMI (kg/m ²) PA duration TV viewing (minutes spent watching TV)	Primary outcome: moderate to vigorous PA
Weeks 2008	BMI (kg/m ²) PA duration	Primary and secondary outcomes were not specified; outcomes included: BMI
Williamson 2007	BMI (kg/m ²) PA duration TV viewing (minutes spent engaged in inactivity)	Primary end point was change in BMI Z-scores, however this outcome was not included, therefore data on this outcome was not extracted Secondary outcomes were: time spent engaged in PA and time spent engaged in sedentary behaviors
Wilson 2011	PA duration	Primary outcome was PA duration
Young 2006	Blood cholesterol level (mg/dL)	Daily energy expenditure, measured as time spent engaged in PA was the primary outcome.

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Blood pressure, diastolic and
systolic (mm Hg)
BMI (kg/m²)

Secondary outcomes included: fitness level, time engaged in sedentary
behavior, BMI, blood pressure, and total plasma cholesterol

BMI: body mass index; PA: physical activity; TV: television; VO₂ max: maximal oxygen uptake.

Appendix 5. Physical activity rates (% of sample physically active)

Character- istic	Measurement period	Study pop- ulation	Interven- tion group	Control group	Overall ef- fect	Comments
Study ID						
Col- in-Ramirez 2010	Baseline	498 boys and girls	87	85	-	Data on TV viewing reported here. Simi- lar results reported for video game play- ing and computer use.
	Follow-up (12 months post- intervention)		92	91	NS	
Dishman 2004	Baseline	2111 girls	71	74	NS	Physical activity was assessed using the 3-Day Physical Activity Recall
	End of inter- vention		69	72	NS	MVPA ≥ 2 blocks of moderate to vigor- ous physical activity/day
Petchers 1988	Baseline	325 boys and girls	NA	NA	NS	Self-reported physical activity level as number of times physically active per week
	Follow-up (year 1)		NA	NA	NS	
Simon 2004	Baseline	954 ado- lescent males and females	64	58	NS	Self-reported physical activity assessed in the last year on a weekly basis in terms of frequency
	During inter- vention (6 months)		83	58	P < 0.0001 OR 2.74 (95% CI 2.01 to 3.75)	
Verstraete 2006	Baseline	235 boys and girls	57 baseline	56 baseline		Accelerometers were used to measure physical activity levels. The 1 min move- ment counts were used to determine light, moderate, and vigorous intensity activity
	End of inter- vention		53 fol- low-up	44 fol- low-up	P < 0.01	
CI: confidence interval; NA: not acknowledged; NS: not significant; OR: odds ratio; TV: television; MVPA: moderate to vigorous physical activity						

Appendix 6. Physical activity duration (minutes/hours engaged in physical activity)

Characteristic	Measurement period	Study population	Intervention group	Control group	Overall effect	Comments
Study ID						
Arau-jo-Soares 2009	Baseline	195 boys and girls	122	115	NS	PA was assessed with the International Physical Activity Questionnaire for adolescents using the 7-day recall method. Children indicated how many sessions of activities they had engaged in and how long each lasted. From this questionnaire a measure of general MVPA and exercise was derived consisting of a composite score that multiplied the frequency of sessions per week with minutes per session. Intention-to-treat analysis conducted Large treatment effect despite minimal intervention Intervention effects increased following intervention
	End of intervention (9 months)		158	113	P = 0.016 45 (95% CI 9 to 82)	
Barbeau 2007	Baseline	201 girls	27.6	27.6	NA	Free-living PA was measured using a 7-day recall tool
	End of intervention		60	40.2	P = 0.0006 22.2 (95% CI 9.6 to 34.2)	
Bayne-Smith 2004	Baseline	442 girls	67.5	82.5	NS	Self-reported activity measured as the number of 15 min sessions engaged in outside of school time
	End of intervention		79.5	82.5	NS	
Donnelly 2009	Baseline	1490 boys and girls	NA	NA	NS	PA assessment was conducted using direct observations via the System for Observing Fitness Instruction Time (SOFIT) method. Values are means taken from 4-day averages of minutes of MVPA (≥ 4 METs)
	End of intervention (year 3)		98	72	P = 0.001	
Ewart 1998	Baseline	88 adolescent girls	8.6	8.1	-	Observed step test exercise duration measured in seconds
	End of intervention		9.55	7.03	P < 0.0003	
Haerens 2006	Boys	2434 boys and girls	18	23	-	Self-reported leisure time PA measured in number of minutes.

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	End of inter- vention (year 2)		25	24	P < 0.05	Intervention 1 = curricula to promote physical activity with parental involvement.
Girls	Baseline		13	17	-	Intervention 2 = curricula to promote physical activity with no parental involvement.
	End of inter- vention (Year 2)		16	18	NS	
Intervention 1	Baseline		16	-	-	
	During inter- vention (9 months)		23	19	P < 0.05	
Intervention 2	Baseline		16	-	-	
	During inter- vention (9 months)		21	19	P < 0.05	
Haerens 2009	Baseline	281 boys and girls	87.6	86.7	-	Physical activity levels were determined using the validated Flemish Physical Activity Questionnaire.
	End of intervention (3 months)		88.6	83.9	NS	
						The FPAQ measured total physical activity (min/day).
Jones 2008	Baseline	606 girls	65	65	NS	PA data were collected using multiple administrations of the Self-Administered Physical Activity Checklist (SAPAC), as well as with the Calcium, Osteoporosis and Physical Activity (COPA) questionnaire
	End of intervention		71	64	P = 0.16	
					7.05 95% CI (6.75 to 7.35)	
Kriemler 2010	Baseline	502 boys and girls	21.2	21.2	NS	PA was monitored with an accelerometer which was worn continuously around the hip for 5 weekdays, at baseline and at the end of the intervention
	End of intervention		21.2	19.4	P = 0.03	
					0.44	

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95% CI (0.05 to 0.82)							
Lubans 2009	Baseline	106 boys and girls	71	73	NS	Yamax SW700 pedometers were used to measure PA. Participants were asked to wear sealed pedometers for 5 days (including 4 consecutive school days and 1 weekend day)	
	Follow-up (6 months)		75.4	64	NS		
Luepker 1996	Vigorous activity	Baseline	4019 boys and girls	NA	NA	NA	Self-reported PA of 1 day. Recall of duration of 22 common physical activities
		End of intervention (year 3)		30	22	P < 0.001	Prolonged treatment effect noted in sample 3 years post intervention. No gender specific analysis
	Total PA	Baseline		NA	NA	NA	Results favor the control group
		End of intervention (year 3)		121	125	P = 0.59	Absence of baseline measurements requires results to be interpreted with caution for both outcomes
McManus 2008	Intervention 1	Baseline	193 boys and girls	159	NA	NS	Percent time and (min) per day moderately active (HR >139 and <160 beats/min). Children had weekday PA assessed using continuous HR telemetry
		End of intervention (6 months)		245	NA	P<0.05	
	Intervention 2	Baseline		193	NA	NS	Intervention 1 = educational group (PE classes with PA and heart health education)
		End of intervention (6 months)		262	NA	P < 0.05	Intervention 2 = Non-educational group (PE classes without PA or heart health education)
Neumark-Sztainer 2009	Baseline	96 boys and girls	NA	NA	NS	PA was assessed with the Past Day Physical Activity Recall. Trained staff completed this tool with participants in a one-on-one interview.	
	End of intervention		157.2	142.8	P = 0.651		

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Neumark-Sztainer 2010	Baseline	336 adolescent girls	90	90		There were the mean of the number of 30-min blocks (~90 min/day, or just under 90 min/day at baseline)
	Follow-up (5 months post-intervention)		84	69	0.186 (NS)	
Peralta 2009	Baseline	32 boys	92	79.7	NA	Weekday MVPA (min/day). PA was measured over 7 consecutive days using MTI 7164 Actigraph accelerometers worn on belts at the right hip. Average minutes of moderate (MPA) vigorous (VPA) and MVPA were calculated using a composite method.
	Follow up (6 months)		123	96.6	P = 0.43	
					16.4 95% CI (-26.8 to 59.6)	
Robinson 1999	Child report	Baseline	192 boys and girls	56.7	44.3	Self-reported time spent in and out of school PA using an activity checklist.
		End of intervention		56.7	48.3	
	Parent report	Baseline		11	9	PA, metabolic equivalent-weighted, min/week
		End of intervention		16	17	
Salmon 2008	Intervention 1	Baseline	268 boys and girls	NA	NA	PA was assessed using Manufacturing Technology Inc. AM7164-2.2C accelerometers. Children wore the MTI on a belt positioned over the right hip during waking hours, except when bathing or swimming, for 8 days at each of the 4 measurement points.
		Follow up (12 months)		NA	NA	
	Intervention 2	Baseline		NA	NA	Intervention 1 = behavioural modification group (BM) - aimed to reduce time spent in sedentary behaviors
		Follow-up (12 months)		NA	NA	
	Intervention 3	Baseline		NA	NA	Intervention 2 = fundamental movement skills group (FMS) - aimed to increase skills and enjoyment of PA.
		Follow-up (12 months)		NA	NA	
					P < 0.05 (FMS) 9.5 (1.4 to 17.6)	Intervention 3 = combined BM/FMS group received both the BM and FMS lessons.
					NS	Baseline data available for boys and girls; however, not available for whole sample. Results only available post intervention for whole sample.

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Statistically significant effect only observed for those in the FMS group compared to control and not the other 2 intervention arms							
Simon 2004	Baseline	954 adolescent males and females	150	162	P < 0.0001 66 (95% CI 33.6 to 97.8)	Self-reported number of months that each activity is performed over the past year and the mean weekly time devoted to PA calculated	
	End of intervention (year 4)		207	153			
Stone 2003	End of intervention	1297 boys and girls	NA	NA	P < 0.05	Accelerometers measured time spent engaged in PA	
Webber 2008	Baseline	36 schools all girls	23.7	23.7	NS 1.6 95% CI (0.0 to 3.3)	MET-weighted minutes of MVPA using accelerometers worn for 7 consecutive days except while bathing, swimming, or sleeping	
	End of intervention (year 2)		22.4	22.4	NS -0.2 (95% CI -1.4 to 1.0)		
	Program Champion– directed intervention (year 3)		22.2	20.8	P = 0.05 1.6 (95% CI 0 to 3.3)		
Weeks 2008	Boys	Baseline	81 boys and girls	NA	NA	NS	A PA score was derived for each subject from responses to a bone-specific physical activity questionnaire (BPAQ), using a custom-designed LabVIEW program (National Instruments). The program ran an algorithm that accounted for frequency of exercise bouts and years of participation in past (whole of life) and current (previous 12 month) exercise involvement
		End of intervention		NA	NA	NS	
	Girls	Baseline		NA	NA	NA	
		End of intervention		NA	NA	P = 0.008	
Effect favors control							
Wilson 2011	Baseline	1308 boys and girls	43.4	44	-	-	
	Follow-up (2 weeks post intervention)		43.6	43.6	NS		

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Williamson 2007	Baseline	586 boys and girls	HEE	ADT	NS	<p>The Self-Administered Physical Activity Checklist (SAPAC) is a 29-item self-report, 1-day recall of physical and selected sedentary activities using a checklist format. Self-reported data from the SAPAC were summarized to measure minutes of MVPA</p> <p>Intervention 1 = healthy eating and exercise group (HEE). Provided with increased opportunity for PA during the day and education</p> <p>Intervention 2 = Alcohol/Drug/Tobacco use/abuse prevention (ADT). Program to modify children's beliefs about the use of tobacco, alcohol, and illicit drugs</p>
	End of intervention (18 months)		NA	NA		
			22	-3	P = 0.06	

CI: confidence interval; NA: not acknowledged; NS: not significant; MVPA: moderate to vigorous physical activity; MET: metabolic equivalent; FPAQ: Flemish Physical Activity Questionnaire; HR: heart rate; PE: physical education; PA: physical activity.

Appendix 7. Television viewing (minutes/hours spent engaged in inactivity)

Character- istic	Measurement period		Study pop- ulation	Interven- tion group	Control group	Overall ef- fect	Comments
Study ID							
Col- in-Ramirez 2010	Baseline		498 boys and girls	84	84	-	-
	Follow-up (12 months post-intervention)			85	89	NS	
Burke 1998	Enrichment group boys	Baseline	720 boys and girls	NA	NA	NS	Self-reported time spent watching TV Time spent watching TV returned almost to baseline levels after the intervention in all groups, except in boys in the enrichment group
		End of intervention		NA	NA	NS	
		Follow-up (6 months)		18	23	P = 0.014	
	Enrichment group girls	Baseline	NA	NA	NS		
		End of intervention	NA	NA	NS		
		Follow-up (6 months)	2	5	NS		
	Gentile 2009	Child report	Baseline	1029 boys and girls	245.1	262.3	Time spent viewing TV and playing video games was assessed by children, using meth- ods that have been used reliably with chil- dren. Time spent on TV and video games was summed to create weekly screen time (hours/ week)
Follow up (6 months)			238.3		249.4	NS	
Parent re- port		Baseline	180		197.1	P < 0.05 Cohen's d 1.38 = 2 hours less screen time in favour of experimen- tal group	
		Follow up (6 months)	205.7		222.9		
Haerens 2006	Boys	Baseline	2434 boys and girls	33.9	53.4	-	Self-reported amount of time spent watching TV
		End of intervention (year 2)		34.6	35.0	P<0.05	

(Continued)

	Girls	Baseline		20.5	24.8	-	
		End of intervention (year 2)		18.7	22.9	NS	
Jones 2008	Baseline		606 girls	137	114	NA	<p>Sedentary activity data were collected using multiple administrations of the Self-Administered Physical Activity Checklist (SAPAC), as well as with the Calcium, Osteoporosis and Physical Activity (COPA) questionnaire. The SAPAC had an additional section for sedentary activities such as TV and video watching at 3 time periods during the previous day</p> <p>It is worth noting that the control group spent a lot more time in sedentary behaviours at follow-up than they had at baseline, and also that the control group had much lower sedentary behavior at baseline than the intervention group</p>
	End of intervention			135	152	P = 0.04 17 (95% CI 16.5 to 17.5)	
Kipping 2008	Weekdays	Baseline	604 boys and girls	150	135		<p>Self reported time spent engaged in screen-based activities. Child self-report about the length of time spent doing screen-based activities on the previous weekday and Saturday</p>
		End of intervention		NA	NA	P = 0.62 -12 (95% CI -43 to 19)	
	Weekends	Baseline		150	180	-	
		End of intervention		NA	NA	P = 0.42 -15 (95% CI -58 to 27)	
Lubans 2009	Baseline		106 boys and girls	150	131.4	NS	<p>Sedentary behaviors were assessed using a questionnaire. The items were adapted from the Adolescent Sedentary Activity Questionnaire used in the NSW Schools Physical Activity and Nutrition Study (SPANS)</p>
	Follow up (6 months)			124.8	135.6	NS	
Neu-mark-Sztainer 2009	Baseline		96 boys and girls	NA	NA	NS	<p>Children were asked on one average weekday and Saturday or Sunday, how many hours are</p>
	End of intervention			136.8	140.4	P = 0.857	

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								spent watching TV/videos; 7 response options ranging from 0 to 6+ hours
Neu-mark-Sztainer 2010	Baseline			336 adolescent girls	168	144	NS	TV viewing for 30 min blocks/day. Overall there was a change in sedentary behaviors, but not for TV viewing
	Follow-up (5 months post-intervention)				137.4	140.4	P = 0.883	
Peralta 2009	Baseline			32 boys	387	315	NS	Time spent in small screen recreation on weekends was assessed using the Adolescent Sedentary Activities Questionnaire. Participants were asked to report (in hours) TV viewing, video viewing, video game, computer game/Internet use, and computer use for homework
	Follow up (6 months)				285	287.7	P = 0.56 12 (95% CI -306 to 168)	
Robinson 1999	Child report	TV	Baseline	192 boys and girls	132	132.8	-	Self-reported time spent in sedentary activities
			End of intervention		77.1	124.3	P < 0.001	
		Videotapes	Baseline	40.3	47.1	-		
			End of intervention	30	44.6	NS		
		Video games	Baseline	22.3	33.4	-		
			End of intervention	11.4	36	P = 0.01		
		Other sedentary behaviors	Baseline	40.3	38.6	-		
			End of intervention	32.6	35.1	NS		
	Parental report	TV	Baseline	102.9	128.6	-		
			End of intervention	77.1	128.6	P < 0.001		
		Videotapes	Baseline	42.9	37.7	-		

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		End of inter- vention		33.1	33.5	NS	
	Video games	Baseline		15.4	23.1	-	
		End of inter- vention		12	22.3	NS	
	Other sedentary behaviors	Baseline		385.7	342.9	-	
		End of inter- vention		351.4	368.6	NS	
Salmon 2008	Intervention 1	Baseline	268 boys and girls	NA	NA	-	Child self-report time (hours/minutes) engaged in TV viewing, computer use and playing electronic games. Each of these variables was summed and divided by 7 to calculate average minutes per day
		Follow-up (12 months)		NA	NA	NS	
	Intervention 2	Baseline		NA	NA	-	Baseline data available for boys and girls; however, not available for whole sample. Results only available post intervention for whole sample.
		Follow-up (12 months)		NA	NA	P < 0.05 (BM)	
	Intervention 3	Baseline		NA	NA	-	Statistically significant effect observed for Behavior Modification arm, in favor of the control group
		Follow-up (12 months)		NA	NA	240 (95% CI 28 to 452)	
Simon 2004	% time in high sedentary activities	Baseline	954 adolescent boys and girls	34%	27%	-	Self-reported time spent in sedentary activities such as TV viewing and video games. High sedentary behaviour ≥ 3 h/day TV viewing and computer/video games
		During intervention (6 months)		28%	36%	P < 0.0001 OR 0.49 (95% CI 0.35 to 0.69)	
	Minutes of TV viewing and computer/ video games	Baseline		108	104	-	
		End of intervention (year 4)		88	99	P < 0.02 -16 (95% CI -29 to -3)	
Singh 2009	Boys	Baseline	875 boys and girls	268	294	NA	Screen-viewing behavior (TV viewing and computer use), min/d assessed using a ques-

(Continued)

	End of intervention Fol- low-up (20 months)		258	278	P = 0.05 -25 (95% CI -50 to -0.3)	tionnaire pre tested for clarity and length among adolescents not participating in the study
Girls	Baseline		212	250	NA	
	End of intervention Fol- low-up (20 months)		258	248	NS -2 (95% CI -9 to 5)	
Webber 2008	Baseline	36 schools all girls	456.5	458	NS -1.5 (95% CI -11 to 8)	Minutes of sedentary behavior defined as the number of minutes with less than light activi- ty
	End of intervention (year 2)		511	514	NS -3.5 (95% CI -11 to 4)	
	Program Champion– directed intervention (year 3)		524	533	P < 0.05 -8 (95% CI -17 to 0)	
Williamson 2007	Baseline	586 boys and girls	HEE NA	ADT NA		The Self-Administered Physical Activity Checklist (SAPAC) 34 is a 29-item self-report, 1-day recall of physical and selected seden- tary activities using a checklist format. The SAPAC was administered to small groups of students in a classroom setting. Self-report- ed data from the SAPAC were summarized to measure minutes in sedentary pursuits
	End of intervention (18 months)		4	-20	P = 0.4864	

CI: confidence interval; NA: not acknowledged; NS: not significant; OR: odds ratio; TV: television; NSW: New South Wales; h/day: hours per day.

Appendix 8. Mean systolic blood pressure (mm Hg)

Character- istic	Measurement period			Study pop- ulation	Interven- tion group	Control group	Overall ef- fect	Comments
Study ID								
Angelopoulos 2009	Baseline			646 boys and girls	120	116	NS	BP was measured in the right arm with the subject seated and quiet after a 5-min rest, using a validated automated sphygmo- manometer (Omron M5i Blood Pressure Mon- itor)
	End of intervention (12 months)				119	119	P = 0.016	
Bayne-Smith 2004	Baseline			442 girls	111	111	-	Measured after 5 to 15 min of rest in a seated position by the auscultatory method from the right arm at heart level. The second of 2 mea- surements was used.
	End of intervention				105	108	P < 0.05	
Burke 1998	Standard PE program	Boys	Baseline	720 boys and girls	NA	NA	-	BP measured using Dinamap. An initial mea- surement was taken and after a 5-min rest period in the sitting position, 3 further mea- surements were taken at 1-min intervals. The mean of the latter 3 measurements was used.
			End of inter- vention		NA	NA	NS	
		Girls	Baseline		NA	NA	-	
			End of inter- vention		NA	NA	NS	
	Enriched PE program	Boys	Baseline		NA	NA	-	No primary data provided in text. Only overall change in systolic BP displayed in graph form. No significant change noted over intervention period of 18 weeks
			End of inter- vention		NA	NA	NS	
		Girls	Baseline		NA	NA	-	
			End of inter- vention		NA	NA	NS	
Bush 1989	Baseline			431 boys and girls	104	103	NS	3 resting BP measurements were taken with a standard mercury sphygmomanometer read to the nearest mm, with the child seated. A mean of the 2nd and 3rd readings were used
	During intervention (year 1)				102	102	P = 0.517	
	During intervention (year 2)				103	107	P < 0.001	

(Continued)

		During intervention (year 3)		111	114	P < 0.004	
		End of intervention (year 4)		116	114	P = 0.393	
Ewart 1998	Baseline	88 adolescent girls		120	120		BP was measured after 15 min in a sitting position. The average of 6 readings was used to assess baseline resting pressure. Same procedure was used at follow-up
	End of intervention			114	116	P < 0.05	
							Small sample size. Results generalizable to high-risk African-American adolescent girls
Kriemler 2010	Baseline	502 boys and girls		104	103	NA	BP was assessed after a rest period of 5 min in the right arm based on recommendations of the American Heart Association. An automated oscillograph was used in order to reduce interobserver variability. BP was measured 5 times and the mean of the 3 measurements with the smallest variation was taken
	End of intervention			101	102	P = 0.88 0 (95% CI -0.3 to 0.2)	
Luepker 1996	Baseline	4019 boys and girls		105	105	P = 0.33	5 recordings (1 min apart) were obtained after a 5-min rest period using the Dinamap automatic BP device. The mean of the last 3 readings was used
	End of intervention (year 3)			114	114	P = 0.71	
Martinez 2008	Boys	Baseline	1044 boys and girls	106	110	P = 0.001	After a 5-min rest, 3 BP readings were taken at 2-min intervals. BP was obtained with an OMRON M5-I automatic sphygmomanometer using 3 cuffs sized for arm circumference. The mean of the 3 BP readings was used in the analyses
		End of intervention (9 months)		105	106	P = 0.22 1 (95% CI -0.6 to 2.7)	
	Girls	Baseline		104	108	P = 0.08	
		End of intervention (9 months)		102	103	P = 0.96 0.1 (95% CI -1.7 to 1.8)	
McManus 2008	Intervention 1	Baseline	193 boys and girls	95	94	-	Systolic BP was measured manually using a pediatric cuff after 15 min of supine rest
		End of intervention (6 months)		102	101	NS	

(Continued)

	Intervention 2	Baseline		101	94	-	
		End of intervention (6 months)		105	101	NS	
Reed 2008	Baseline		514 boys and girls	105	104	NS	Duplicate measurements were taken on the left arm using an automated sphygmomanometer and an appropriately sized cuff after 5 to 10 min rest in a supine position The lowest systolic and diastolic BPs (mm Hg) were recorded
	End of intervention			102	108	P = 0.05	
Simon 2004	Baseline		954 adolescent males and females	109	107	-	Systolic BP was measured on seated children, after a 5-min rest, using a fully automatic BP monitor and an adapted cuff size -0.4 (95% CI -2.3 to 1.4)
	End of intervention (year 4)			115	114	P = 0.66	
Stephens 1998	Baseline		90 boys and girls	98	100	-	
	End of intervention			96	97	NS	
Walter 1988	Westchester (whole sample)	Baseline	3388 boys and girls	102	106	NA	BP was measured in the seated position using the right arm using a Baum mercury sphygmomanometer three times. The mean of the 3 measurements was used.
		End of intervention		103	107	NS	
	Bronx	Baseline		105	104	NA	
		End of intervention		106	105	NS	
Walther 2009	Baseline		182 boys and girls	129	128	NS	-
	End of intervention (year 1)			138	139	P = 0.232 -2 (95% CI -5 to 1)	
Wang 2008	Baseline		316 boys and girls	110	110	NS	The biological measurements were made in a mobile laboratory that was brought to the school sites. Systolic BP was measured with a Dinamap. Subjects sat quietly for 5 min, 5 measures were taken at 1-min intervals, and
	End of intervention			106	108	P = 0.15	

(Continued)

				-2 (95% CI -4 to 1)	the mean of the last 3 measurements was used
Young 2006	Baseline	210 adolescent girls	109	110	-
	End of intervention (1 year)		108	107	NS
				P = 0.06	
BP: blood pressure; CI: confidence interval; NA: not acknowledged; NS: not significant; PE: physical education.					

Appendix 9. Mean diastolic blood pressure (mm Hg)

Character- istic	Measurement period			Study pop- ulation	Interven- tion group	Control group	Overall ef- fect	Comments
Study ID								
Angelopoulos 2009	Baseline			646 boys and girls	73	74	NS	BP was measured in the right arm with the subject seated and quiet after a 5-min rest, using a validated automated sphygmo- manometer (Omron M5i Blood Pressure Mon- itor)
	End of intervention (12 months)				73	76	P = 0.005	
Bayne- Smith 2004	Baseline			442 girls	71	70		Measured after 5 to 15 min of rest in a seated position by the auscultatory method from the right arm at heart level. The second of two measurements was used
	End of intervention				68	70	P < 0.001	
Burke 1998	Standard PE program	Boys	Baseline	720 boys and girls	NA	NA		BP measured using Dinamp. An initial mea- surement was taken and after a 5-min rest pe- riod in the sitting position, 3 further measure- ments were taken at 1 minute intervals. The average of the latter 3 measurements was used
			End of inter- vention		NA	NA	NS	
		Girls	Baseline		NA	NA		
			End of inter- vention		NA	NA	P < 0.05	
	Enriched PE program	Boys	Baseline		NA	NA		All measures of diastolic BP increased over time and results tended to favor the control group, except for high risk girls attending the standard PE program
			End of inter- vention		NA	NA	NS	
		Girls	Baseline		NA	NA		
			End of inter- vention		NA	NA	NS	
Bush 1989	Baseline			431 boys and girls	73	71	P < 0.001	3 resting BP measurements were taken with a standard mercury sphygmomanometer read to the nearest mm, with the child seated. An average of the 2nd and 3rd readings were used
	During intervention (year 1)				67	70	P < 0.000	
	During intervention (year 2)				64	68	P < 0.000	



(Continued)

		During intervention (year 3)		57	61	P < 0.000	Positive treatment effects prolonged throughout intervention period
		End of intervention		59	61	P < 0.009	
Ewart 1998	Baseline	88 adolescent girls		58	60	NS	BP was measured after 15 min in a sitting position. The average of 6 readings was used to assess baseline resting pressure. Same procedure was used at follow-up.
	End of intervention			57	59	NS	
Kriemler 2010	Baseline	502 boys and girls		62	61	NA	BP was assessed after a rest period of 5 min at the right arm based on recommendations of the American Heart Association. An automated oscillograph was used in order to reduce inter-observer variability. BP was measured 5 times and the mean of the 3 measurements with the smallest variation was taken
	End of intervention			60	61	P = 0.28 -0.1 (95% CI -0.4 to 0.1)	
Luepker 1996	Baseline	4019 boys and girls		54	53	P < 0.93	5 recordings (1 min apart) were obtained after a 5 min rest period using the Dinamap automatic BP device. The average of the last 3 readings was used
	End of intervention (year 3)			56	56	P < 0.66	
Martinez 2008	Boys	Baseline	1044 boys and girls	63	66	P = 0.007	After a 5-min rest, 3 BP readings were taken at 2-min intervals. BP was obtained with an OMRON M5-I automatic sphygmomanometer using 3 cuffs sized for arm circumference. The mean of the 3 BP readings was used in the analyses
		End of intervention		63	62.5	P = 0.03	
		(9 months)				1.6 (95% CI 0.2 to 2.9)	
	Girls	Baseline		65	67	P = 0.001	
		End of intervention		63	64	P = 0.85	
		(9 months)				0.1 (95% CI -1.4 to 1.2)	
McManus 2008	Intervention 1	Baseline	193 boys and girls	56	54		Diastolic BP was measured manually using a paediatric cuff after 15 min of supine rest
		End of intervention (6 months)					
		End of intervention (6 months)		60	57	NS	

(Continued)

	Intervention 2	Baseline		58	54		
		End of intervention (6 months)		60	57	NS	
Reed 2008	Baseline	514 boys and girls	63	60	NA	Duplicate measurements were taken on the left arm using an automated sphygmomanometer and an appropriately sized cuff after 5 to 10 min rest in a supine position The lowest systolic and diastolic BP (mm Hg) were recorded	
	End of intervention		63	65	NS		
Simon 2004	Baseline	954 adolescent males and females	65	64			Diastolic BP was measured on seated children, after a 5-min rest, using a fully automatic BP monitor and an adapted cuff size.
	End of intervention (year 4)		67	66	P = 0.60 -0.5 (95% CI -2 to 1)		
Stephens 1998	Baseline	90 boys and girls	58	58			
	End of intervention		50	50	NS		
Walter 1988	Westchester	Baseline	3388 boys and girls	70	73	NS	BP was measured in the seated position using the right arm using a Baum mercury sphygmomanometer 3 times. The average of the 3 measures was used
		End of intervention		70	73	NS	
	Bronx	Baseline		74	73	NS	
		End of intervention		73	73	NS	
Walther 2009	Baseline	182 boys and girls	63	65	NS		
	End of intervention (year 1)		54	54	P = 0.937 0 (95% CI -3 to 3)		
Wang 2008	Baseline	316 boys and girls	66	66	NS	The biological measurements were made in a mobile laboratory that was brought to the school sites. Diastolic BP was measured with a Dinamap. Subjects sat quietly for 5 min, 5 measurements were taken at 1-min intervals,	
	End of intervention		63	65	P = 0.41		

(Continued)

					-1 (95% CI -4 to 2)	and the mean of the last 3 measurements was used
Young 2006	Baseline	210 adolescent girls	60	59		
	End of intervention (1 year)		58	57	NS	
					P = 0.49	
CI: confidence interval; NA: not acknowledged; NS: not significant; BP: blood pressure; PE: physical education.						

Appendix 10. Blood cholesterol level (mg/dL)

Characteris- tic Study ID	Measurement period		Study popu- lation	Intervention group	Control group	Overall effect	Comments
Bayne-Smith 2004	Baseline		442 girls	160	154	-	A Reflotron reflectance photometer measured to- tal serum cholesterol.
	End of intervention			151	150	NS	
Bush 1989	Baseline		431 boys and girls	180	175	P < 0.01	Nonfasting blood samples were taken using venipuncture Treatment effect favors intervention group but not statistically significant
	During intervention (year 1)			187	189	P < 0.02	
	During intervention (year 2)			189	189	P = 0.418	
	During intervention (year 3)			171	167	P = 0.432	
	End of intervention (year 4)			177	180	P = 0.348	
Luepker 1996	Baseline		4019 boys and girls	4.39	4.41	P = 0.64	Nonfasting blood samples were obtained via venipuncture and analyzed for total cholesterol.
	End of intervention (year 3)			4.15	4.14	P = 0.21	
Martinez 2008	Boys	Baseline	1044 boys and girls	169	171	P = 0.48	12-hour-fasting blood samples were obtained under standardized conditions from the cubital vein in Vacutainer serum-gel-separator tubes. Samples were processed within 60 min of draw- ing
		End of inter- vention (9 months)		163	165	P = 0.54 1 (95% CI -2 to 4)	
	Girls	Baseline		169	169	NS	
		End of inter- vention (9 months)		165	163	P = 0.78 1 (95% CI -3 to 4)	
Reed 2008	Baseline		514 boys and girls	4.3	4.5	NS	Intravenous samples were taken from the ante- cubital vein between 8:00 AM and 9:30 AM, af- ter an overnight fast. A 10 mL sample was taken by a nurse and stored on ice in a serum separa-
	End of intervention			4.1	4.3	NS	

(Continued)

						tor tube. Blood was separated within 30 min and then stored at -80 °C	
Simon 2004	Baseline		954 adolescent males and females	158	153	-	Subjects are asked to fast for a minimum of 10 h before the blood sampling, which was performed in the morning, before the medical examination, with minimal venous stasis. All samples were processed within 3 h of sampling and the serum and plasma samples were aliquoted for immediate analysis or long-term storage at -80 °C until assay
	End of intervention (year 4)			168	160	P = 0.15 3 (95% CI -1 to 6)	
Walter 1988	Westchester	Baseline	3388 boys and girls	169	166	-	Nonfasting blood samples were taken to measure total cholesterol
		End of intervention		167	166	P < 0.05	
	Bronx	Baseline		174	170	-	
		End of intervention		171	168	NS	
Walther 2009	Baseline		182 boys and girls	4.2	4.26	NS	Peripheral blood samples were obtained before the specific tests were performed in all pupils. Technicians were blinded for group assignments
	End of intervention (year 1)			4.19	4.12	P = 0.370 0.11(-0.13 to 0.35)	
Wang 2008	Baseline		316 boys and girls	166	161	NS	The biological measurements were made in a mobile laboratory that was brought to the school sites. Non-fasting total cholesterol were measured with a Cholestech LDX system
	End of intervention			172	169	P = 0.94 0 (95% CI -6 to 6)	
Young 2006	Baseline		210 adolescent girls	155	161	-	-
	End of intervention (1 year)			155	163	P = 0.43	
CI: confidence interval; NA: not acknowledged; NS: not significant; mL: millilitres.							

Appendix 11. Body mass index (BMI - kg/m²)

Characgter- istic	Measurement period		Study pop- ulation	Interven- tion group	Control group	Overall ef- fect	Comments
Study ID							
Angelopou- los 2009	Baseline		646 boys and girls	20.3	20.1	NS	Body weight was measured using a digital scale (Seca Personal Floor Scale 861) with an accuracy of 100 g. Subjects were weighed without shoes, in the minimum clothing possible (i.e. underwear). Standing height was also measured without shoes to the nearest 0.1 cm with the use of a portable commercial stadiometer (Leicester Height Measure). Standard BMI formula was used
	End of intervention			19.2	20.2	P = 0.047	
Barbeau 2007	Baseline		201 girls	20.9	20.9	NS	Height and weight were measured by standard methods using a wall-mounted stadiometer and a scale, respectively
	End of Intervention			21.6	22.2	P = 0.008 -0.5 (95% CI -0.8 to -0.1)	
Bayne- Smith 2004	Baseline		442 girls	22.8	23.6	NS	Height and weight were measured on a standard physicians scale wearing lightweight clothing
	End of intervention			22.8	23.7	NS	
Burke 1998	Standard PE program	Boys	Baseline	720 boys and girls	NA	NA	P = 0.016 Standard formula for height and weight used Positive effect only seen in boys in the standard treatment program
			End of inter- vention		NA	NA	
		Girls	Baseline		NA	NA	
			End of inter- vention		NA	NA	
	Enriched PE program	Boys	Baseline		NA	NA	NA
			End of inter- vention		NA	NA	
		Girls	Baseline		NA	NA	NA

(Continued)

End of inter- vention				NA	NA		
Bush 1989	Baseline		431 boys and girls	14.3	14.0	NS	Height and weight were measured using a standard medical balance beam type scale with rigid height bar. Weight was measured to the nearest gram, with light clothing and no shoes. Height was measured to the nearest millimeter, with no shoes. Measurements were taken twice and a mean of the 2 measurements was used
	During intervention (year 1)			14.5	14.2	P < 0.011	
	During intervention (year 2)			14.8	14.3	P < 0.070	
	During intervention (year 3)			15.2	14.8	P < 0.424	
	End of intervention (year 4)			15.0	15.1	P < 0.954	
Donnelly 2009	Baseline		1490 boys and girls	17.9	19.9	NS	Height and weight were obtained at the beginning and end of 3 years with a stadiometer and digital scale accurate to ±0.1 kg. Children were measured in private during the first period of the school day in t-shirts, shorts, and socks provided by the project staff
	End of intervention (year 3)			18.0	20.0	0.83	
Dorgo 2009	Intervention 1	Baseline	222 boys and girls	24.4	24.9	NS	No details on how height and weight were measured
		End of intervention		24.5	24.6	NS	
	Intervention 2	Baseline		24.8	24.9	NS	
		End of intervention		24.7	24.6	NS	
Ewart 1998	Baseline		88 adoles- cent girls	24.8	24.1	NS	No details on how height and weight were measured
	End of intervention			25.1	24.1	NS	
Gentile 2009	Baseline		1029 boys and girls	18.4	18.5	NS	Standing height and weight were measured by trained school nurses using standardized procedures. Standing height was measured using a portable stadiometer. Body mass was measured using a strain gauge scale
	Follow up (6 months)			19.4	19.5		
Haerens 2006	Intervention 1	Boys	2434 adoles- cent boys and girls	19.2	18.5	-	Height and weight were measured in light clothing and bare feet. Weight was assessed to the nearest 0.1 kg, height to the nearest millimeter, using a wall-mounted stadiometer. Standard BMI formula used
		Baseline End of in- tervention (year 2)		20.5	19.7	NS	

(Continued)

	Girls	Baseline	20.2	19.1	-	Intervention 1 = curricula to promote physical activity with parental involvement
		End of intervention (year 2)	21.3	20.8	P < 0.05	Intervention 2 = curricula to promote physical activity with no parental involvement
Intervention 2	Boys	Baseline	19.3	18.5	-	
		End of intervention (year 2)	20.9	19.7	NS	
	Girls	Baseline	20.2	19.1	-	
		End of intervention (year 2)	21.7	20.8	P < 0.05	
Kipping 2008	Baseline	604 boys and girls	17.9	17.7	NA	Height (without shoes) was measured to the nearest 0.1 cm with minimeter height scales. Weight (without heavy clothing) was measured to the nearest 0.1 kg on portable bathroom scales
	End of intervention		NA	NA	P = 0.58 0.10 (95% CI -0.3 to 0.5)	
Kriemler 2010	Baseline	502 boys and girls	17.1	17.0	NA	Standing and sitting height were measured by a wall mounted stadiometer and body weight was determined using an electronic scale
	End of intervention		17.4	17.4	P = 0.003 -0.1 (95% CI -0.2 to -.04)	
Li 2010	Baseline	4120 adolescent boys and girls	17.8	17.7	-	In subgroup analysis a statistically significant difference was observed for girls (-0.19, 95% CI -0.34 to -0.03; P = 0.02), but not for boys (-0.08, 95% CI -0.25 to 0.09; P < 0.37)
	Follow-up 1 year post intervention		+1.6	+1.7	Mean difference -0.1 (95% CI -0.3 to -0.01) P < 0.04	
Luepker 1996	Baseline	4019 boys and girls	17.6	17.6	P = 0.72	Height was measured to the nearest 0.1 cm and weight to the nearest 0.1 kg
	End of intervention (year 3)		22.0	22.1	P = 0.88	

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Martinez 2008	Boys	Baseline	1044 boys and girls	18.4	18.6	P = 0.70	Children were weighed twice to the nearest 0.1 kg in light clothing using a portable electronic scale. Height was measured twice to the nearest 0.1 cm without shoes using a wall-mounted stadiometer. BMI was calculated using the mean of these measurements
		End of intervention (9 months)		18.8	19.0	P = 0.45 0.07 (95% CI -0.1 to 0.3)	
	Girls	Baseline		18.7	18.5	NS	
		End of intervention		18.9	18.8	P = 0.22	
		(9 months)				-0.1 (95% CI -0.3 to 0.1)	
McManus 2008	Intervention 1	Baseline	193 boys and girls	18.2	17.5	-	Body weight was determined using electronic scales. Height was measured barefoot using a fixed stadiometer.
		End of intervention (6 months)		18.5	17.9	NS	
	Intervention 2	Baseline		17.9	17.5	-	
		End of intervention (6 months)		18.0	17.9	NS	
Neu-mark-Sztainer 2009	Baseline	96 boys and girls	NA	NA	NS	Height and weight measures were taken by trained research staff using standardized equipment and procedures. Each child was assessed individually in a private area in the school.	
	End of intervention		21.5	21.7	P = 0.598		
Neu-mark-Sztainer 2010	Baseline	336 adolescent girls	25.9	25.5	-	-	
	Follow-up (5 months post-intervention)		26	26.1	P = 0.446		
Peralta 2009	Baseline	32 boys	22.8	20.4	NS	Height and weight were measured using standardized procedures and used to calculate BMI	
	Follow up (6 months)		23.1	21	P = 0.50		
							0.1 (95% CI -0.8 to 0.4)
Reed 2008	Baseline	514 boys and girls	18.8	19.1	NS	Standing height (without shoes) was measured to the nearest 1 mm (Seca stadiometer Model 242, Hanover, MD). Weight in light	
	End of intervention		19.2	19.4	NS		

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							clothing was measured using an electronic scale (Seca Model 840, Hanover, MD) to the nearest 0.1 kg	
Robinson 1999	Baseline		192 boys and girls	18.4	18.1	-	Height was measured standing using a portable stadiometer and weight was measured using a digital scale	
	End of intervention			18.7	18.8	P < 0.002 -0.5 (95% CI -0.7 to -0.2)		
Salmon 2008	Intervention 1	Baseline	268 boys and girls	NA	NA	NS		Children's weight and height without shoes were measured in private. 2 trained staff members collected children's height and weight at each of the 4 time points. On each occasion, children's height and weight were measured twice and the average reading was used in data analyses.
		Follow up (12 months)		NA	NA	P < 0.05 (BM/FMS) -1.5 (95% CI -2.8 to -0.2)		
	Intervention 2	Baseline		NA	NA	NS	Baseline data available for boys and girls; however, not available for whole sample. Results only available post intervention for whole sample	
		Follow-up (12 months)		NA	NA	P < 0.05 (BM/FMS) -1.5 (95% CI -2.8 to -0.2)		
	Intervention 3	Baseline		NA	NA	NS		
		Follow up (12 months)		NA	NA	P < 0.05 (BM/FMS) -1.5 (95% CI -2.8 to -0.2)		
	Simon 2004	Baseline		954 adolescent males and females	18.7	18.9	-	
		End of intervention (year 4)			21.1	21.3	P < 0.01 -0.3 (95% CI -0.5 to 0.01)	



(Continued)

Singhal 2010	Baseline		201 adolescent boys and girls	NA	NA	-	The difference between the 2 schools 95% CI -0.98 to 0.34
	End of intervention			-0.1	-0.1	NS	
Singh 2009	Boys	Baseline	875 boys and girls	18.2	19.0	NA	Body height was measured and recorded with a portable stadiometer (Seca 225; Seca Deutschland, Hamburg, Germany) with an accuracy of 1 mm. A level was attached to the stadiometer to ensure that head posture was positioned correctly for the measurement. Body weight was measured and recorded within 0.1 kg using a calibrated electronic flat scale (Seca 888; Seca Deutschland), which was leveled after each placement
		End of intervention Follow-up (20 months)		19.4	20.0	NS	
					0.2 (95% CI -0.1 to 0.4)		
	Girls	Baseline		19.0	19.5	NA	
		End of intervention Follow-up (20 months)	20.2	20.9	NS		
					0.2 (95% CI -0.1 to 0.5)		
Stone 2003	End of intervention		1297 boys and girls	19.0 22.0	19.1 22.2	NS	-
Walter 1988	Westchester	Baseline	3388 boys and girls	11.3	11.9	-	Height and weight were measured using a standard medical balance beam-type scale with a rigid vertical height bar
		End of intervention		11.3	12.0	NS	
	Bronx	Baseline	11.8	11.8	-		
		End of intervention	11.9	12.0	NS		
Wang 2008	Baseline		316 boys and girls	19.4	19.3	NS	The biological measurements were made in a mobile laboratory that was brought to the school sites. Weight was measured using a digital weight scale; and height using a stadiometer, were measured twice, and the means were used to calculate BMI
	End of intervention			19.5	19.6	P = 0.18 -0.2 (95% CI -0.4 to 0.1)	
Webber 2008	Baseline		36 schools	20.7	20.9	NS	Standing height was measured without shoes using a portable stadiometer (Shorr Productions) to the nearest 0.1 cm. Body weight was assessed using a digital scale (Seca 880) and measured to the nearest 0.1 kg while the girl was dressed in light clothing without shoes
	End of intervention (year 2)		All girls	22.7	22.9	NS -0.2 (95% CI -0.6 to 0.2)	

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Program Champion– directed intervention (year 3)				22.8	22.7	NS	0.1 (95% CI -0.4 to 0.7)
Weeks 2008	Boys	Baseline	81 boys and girls	20.3	21.5	NS	Subject height and sitting height were measured to the nearest millimeter using the stretch stature method with a portable stadiometer (HART Sport & Leisure)
		End of intervention		20.6	21.9	NS	
	Girls	Baseline		19.5	19.5	NS	Weight was measured to the nearest 0.1 kg using the mean of measures from two sets of digital scales (Soehnle Co.) Results favored controls
		End of intervention		20.3	20.0	P = 0.001	
Williamson 2007	Baseline		586 boys and girls	NA	NA	-	Height and weight of each child participant were measured in normal school clothing, without shoes and socks. Children wore the same style uniforms throughout the study. Height was measured using a stadiometer. Body weight was measured using Tanita (model TBF-310; Tanita Corporation, Arlington Heights, IL) scales that capture body weight and body composition using a laptop computer
	End of intervention (18 months)			NA	NA	P = 0.5458	
Young 2006	Baseline		210 adolescent girls	25.0	25.2	-	-
	End of intervention (1 year)			25.3	25.6	NS	
							P = 0.81
BM: behavioral modification; BMI: body mass index; CI: confidence interval; FMS: fundamental motor skills; g: gram; Kg: kilogram; NA: not acknowledged; NS: not PE: physical education.							

Appendix 12. Fitness level / maximal oxygen consumption (VO₂max - mL/kg/minute)

Characteristic	Measurement period		Study population	Intervention group	Control group	Overall effect	COMMENTS
Study ID							
Barbeau 2007	Baseline		201 girls	21	21	NS	Oxygen consumption (VO ₂) was measured using a Sensormedics Vmax 229 cardiopulmonary system (Yorba Linda, CA). The treadmill protocol began with a 4-min warm up at 0% grade and 2.0 mph. The speed was then increased 0.5 mph every 2 min until reaching 3.0 mph, at which time the grade increased to 2% for 2 min, then increased an additional 3% every 2 min until reaching 20% grade or exhaustion
	End of Intervention			22	21	P = 0.02 1.57 (0.22 to 2.92)	
Bayne-Smith 2004	Baseline		442 girls	35	34	NS	Measured fitness level as recovery from Queens College step test. Subjects stepped up and down a step for 3 min at 22 steps per minute. HRs were counted for 15 seconds beginning at 5 seconds after stepping ended
	End of intervention			37	36	NS	
McManus 2008	Intervention 1	Baseline	193 boys and girls	44	47	NS	Peak oxygen uptake (peak VO ₂) was assessed from a walk-run treadmill test to volitional exhaustion. If maximum was not reached at the end of the running stages, speed was held constant and the gradient increased by 2% each minute until exhaustion. Respiratory gas samples were analyzed using an Oxycon Pro metabolic cart. The system was calibrated before each test with gases of known concentrations. Peak VO ₂ was accepted as a maximal effort when at least 2 of the following were achieved: (i) respiratory exchange ratio over 1.0 (ii) heart-rate within 5% of the age-predicted maximum (iii) leveled heart-rate over the final stages (iv) intense signs of effort such as facial flushing, sweating, hyperpnea
		End of intervention (6 months)		45	46	NS	
	Intervention 2	Baseline		46	47	NS	
		End of intervention (6 months)		47	46	NS	
Trevino 2004	Baseline		1221 students	64	66	NS	Outcome measured as physical fitness score using a modified Harvard step test. Baseline HR was recorded. Child then stepped on and off a stool with both feet for 5 minutes. The student was paced at 30 cycles per minute. A physical fitness score was calculated from the total time of exer-
	End of intervention			66	65	P < 0.04 1.87 (-1.44 to -5.17)	

(Continued)

						cise (in seconds) multiplied by 100 and divided by the sum of 3 HR values measured at 0, 1, and 2 min after exercise
Walther 2009	Baseline	182 boys and girls	38	39	NS	All participants underwent a graded treadmill test with spirometry until exhaustion, according to a modified Bruce protocol for children starting at 1.7 mph and 0 degrees
	End of intervention (year 1)		49	46	P = 0.032 3.7 (0.3 to 7.2)	
Wang 2008	Baseline	316 boys and girls	159	163	NS	The biological measurements were made in a mobile laboratory that was brought to the school sites. Fitness level was assessed by HR at the completion of the bench-stepping test. Low HR at the end of 3-min stepping indicates better CVF
	End of intervention		155	161	P = 0.025 -4.4(-8.2 to -0.6)	
CI: confidence interval; HR: heart rate; NA: not acknowledged; NS: not significant; mph: miles per hour.						

Appendix 13. Pulse rate (beats/minute)

Character- istic	Measuremet period		Study population	Interven- tion group	Control group	Overall ef- fect	Comments
Study ID							
Bush 1989	Baseline		431 boys and girls	3	3	NS	Fitness score determined by taking the mean of pulse rate at 1, 2 and 3 min after exercise and assigning score of 1 to 6 (low to high)
	1st year of intervention			3	3	P = 0.437	
	2nd year intervention			3	3	P = 0.011	
	3rd year intervention			3	3	P = 0.134	
	End of intervention (year 4)			3	3	P = 0.596	
Ewart 1998	Baseline		88 adolescent girls	80	84	NS	Heart rate recorded by a watch mon- itor
	End of intervention			79	84		
Luepker 1996	Baseline		4019 boys and girls	87	87	P = 0.61	5 recordings (1 min apart) were obtained for heart rate after a 5 min rest period using the Dinamap automatic blood pressure device. The average of the last 3 readings was used
	End of intervention (year 3)			80	79	P = 0.03	
McManus 2008	Intervention 1	Baseline	193 boys and girls	83	84	NS	Resting heart-rate was recorded supine and standing using a Polar S810
		End of intervention (6 months)		83	86		
	Intervention 2	Baseline		86	84	NS	
		End of intervention (6 months)		83	86		
Stephens 1998	Intervention 1	Baseline	90 boys and girls	78	76	NS	Pulse rate: resting

(Continued)

		End of intervention		73	81		
	Intervention 2	Baseline		140	144	P < 0.05	Pulse rate: maximal exercise
		End of intervention		125	146		
	Intervention 3	Baseline		108	112	P < 0.05	Pulse rate: recovery
		End of intervention		88	123		
Walter 1988	Baseline	3388	Westchester	79	78	NS	
	End of intervention			78	76		
	Baseline		Bronx	77	77	NS	
	End of intervention			74	75		
CI: confidence interval; NA: not acknowledged; NS: not significant.							

WHAT'S NEW

Date	Event	Description
21 October 2011	New citation required but conclusions have not changed	This update has not impacted the conclusions and recommendations from the original review. One change to note is that the physical health status outcome blood cholesterol level (mg/dL) is no longer statistically significant.
21 October 2011	New search has been performed	Searches run for update period (July 2007 - October 2011); 30 new project accounts identified and included in updated review

HISTORY

Review first published: Issue 1, 2009

Date	Event	Description
29 April 2010	Amended	Change in Scope: Three new relevance criteria added and applied to all included studies: 1) Randomized controlled trial; 2) Intervention implemented for a minimum of 12 weeks; 3) Intervention aimed at general population. This resulted in 12 studies from the original review being excluded from the update: 9 because they were not RCTs (Alexandrov 1988; Berenson 1993; Graf 2005; Klepp 1994; Lionis 1991; Manios 1999; Marcus 1987; Plotnikoff 1999; Sallis 1997); 2 because the intervention was shorter than twelve weeks (Eliakim 1996; Fardy 1996); and 1 because the study sample included overweight or obese children only (Carrel 2005a)
19 January 2010	Amended	Addition of author: RL LaRocca
21 May 2008	Amended	Converted to new review format

CONTRIBUTIONS OF AUTHORS

Maureen Dobbins (MD): as lead author, I oversaw all aspects of the review process. In particular I was responsible for conceiving and designing the review, assisting with the development of the search strategies, screening search results, screening retrieved papers against inclusion criteria, appraising quality of papers, extracting data from papers, analysis of data, interpretation of data, providing a methodological perspective, writing the review.

Heather Husson (HH): undertaking update searches, organizing retrieval of papers, data management, entering data into RevMan, and editing and coordination of the final draft of the update.

Kara Decorby (KD): overall coordination of the original review, and data extraction and review of drafts of this update.

Rebecca Larocca (RL): coordinating the review, screening search results, organizing retrieval of papers, screening retrieved papers against inclusion criteria, appraising quality of papers, extracting data from papers, updating original review new inclusion/exclusion criteria, wrote update section on risk of bias, contributed findings from the searches to the results section.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- No sources of support supplied

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- Cochrane Health Promotion and Public Health Field, Australia.
- City of Hamilton Public Health Services, Canada.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Significant differences between the protocol and review exist including the addition of risk of bias and overview of study population tables. Changes were made to the inclusion criteria after consulting with the Metabolic and Endocrine Disorders Group because of the large number of studies published since 2008. On 11 March 2010, review authors decided to exclude studies that did not provide the intervention to the general population of elementary students. This decision was made because in a number of developed countries more than half of school attending children are overweight. The purpose of this review is to determine if school-based intervention, directed at otherwise healthy children. On 29 April 2010, review authors decided to limit their scope by including only RCTs and studies where the intervention was implemented for a minimum of 12 weeks. Similar criteria have been implemented in recent Cochrane reviews. This resulted in 12 of the 26 studies included in the original review being excluded in this update. In the original review, studies of very poor methodological quality were excluded from the review. In this update, all studies identified for the update meeting the relevance criteria, were included regardless of the level of bias.

INDEX TERMS

Medical Subject Headings (MeSH)

*Health Promotion; *Schools; Exercise [*physiology]; Motor Activity; Physical Fitness [*physiology]; Program Evaluation; Randomized Controlled Trials as Topic

MeSH check words

Adolescent; Child; Humans