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Review

Evaluation of physical activity interventions in children via the reach, efficacy/effectiveness, adoption, implementation, and maintenance (RE-AIM) framework: A systematic review of randomized and non-randomized trials

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ABSTRACT

Context. Existing reviews of physical activity (PA) interventions designed to increase PA behavior exclusively in children (ages 5 to 11 years) focus primarily on the efficacy (e.g., internal validity) of the interventions without addressing the applicability of the results in terms of generalizability and translatability (e.g., external validity).

Objective. This review used the RE-AIM (Reach, Efficacy/Effectiveness, Adoption, Implementation, Maintenance) framework to measure the degree to which randomized and non-randomized PA interventions in children report on internal and external validity factors.

Methods and results. A systematic search for controlled interventions conducted within the past 12 years identified 78 studies that met the inclusion criteria. Based on the RE-AIM criteria, most of the studies focused on elements of internal validity (e.g., sample size, intervention location and efficacy/effectiveness) with minimal reporting of external validity indicators (e.g., representativeness of participants, start-up costs, protocol fidelity and sustainability).

Conclusions. Results of this RE-AIM review emphasize the need for future PA interventions in children to report on real-world challenges and limitations, and to highlight considerations for translating evidence-based results into health promotion practice.

Contents

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Introduction

The importance of physical activity (PA) for health is evident and well-defined (Bailey et al., 2013). The literature suggests that participation in regular PA, especially in childhood, can foster healthy human development and equip individuals and communities with sustainable health promotion and disease prevention practices (Boreham and Riddoch, 2001; Kelder et al., 1994). Unfortunately, global data suggest that the majority of school-aged children (5 to 11 years) and adolescents (12 to 17 years) are not participating in the recommended daily 60 min of moderate-to-vigorous physical activity (MVPA) (Physical Activity Guidelines Advisory Committee, 2008; Tremblay et al., 2011, 2014; WHO, 2010). Self-reported PA data from 39 countries show that only 23% of children aged 11 years met the recommended guidelines (Currie et al., 2012). Therefore, it is important to study the effectiveness and efficacy of different PA interventions in order to develop appropriate programmatic strategies to promote children's PA participation.

To that end, many systemic reviews and meta-analyses of PA interventions have been conducted in young people (Atkin et al., 2011; Brown and Summerbell, 2009; Jago and Baranowski, 2004; Kriemler et al., 2011; Lai et al, 2014; Lonsdale et al., 2013; Lubans et al., 2009; Metcalf et al., 2012; Rees et al., 2006; Salmon et al., 2007; Strong et al., 2005; van Sluijs et al., 2011). However, most of these studies include a broad age range for participants and have made little distinction between the intervention effects on younger (i.e., children) versus older (i.e., adolescents) participants. Further, of the studies that reviewed PA interventions in children exclusively (Biddle et al., 2014; Kellou et al., 2014; Norris et al., 2015; Salmon et al., 2009) or separately from other age groups (Timperio et al., 2004; van Sluijs et al., 2007), all primarily focused on the efficacy/effectiveness (i.e., internal validity) of the interventions by attempting to provide evidence of a causal relationship between intervention strategies and increased PA levels. In so doing, the generalizability and translatability (i.e., external validity) of the results have not been addressed in this population, thereby underscoring the need for research that focuses on the translation of health behavior interventions into practice (Loef and Walach, 2015).

In response to this research–practice gap, Glasgow et al. (1999, 2004) designed the five-dimension RE-AIM (Reach, Efficacy/Effectiveness, Adoption, Implementation, Maintenance) evaluation framework. The RE-AIM model expands assessments of interventions beyond *efficacy/effectiveness*, which addresses the impact of an intervention on important outcomes when tested under optimum conditions (efficacy) or in real-world settings by individuals who are not part of the research team (effectiveness) (Flay, 1986; Glasgow et al., 2003). *Reach* and *Adoption* dimensions address the generalizability of an intervention by respectively considering: (i) the extent to which a sample of participants reflects the entirety of the potentially eligible population; and, (ii) the potential influences of the intervention's site characteristics on the intervention's delivery (Glasgow et al., 1999, 2004). Translatability of an intervention into an applied setting is addressed via the *Implementation* and *Maintenance* dimensions, which jointly consider the extent and fidelity of the intervention, and the costs associated with its delivery and institutionalization (Glasgow et al., 1999, 2004). Collectively, the RE-AIM dimensions form a model that considers the population health impact of an intervention by balancing the emphasis on internal and external validity.

The RE-AIM framework has been successfully applied to a number of health behavior interventions (e.g., obesity prevention) (Duffy et al., 2015; Martínez-Donate et al., 2015; Thomas et al., 2015), and has demonstrated utility in guiding literature reviews focused on assessing the internal and external validity of health promotion intervention research (Akers et al., 2010; Allen et al., 2011; Bellicha et al., 2015; Dzewaltowski et al., 2004; Klesges et al., 2008). More specifically, the RE-AIM framework has been used to guide PA interventions in children (De Meij et al., 2010; Dunton et al., 2009; Janssen et al., 2013; Nigg et al., 2012), adolescents (Jenkinson et al., 2012) and adults (Caperchione et al., 2015; DerAnanian et al., 2012), and to evaluate reviews of PA interventions in adolescents (McGoey et al., 2015) and/or adults (Antikainen and Ellis, 2011; Bellicha et al., 2015; Blackman et al., 2013; White et al., 2009). However, there has yet to be a review of PA interventions in children conducted using the RE-AIM framework. Therefore, the purpose of this article is to present the findings of a RE-AIM review in order to address the following research question: to what extent are randomized and non-randomized PA interventions in children reporting internal and external validity measures. The findings reported herein complement those reported in a previous review (McGoey et al., 2015), which focused on PA interventions in adolescents and similarly assessed their generalizability across settings and populations, and considered variables that may have moderated the interventions' efficacy/effectiveness, such as cost and implementation fidelity (Glasgow et al., 2003, 2004).

Method

Database search and study inclusion

Five electronic databases (PubMed, Nursing and Allied Health Literature, SPORTDiscus, PsycINFO, and Educational Resources Information Center) were searched for articles written in English and published in peer-reviewed journals from January 2003 to January 2015 (see Appendix A for search terms). After removal of duplicate citations and screening of abstracts, 692 full-text articles were assessed. To be eligible: studies had to include a direct comparison between intervention and control/comparison groups, which could be formed by random assignment (experimental) or included in the study as intact units (quasi-experimental); participants had to be 5 to 11 years old (defined as the age range for children in the Canadian Physical Activity Guidelines; Tremblay et al., 2011) and not selected on the basis of having a health problem; and, outcomes had to include a measure of PA participation and/or psychosocial status related to PA behavior change. All intervention settings, strategies, and types of assessment were eligible for inclusion. The final review included 104 articles representing 78 unique interventions (see Fig. 1).

RE-AIM coding and scoring

Two members of the research team independently coded all eligible articles based on the presence (1) or absence (0) of components for each RE-AIM dimension (defined in Table 1). Initial percent agreement was 89.8%, and all discrepancies were resolved by discussion. Following resolution, frequency counts and percentages were recorded for each RE-AIM component, and means were calculated for each RE-AIM indicator using Microsoft Excel 2007.

Results

The characteristics of the reviewed interventions and measured outcomes are summarized in Table 2 and Appendix B.

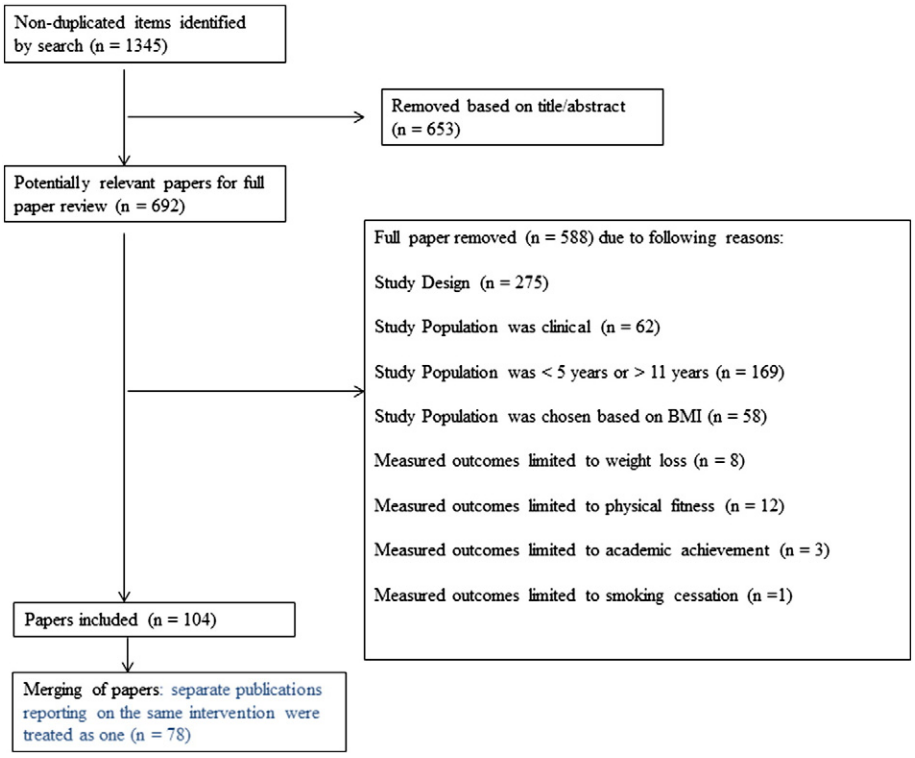

Fig. 1. Selection of physical activity interventions for RE-AIM review.

RE-AIM dimensions and their components

Table 1 summarizes the number and percent of studies reporting on each of the RE-AIM components. The average comprehensiveness of reporting score was 14.2 (ranged from 9 to 20) out of a possible 27 components. The majority of the studies (80.8%) reported on approximately 50% (11 to 17) of the RE-AIM components. Of the remaining studies, five reported on only 35% (9 or 10) and ten reported on more than 65% (18 to 20) of the RE-AIM components.

Reach

Baseline sample sizes ranged from 18 to 2258 (median 319.5) participants. In the cluster RCTs, the number of clusters ranged from 2 to 69 (median 15). All studies reported the age (range = 5 to 11 years) and sex of the participants; most included a racial/ethnic distribution and measures of socioeconomic status (SES) and anthropometry (e.g., weight, height); and some reported characteristics such as language literacy and geographical residence (e.g., urban versus rural). Some of the interventions (38.5%) targeted specific sub-populations (see Table 2) and most were conducted in North America (53.8%) or Western Europe (25.6%).

When reported, participation rate was between 4.3% and 100% (median 76.7%) at the student level and between 12% and 100% (median 44.5%) at the school level. The eight studies that reported on the representativeness of the recruited participants compared with the non-participants found no differences (Cradock et al., 2014; Gortmaker et al., 2012; Grydeland et al., 2013), that participating students were more likely to have been already active (Jurg et al., 2006), or that non-participating schools had lower (Gabriel et al., 2011) or higher (Janssen et al., 2013) enrolment, or were already involved in community-based health initiatives (Rowland et al., 2003). The seventh study (McNeil et al., 2009) was denied access to the non-participant data and was therefore unable to make comparisons.

Efficacy/effectiveness

All reviewed articles included measures of PA participation (52.6%), PA-related psychosocial outcomes (1.3%), or both (42.3%) (see Table 2). PA outcomes (reported most frequently as time engaged in overall PA) were measured in 77 studies, 53 of which reported statistically significant improvements in PA behavior compared with controls. Psychosocial outcomes were measured in 34 of the studies (54.3% were theory- and 28.1% were non-theory-based), 18 of which reported statistically significant improvements. Of the studies that specified an intervention focus, 33 and 12 were identified as effectiveness and efficacy trials, respectively. The remaining 33 were coded as effectiveness trials (n = 23) if they were implemented by regular staff and relied on existing resources and/or procedures, or as efficacy trials (n = 10) if they were implemented by the research staff (Glasgow et al., 2003). The percentage of studies that assessed PA with objective measures (e.g., accelerometers, pedometers, telemeters) alone (40.3%) or in combination with observation or self-report measures (9.1%) was roughly equal to the percentage of studies that assessed PA solely by observation and/or self-/parental-report (50.6%).

Sub-analyses of PA outcomes indicated that study design did not appear to influence results, with 62.5%, 66.7%, and 73.3% of the randomized controlled trials (RCT), cluster RCT, and non-randomized trials reporting significant findings, respectively. Similarly, the percentages of studies reporting significant findings were comparable for effectiveness (70.9%) and efficacy (63.6%) trials, as well as for studies that did (72.4%) and did not (66.7%) target sub-populations. However, the PA measure used, as well as the intervention setting and strategy did appear to influence measured outcomes. Of the interventions that used objective measures (alone or in combination with self-report or observation), 78.9% reported significant differences in PA levels between experimental and control groups, compared with 59% of those that relied solely on observation and/or self-/parental-report.

Table 1
Proportion of physical activity interventions reporting RE-AIM dimensions and components (n = 78 interventions).

Dimension Component[a]	Number reporting	Percent reporting[d]
Reach		
Method to identify target population	73	93.6
Inclusion criteria	78	100.0
Exclusion criteria	24	30.8
Sample size	78	100.0
Participation rate	58	74.4
Characteristics of participants	78	100.0
Characteristics of non-participants	8	10.3
Efficacy/effectiveness		
Measures and results	78	100.0
Intent-to-treat analysis utilized	19	24.4
Presence of psychosocial measures[b]	37	47.4
Participant attrition	62	79.5
Baseline activity reported[b]	64	82.0
Theory-based[b]	46	59.0
Adoption		
Description of intervention location[c]	77	98.7
Description of staff delivering intervention[c]	76	97.4
Methods used to identify staff	8	10.3
Level of expertise of staff	58	74.4
Inclusion/exclusion criteria for setting and staff	0	0.0
Adoption rate	1	1.3
Characteristics of adoption/non-adoption	1	1.3
Start-up costs	12	15.4
Implementation		
Type, frequency, intensity of intervention	78	100.0
Extent to which protocol was delivered	47	60.3
Cost of delivery	15	19.2
Maintenance		
Assessed outcomes ≥ 6 months post-intervention	10	12.8
Current status of program/policy	17	21.8
Cost of maintenance[c]	5	6.4

[a] Components were derived from a reliable extraction tool (Akers et al., 2010; Dzewaltowski et al., 2004; Estabrooks et al., 2002; Glasgow et al., 2004) that was developed based on the RE-AIM framework, unless otherwise indicated.
[b] Components were included to ensure relevancy with the behavior (PA) and population (children) under review.
[c] Components were informed by other RE-AIM reviews of health behavior interventions (Allen et al., 2011; Blackman et al., 2013).
[d] Based on a denominator of 78 interventions.

Considering intervention setting, school-based studies (n = 62) were the most successful, with 69.3% of the studies reporting significant positive PA outcomes. Of these, the extra-curricular interventions delivered after-school and/or during recess (n = 17) were most promising, with 82.3% of the studies showing significant differences between intervention and control groups. The school-based interventions that included policy strategies and/or community and family linkages (multi-level) (n = 27) and those that were curriculum-based (n = 18) were also relatively successful, with 63% and 66.7% of the studies, respectively, reporting significant results. For the interventions that were performed in a community- and/or family-based setting (n = 15), 66.7% reported statistically significant differences in PA outcomes. Examining intervention strategy, of the school-based interventions that included playground markings, 83.3% reported significant findings. Across setting types, the use of computer-based implementation tools (n = 3) was unanimously effective, with one delivered as curricular interactive animated lessons (Goran and Reynolds, 2005) and two delivered in the form of exergaming during recess (Gao and Xiang, 2014) or at home (Mark and Rhodes, 2013).

Slightly more than half of the interventions (59%) were theory-based, most of which applied one or more of the following theories: social cognitive theory (SCT) (Bandura, 1998), the theory of planned behavior (TPB) (Ajzen, 1991), and social–ecological models (SEM) (McLeroy et al., 1988; Stokols, 1992). The SCT was the most frequently referenced theory and was applied either alone (n = 15) or in combination with another theory (n = 13). The TPB and a SEM each singularly informed four studies, and were combined with each other in one study, and with the SCT in one and four studies, respectively. Of the 46 theory-based studies, 69.6% reported significant findings in measured PA and/or psychosocial outcomes, compared with 68.7% of the 32 non-theory-based studies. Studies that combined theories (n = 15) did not appear to be more or less successful than those using only one (n = 31), with 66.7% and 71% reporting significant findings, respectively. Of the studies that used the TPB or SCT (alone and in combination with other theories), 71.4% and 67.9% reported significant outcomes, respectively. Comparatively, 88.9% of the studies using a SEM (alone and in combination with other theories) reported significant outcomes.

Attrition data were provided in 79.5% of the studies, with a median attrition rate of 14%. Reasons for attrition included participant absence or re-location and improper use of the assessment tool (e.g., pedometer malfunction). Some of the highest attrition rates (>35%) occurred when the intervention was delivered in a community or family setting, while all of the lowest attrition rates (< 5%) occurred in school-based interventions.

Adoption

At the setting level, all of the studies specified the location of the study site, except for one (Chen et al., 2010), which simply identified as family-based. The percentage and representativeness of the settings that adopted the intervention program were reported in one study (Janssen et al., 2013), which cited a 90% adoption rate, and specified that the decision to adopt was discussed with teachers first, rather than made top-down by administration. No studies included information on why the locations were selected.

At the staff level, all but two of the studies described the intervention's delivery agent, which included on-site staff (e.g., teachers) (60.5%), the research staff (10.5%), experts or trained staff (e.g., fitness specialist) (10.5%), or a combination thereof (18.5%). The studies that did not specify a delivery agent examined the effects of the school play environment on student PA levels (Loucaides et al., 2009; Wood et al., 2014). When specified, the level of expertise of the staff was pre-existing (n = 8), and/or was augmented through the provision of intervention-specific training, support and/or resources (n = 55). When reported, start-up costs were associated with assessment tools, delivery agents (training of/salary for), and equipment acquisition. Two interventions (Erwin et al., 2011; Grydeland et al., 2013) were reportedly designed to not require any additional resources relating to facilities, space or equipment.

Implementation

All studies described the intervention and documented its duration, which ranged from a single session (n = 3) to one or more (max = 6) school years (n = 36). Fidelity of implementation was reported in 60.3% of the studies, 17 of which included process evaluations, and was either considered a non-issue (i.e., protocol was deliberately flexible) (n = 2), or was influenced by staff adherence to protocol (n = 16) or training (n = 2), student attendance/participation (n = 7), scheduling or technical barriers (e.g., equipment malfunction) (n = 3), and differences in implementation across study sites (n = 1). Implementation cost data were collected in four studies, and were either not reported (Cradock et al., 2014; Kipping et al., 2014), or were itemized as participant remuneration (Chen et al., 2010) and required resources (Erwin et al., 2011). Four studies indicated that they received funding for implementation (Coleman et al., 2005; Janssen et al., 2013; Kelder et al., 2005; Stratton and Mullan, 2005), and seven were designed to be either low-cost (Chin and Ludwig, 2013; Gortmaker et al., 2012; Harrison et al., 2006;

Table 2
Intervention characteristics of studies reviewed.

Intervention (+ companion publications)[a]	Int. setting + strategy[b]	Int. length (weeks)[c]	Int. focus	PA measure	Targeted sub-population	Sig. outcomes[d]	
						PA[e]	PS[f]
Cluster randomized controlled trials (51.3% of studies)							
Angelopoulos et al. (2009)[a,1]	III[b,3]	48	Effect[l]	S-R	Low SES	Yes	NM
Butcher et al. (2007)	II	1	Effect[2]	Ped	No	Yes	NM
Caballero et al. (1998)[a,2]	III[b,3]	96	Effect[1]	S-R	Rural A. Indian communities	Yes°[1]	Yes
Christodoulos et al. (2006)	III	32	Effect[2]	S-R	No	Yes	Yes
Efrat (2013)	II	6	Effic[2]	Acc	No	No	NM
Fairclough et al. (2013)	I[b,3]	20	Effect[2]	Acc	Low SES	Yes	NM
French et al. (2005)	IV[b,3]	104	Effic[2]	S-R	♀s	No	NM
Gentile et al. (2009)	III[b,3]	32	Effect[2]	Ped	No	No	NM
Goran and Reynolds (2005)	III[b,2]	8	Effic[1]	Acc	No	Yes°[2]	Yes
Grydeland et al. (2013)[a,3]	III[b,3]	80	Effect[2]	Acc	No	Yes	Yes
Hands et al. (2011)	V	24	Effic[2]	P-R	No	Yes°[2]	NM
Horne et al. (2009)	I	14	Effic[1]	Ped	No	Yes	NM
Huberty et al. (2014)[a,4]	II[b,1]	32	Effect[1]	Acc, PAO	No	Yes°[5]	NM
Kain et al. (2014)	III[b,3]	48	Effect[1]	Ped	No	No□	NM
Keihner et al. (2011)	I[b,3]	8	Effect[2]	N/A	Low SES	NM	Yes
Kipping et al. (2014)[a,5]	III[b,3]	32	Effect[1]	Acc	No	No	NM
Kiran and Knights (2010)	I	12	Effect[1]	S-R	No	No	No
Levy et al. (2012)	III[b,3]	24	Effect[1]	S-R	No	No	Yes
Loucaides et al. (2009)	II[b,1]	4	Effect[1]	Ped	No	Yes	NM
Magnusson et al. (2011)	I[b,3]	64	Effect[2]	Acc	No	Yes°[3,4]	NM
Mahar et al. (2006)	I	12	Effect[1]	Ped	No	Yes	NM
McNeil et al. (2009)	III	44	Effect[1]	S-R	Low SES	Yes	No
Meyer et al. (2014)[a,6]	I	32	Effect[1]	Acc	No	Yes	No
Michaud et al. (2012)	I	12	Effect[1]	S-R	No	Yes	NM
Muth et al. (2008)	I[b,3]	12	Effect[1]	S-R	Rural area	No	No
Naylor et al. (2008)[a,7]	III	44	Effect[2]	S-R, Ped	No	Yes°[1,8]	NM
Olvera et al. (2010)[a,8]	V[b,3]	12	Effic[1]	Acc	♀s (Latina)	No	NM
Pangrazi et al. (2003)	I	12	Effect[1]	Ped	No	Yes°[2]	NM
Rosenkranz et al. (2010)	IV + V[b,3]	16	Effect[1]	S-R, Acc	♀s	Yes°[5]	NM
Rowland et al. (2003)	III	32	Effic[2]	P-R	No	No	NM
Salmon et al. (2005)[a,9]	I	36	Effect[1]	Acc	Low SES	Yes	Yes
Salmon et al. (2011)	I	7	Effect[1]	S-R	Low SES	No	No
Spiegel and Foulk (2006)	III[b,3]	24	Effect[1]	S-R	No	No	NR
Trost et al. (2009)	IV	4	Effic[1]	Ped	No	Yes	No
Verstraete et al. (2007a)[a,10]	III	64	Effect[2]	S-R, PAO	No	Yes°°	No
Verstraete et al. (2006)	II	12	Effic[2]	Acc	No	Yes	NM
Wen et al. (2008)	III	64	Effect[1]	S-R, P-R	No	Yes°[9]	NM
Williamson et al. (2007)	III[b,3]	64	Effic[1]	S-R	No	No□	No[d]
Wilson et al. (2011)	II	17	Effic[1]	Acc	Low SES	Yes°[4]	Yes°[4]
Yıldırım et al. (2013)	III[b,1]	72	Effect[2]	Acc	No	Yes°[4]	Yes°[2,4]
Non-randomized trials with a comparison group (38.5% of studies)							
Barr-Anderson et al. (2012)	III[b,3]	6	Effect[2]	S-R	Low SES	Yes°[2]	NM
Boyle-Holmes et al. (2010)	I	64	Effect[2]	S-R	No	Yes°[7]	Yes
Chin and Ludwig (2013)	II	12	Effect[2]	PAO	No	Yes	NM
Coleman et al. (2005)	III[b,3]	96	Effect[2]	PAO	Low SES	Yes	NM
Cradock et al. (2014)	III	12	Effect[2]	Acc	No	Yes	NM
Digelidis et al. (2003)	I	32	Effect[2]	S-R	No	No	Yes
Erwin et al. (2011)	I	32	Effect[2]	Ped	No	Yes	NM
Farley et al. (2007)	IV	104	Effect[2]	PAO	Low SES	Yes	NM
Gabriel et al. (2011)	II	12	Effic[2]	S-R	♀s	Yes	Yes
Gao and Xiang (2014)	II[b,2]	36	Effic[2]	S-R	Low SES	Yes	NM
Gorely et al. (2009)	III[b,3]	40	Effect[2]	Ped	No	Yes°°	No
Gortmaker et al. (2012)	IV[b,3]	24	Effect[1]	Acc	No	Yes	NM
Harrison et al. (2006)	I	16	Effic[1]	S-R	Low SES	Yes	Yes
Herbert et al. (2013)	III[b,3]	12	Effect[1]	S-R	No	No	NM
Herrick et al. (2012)	II	20	Effect[1]	S-R, Acc	Low SES	No	Yes
Janssen et al. (2011)[a,11]	II	32	Effect[1]	PAO	Low SES	Yes	NM
Jordan et al. (2008)	I[a,3]	32	Effect[1]	S-R	No	No	NR
Jurg et al. (2006)[a,12]	III	32	Effect[1]	S-R	Low SES	Yes°[7]	Yes
Kafatos et al. (2007)[a,13]	III[b,3]	192	Effect[1]	S-R	Rural	Yes	NM
Kelder et al. (2005)	IV[b,3]	20	Effect[1]	PAO	No	Yes	No
Kelly et al. (2012)	II[b,1]	6	Effect[1]	PAO, Acc	Low SES	No	NM
Pate et al. (2003)	III	72	Effect[1]	S-R	Rural, low SES	No	No
Puma et al. (2013)	I[b,3]	64	Effect[1]	S-R	Rural	No	No
Ridgers et al. (2007)	II[b,1]	<1	Effect[1]	Acc	Low SES	Yes	NM
Sharpe et al. (2011)	IV	32	Effect[2]	PAO	No	No	NM
Stratton and Mullan (2005)	II[b,1]	<1	Effect[2]	Tel	Low SES	Yes	NM
Taylor et al. (2007)[a,14]	III[b,3]	64	Effect[1]	S-R, Acc	No	Yes°[4,5]	NM
van Beurden et al. (2003)	I	32	Effect[2]	PAO	No	Yes	NM
Wilson et al. (2005)	II	4	Effic[2]	Acc	Low SES	Yes	Yes
Wood et al. (2014)	II	2	Effect[2]	Acc	No	Yes	No
Randomized controlled trials (10.2% of studies)							

Table 2 (*continued*)

Intervention (+ companion publications)[a]	Int. setting + strategy[b]	Int. length (weeks)[c]	Int. focus	PA measure	Targeted sub-population	Sig. outcomes[d]	
						PA[e]	PS[f]
Armitage and Sprigg (2010)	II	<- 1	Effic[2]	S-R	Low SES	Yes	Yes
Chen et al. (2010)	V[b,3]	8	Effic[1]	Ped	Chinese A.	Yes	Yes
Hovell et al. (2009)	V[b,3]	8	Effic[2]	S-R	No	No	NM
Mark and Rhodes (2013)	V[b,2]	6	Effect[1]	S-R	No	Yes	NM
Morgan et al. (2011)	V[b,3]	12	Effic[1]	Ped	No	Yes	NM
Morrison et al. (2013)	V	10	Effic[1]	S-R, Acc	No	No	No
Roemmich et al. (2004)	V	6	Effic[1]	Acc	No	Yes	NM
Warren et al. (2003)	III[b,3]	32	Effic[1]	S-R	No	No	NM

Int. intervention, *PA*: physical activity, *PS*: psychosocial, *PE*: physical education, *Sig*: statistically significant, *NM*: not measured/not compared with a control or comparison group, *NR*: not reported, *PAO*: physical activity observation, *S-R*: self-report, *Acc*: accelerometer, *Ped*: pedometer, *Tel*: telemeter, *P-R*: parental-report, *SES*: socioeconomic status, *A*: American.

Effect = effectiveness; *Effic* = efficacy ([1]specified in study; [2]coded by researcher).

[I] : school-based (curricular), *II*: school-based (extra-curricular), *III*: school-based (multi-level), *IV*: community-based, *V*: family-based.

[□] Not adequately powered to detect statistically significant differences or statistical significance not specified.

[°] only for: [1]S-R data; [2]♀s; [3]♂s; [4]mid-point data; [5]Acc data; [6]sedentary children, [7]select age groups, [8]♂s Ped data, [9]P-R data. °sub-sample measured with ([1]Acc) ([2]Ped) did not have significant outcomes.

[°°] sub-sample(s) measured with Acc also had significant outcomes.

[a] Interventions with separate publications in which additional outcomes were measured: ([1]Angelopoulos et al., 2006) ([2]Caballero et al., 2003; Davis et al., 2003; Stevens et al., 2003; Stone et al., 2003; Teufel et al., 1999; Going et al., 2003; Steckler et al., 2003) ([3]Bergh et al., 2012; Lien et al., 2010) ([4]Huberty et al., 2011) (Lawlor et al., 2011, 2013) ([6]Kriemler et al., 2010; Zahner et al., 2006) ([7]Naylor et al., 2006) ([8]Olvera et al., 2008) ([9]Salmon et al., 2006, 2008) ([10]Verstraete et al., 2007b; Cardon et al., 2009) ([11]Janssen et al., 2013) ([12]De Meij et al., 2010, 2011) ([13]Manios and Kafatos, 2006) ([14]Taylor et al., 2006).

[b] Intervention strategy ([1] included the use of playground markings) ([2]incorporated computer-based delivery) ([3]targeted both PA and dietary behavior).

[c] 32 weeks = 1 school year; 64 weeks = 2 school years; 96 weeks = 3 school years; 128 weeks = 4 school years, 4 weeks = 1 month.

[d] Yes = primary PA and/or PS measure reported a statistically significant difference compared with a control or comparison condition.

[e] PA context (with output measures) include: leisure time PA (measured via the implementation of school travel plans and percentage of students who walked to and from school, in minutes of MVPA/day, as percentage of time spent in MVPA on the playground or during girl scout troop meeting, number of children outdoors and physically active, usage of exercise equipment, and steps/min); overall PA participation (measured in steps/day, daily counts/min and minutes of accumulated MVPA, MPA and/or VPA, frequency of engagement in organized sport activities, and energy expenditure in METS); recess PA levels (measured in counts/min, as percentage of students engaged in VPA, percentage of time spent in MVPA, VPA and/or LPA, energy expenditure in METS, and steps/min); and, in-school PA levels (measured in minutes spent in bouts of VPA, counts/min, and steps/day).

[f] measured outcomes include: PA-based knowledge, self-efficacy, enjoyment, intentions, attitude, outcome expectancy, motivation, self-esteem, and perceptions of social support from teachers, school environment, advantage of regular PA, and individual PA levels.

Loucaides et al., 2009), or to not incur any extra costs (Grydeland et al., 2013; Salmon et al., 2008; Verstraete et al., 2007a).

Maintenance

Most studies followed up immediately post-intervention (74.3%), some within 6 months (16.7%), and the remaining at least 9 months (max = 4 years) following completion of the intervention (9%). When follow-up measures were collected immediately or between 2 weeks and 6 months post-intervention, the same percentage of studies (69%) indicated that significant differences between experimental and control conditions were maintained, compared with only 42.8% of those that reported follow-up measures after 6 months post-intervention. The current status of the intervention was indicated in 17 of the studies; four of which are either works-in-progress (Herbert et al., 2013; Yıldırım et al., 2013) or being followed-up with a companion study (Horne et al., 2009; Morrison et al., 2013). Of the remaining, three have not been continued (Kelder et al., 2005; Kiran and Knights, 2010; Meyer et al., 2014), five were already (Cradock et al., 2014; Gabriel et al., 2011), or have developed into (Jordan et al., 2008; McNeil et al., 2009; Pangrazi et al., 2003) ongoing programs or policies, and five are currently (as of the date of each publication) being implemented at additional sites (Chin and Ludwig, 2013; Coleman et al., 2005; Gortmaker et al., 2012; Jurg et al., 2006; Muth et al., 2008). The cost of maintenance was referenced in five studies, of which one itemized the annual total implementation costs (Cradock et al., 2014), three indicated that their PA program received ongoing funding/support (Chin and Ludwig, 2013; Janssen et al., 2013; Jurg et al., 2006), and one acknowledged that the cost would make the intervention unsustainable (Warren et al., 2003).

Discussion

This study used the RE-AIM framework to systematically review the degree to which randomized and non-randomized PA interventions in children report on internal and external validity factors. The results indicate that, on average, studies reported on 52.6% of the RE-AIM components, the majority of which are related to internal validity. A shared characteristic of the studies that reported on more than 65% of the RE-AIM components was a recent publication date (2013 or later), which suggests that the importance of reporting on external validity factors is gaining recognition among researchers in this field; however, the significance of this finding is controverted by the concurrent finding that not all recently published studies scored highly on RE-AIM component reporting. Further, those reviewed studies with a common purpose of replicating a PA intervention in a different setting/with a different population (Coleman et al., 2005; Herrick et al., 2012; Kelder et al., 2005; Sharpe et al., 2011; Verstraete et al., 2007a,b) were not more likely to report on RE-AIM components, highlighting that the reporting of translation-relevant data is not necessarily linked to study purpose, but rather represents a comprehensive gap in the literature.

Reach

Reach was the most consistently reported RE-AIM dimension across all studies, with sample size, characteristics of the participants, and inclusion criteria specified for each study. However, consistent with past research in the field of PA promotion (Blackman et al., 2013; McGoey et al., 2015; White et al., 2009), very few studies indicated the degree to which their study samples were representative of the larger population. Without data on the

characteristics of the external population from which the study samples were drawn, it is difficult to generalize the findings to populations with different demographic, economic and/or behavioral characteristics. For example, one of the reviewed studies that did examine the representativeness of the study sample found that participating children were more likely to have been already active (Jurg et al., 2006). Although high-risk groups were targeted in a few of the studies, the reporting of non-participant data, across all studies, is crucial for ensuring that PA interventions for children are designed to address the needs of subgroups that are most in need (e.g., those at risk for obesity).

Efficacy/effectiveness

Intervention outcomes (PA and/or psychosocial) were reported with unanimous consistency across studies. This was expected since it was an inclusion criterion for study selection and is the focus of most efficacy/effectiveness studies (Flay, 1986). Almost half of the studies reviewed for this paper relied solely on objective PA measures. By contrast, similar studies conducted with adolescents were less likely to use only objective (16%) and more likely (73%) to use only self-report PA measures (McGoey et al., 2015). Potential reasons for the increased frequency of use of objective measures in children could be related to concerns surrounding their ability to accurately recall PA, thus introducing limitations to the self-report measure (Cale, 1994; Sallis, 1991).

Systematic reviews have reported that the outcomes of PA interventions in children range from negligible (Timperio et al., 2004; van Sluijs et al., 2007) to inconclusive (Norris et al., 2015) to positive (Biddle et al., 2014; Kellou et al., 2014; Salmon et al., 2009). Results from the present review support positive findings, with 68.8% of the reviewed studies reporting statistically significant improvements in intervention children's PA behavior compared with controls. The high percentage of positive effects found across studies may be overestimated due to (i) the use of broad inclusion criteria for study selection; and, (ii) the degree to which attrition was considered in follow-up analyses within the reviewed studies. The focus of this review was on the quality of reporting across the RE-AIM dimensions; therefore, leniencies in study selection were conceded in order to ensure a broad representation of how intervention strategies are being implemented with children. Comprehensive consideration of how individual study quality may have influenced its relative statistical significance, such as analyses of effect sizes and risks of biases (e.g., publication bias, selection bias, reporting bias), were beyond the scope and purpose of this paper. Regarding follow-up analyses, only 19 of the studies reported using intent-to-treat analyses while the remaining studies either did not specify or limited study results to those participants who were present at follow-up, which introduces a potential bias in generalizability of the findings.

Previous reviews conducted with children and/or youth have indicated that school-based interventions that target individuals while involving families and/or the community had a greater potential to increase PA levels of the students (Kellou et al., 2014; McGoey et al., 2015). Results from this review support the efficacy/effectiveness of this intervention setting and further highlight the potential leadership role of schools in the provision and promotion of daily PA for young people (Pate et al., 2006). The most successful setting in this review was after-school and/or during recess, and the use of playground markings and computer-based implementation tools (e.g., exergaming) were successful intervention strategies across settings. Collectively, and consistent with recently published research (Gao et al., 2015), the data reviewed herein suggest that recess and exergaming provide more effective opportunities for children to accumulate daily PA at school, compared with curriculum-based programs. Suggested reasons for the success of recess may be related to time spent outdoors, which is positively associated with children's PA (Cleland et al., 2008; Gray et al., 2015; Sallis et al., 2000; Schaefer et al., 2014). For exergaming, data suggest that it has a strong motivational power due to the appealing effect of technology for children (Sun, 2012); however, reviews of the relevant literature have concluded that there is currently insufficient evidence to recommend exergaming as a sustainable means of contributing to daily PA (Biddiss and Irwin, 2010; LeBlanc et al., 2013).

The literature proposes that theory-based PA interventions are more successful than atheoretical approaches in both adults (Antikainen and Ellis, 2011) and adolescents (McGoey et al., 2015); however, the results from the present review are less convincing, with theory-based and atheoretical studies being equally successful. Comparing the results from this review with those from McGoey et al (2015) indicates that PA interventions in children in comparison with adolescents are less likely to be informed by a theory (78% versus 59% for adolescents and children, respectively), and are much less likely to report on psychosocial measures (70% versus 47.4% for adolescents and children, respectively) (McGoey et al., 2015). The latter is consistent with findings reported by Sallis et al (2000), who indicated that the paucity of data surrounding psychosocial measures in children may be a reflection of their developing cognitive abilities, which can influence the accuracy of self-reported measures such as those used to assess theory-based constructs (Cale, 1994; Saunders et al., 1997; Wallander et al., 2001).

Structuring study design on a theoretical framework has been argued to promote an understanding of causal mechanisms when studying complex behavior change such as regular participation in PA (Baranowski et al., 1998; Michie et al., 2009). Further, as potential mediators of behavior change, psychosocial variables such as self-efficacy and outcome expectancy (Brown et al., 2013; Sallis et al., 2000) are relevant measures that could inform how interventions are affecting PA behavior in children. Since this type of information could be used to adapt interventions to different settings and populations, it would facilitate the dissemination of interventions and increase the likelihood of widespread implementation. Collectively, these findings support those of a recent systemic review of school-based PA interventions in children and adolescents (Lai et al., 2014), which concluded that future research examining the effectiveness of different theoretical constructs as mediators of change in PA levels in children is needed.

Adoption

Descriptions of both the intervention location and the staff delivering the intervention were well reported in the reviewed studies; however, consistent with other RE-AIM reviews (Akers et al., 2010; Antikainen and Ellis, 2011; Blackman et al., 2013; Dzewaltowski et al., 2004; Klesges et al., 2008; McGoey et al., 2015), transparency surrounding the methods used to identify settings and staff was lacking, which makes it difficult to determine which types of delivery agents may be suitable based on the interventions' strategies.

Further, characteristics of intervention sites that agree to adopt the program, as well as the costs associated with start-up, are of significant interest to future program development. For example, some interventions reported findings or design characteristics that promote translatability, including no start-up costs (Erwin et al., 2011; Grydeland et al., 2013), the use of on-site delivery agents without requiring additional training (Gorely et al., 2009; Salmon et al., 2011; Stratton and Mullan, 2005), and effective communication among those involved in the program's delivery (Janssen et al., 2013). Future reporting of such findings/characteristics will add to the evidence base and ultimately

promote adoption of PA interventions for children across a variety of contexts.

Implementation

Intervention duration was consistently reported across studies, with eight lasting less than 5 weeks in duration, and the remaining equally distributed (approximately 45% in each group) between those that were implemented for at least one school year and those that were shorter than a school year but at least 5 weeks. Of these three categories, the studies of shortest duration were the most successful, with 100% of them reporting significant intervention effects on PA levels compared with controls. Most of these interventions were delivered either entirely (Loucaides et al., 2009; Stratton and Mullan, 2005; Ridgers et al., 2007; Wilson et al, 2005; Wood et al., 2014) or partially (Butcher et al., 2007) during recess or after-school. For each of the other intervention length categories (5 weeks to <1 school year and ≥1 school year), approximately 65% of the studies reported significant differences between groups, suggesting that sustained contact does not influence behavior change in children. These data do not support findings that sustained contact over a prolonged period of time (at least 1 school year) may increase the likelihood of positive behavior change (Lai et al., 2014; McGoey et al., 2015); rather, they provide an evidence base for the use of recess and/or after-school periods in children's PA interventions of short duration (<5 weeks). In their review of PA interventions targeting young girls, Biddle et al (2014) also reported that interventions of short duration (<12 weeks) were more effective, citing decreased motivation and increased boredom over time as potential reasons for the finding.

Consistent with some RE-AIM evaluations of behavior change interventions (McGoey et al., 2015; White et al., 2009), but in contrast to others (Allen et al., 2011; Antikainen and Ellis, 2011; Blackman et al., 2013; Klesges et al., 2008), the majority of the reviewed studies herein reported information on the fidelity of protocol implementation. For example, RE-AIM process evaluations (De Meij et al., 2010; Janssen et al., 2013) have been published for two of the reviewed studies (Jurg et al., 2006; Janssen et al., 2011), and based on reported facilitators and barriers, the researchers were able to make informed recommendations towards improving program content and organization for future implementation. However, although they both applied the RE-AIM framework, only one of the interventions (Janssen et al., 2011, 2013), along with only eight of the other reviewed studies, mentioned the cost associated with program delivery, making it one of the least reported components among the RE-AIM dimensions.

Of the successful school-based studies, two (Coleman et al., 2005; Gorely et al., 2009) reported that the protocol was deliberately flexible, and three (Grydeland et al., 2013; Salmon et al., 2008; Verstraete et al., 2007a) were designed to not incur any additional costs. The goal in each study was to promote wider-spread dissemination of the intervention. These strategies, which ease program implementation by limiting reliance on external support, were also associated with many of the successful school-based PA interventions targeting adolescents (McGoey et al., 2015).

Maintenance

As is supported by the data herein, RE-AIM evaluations of PA interventions have consistently ranked maintenance as the least reported dimension (Antikainen & Ellis, 2011; Blackman et al., 2013; McGoey et al., 2015; White et al., 2009). For the present review, 52 of the 78 studies did not report on any of the maintenance components, making it difficult to assess the cost of continued delivery and institutionalization of the interventions. This paucity of data, which includes a lack of follow-up measures, is reflective of the fact that most of the studies did not have a goal to achieve and track maintained delivery, and means that the reported significant differences in PA levels can only be considered short term benefits. As is consistent with the general consensus among recent reviews of PA interventions in children, studies need to conduct long-term follow-ups beyond post-intervention to assess behavior maintenance (Biddle et al., 2014; Kellou et al., 2014; Norris et al., 2015).

For this review, the studies that conducted follow-up analyses immediately or within the first 6 months post-intervention indicated similar outcomes; however, longer-term follow-ups indicated a drop in behavior change maintenance. These findings suggest recidivism of positive PA behavior change in children, and suggest that accurate measurements of maintenance should occur after 6 months post-intervention.

Conclusions reached herein reflect the degree to which the reviewed studies reported on specific RE-AIM components. Recognizing that editorial criteria may limit the extent to which researchers report on issues of external validity, it is possible that some of these data have been collected, but not reported. In an effort to address this possibility, all available publications for each intervention were included in this review; however, a lack of reporting on an outcome cannot be equated to a lack of measurement, and it is possible that not all publications related to the interventions were recovered. Further, there was considerable heterogeneity across interventions due to different PA contexts and output measures (see Appendix B), which makes it difficult to develop a comprehensive understanding of the successful elements of the PA interventions.

Conclusion

Systematic reviews of PA interventions in children (Biddle et al., 2014; Kellou et al., 2014; Salmon et al., 2009) have highlighted an existing need for future interventions to evaluate indicators of external validity (Glasgow et al., 2004), and to study mediators of behavior change (Michie et al., 2009), thereby matching successful intervention strategies to population, setting and other contextual characteristics. To address this need, this review used the RE-AIM framework to expand the assessment of PA interventions in children beyond efficacy/effectiveness. Results of this RE-AIM review parallel those reported in a previous review that focused on adolescents (McGoey et al., 2015) and emphasize the need for future PA interventions in children to report on real-world challenges and limitations. The data provide evidence that, in children, extra-curricular school-based interventions of short duration are successful, and that long-term follow-up measures should be collected more than 6 months post-intervention. However, conclusions drawn from reviewing evidence can only reflect the data that are available (Rychetnik et al., 2012), and due to an underreporting of the representativeness of participants and settings, adoption rates, and costs associated with start-up, implementation and maintenance, there is currently not enough information for future users to adapt programs to different populations and settings. Therefore, in order to comprehensively address promotion of PA in children, the relevance of research findings needs to be increased and expanded to include these elements of external validity.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

Appendix A. Search terms

For each database, the following search terms were used: (physical activity OR fitness OR exercise OR physical education OR sport OR running) AND (random OR controlled OR trial OR clinical OR intervention) AND (programs OR strategy OR initiative OR promotion OR curriculum) AND (effectiveness OR sustainability OR feasibility OR implementation) AND (child OR youth OR juvenile OR boy OR girl).

Appendix B. Intervention characteristics: PA output measures and their context

PA output measure	Context of measured PA			
	Overall (e.g., weekdays and weekends) n = 39 (61.5% reported significant outcomes)	In-school n = 9 (88.9% reported significant findings)		Leisure Time (e.g., after-school) n = 17 (64.7% reported significant outcomes)
		Class-based only n = 4 (75% reported significant findings)	Recess only n = 8 (87.5% reported significant findings)	
PA frequency n = 12 (50% reported significant outcomes)	n = 7 (Caballero et al., 1998[a]; Gabriel et al., 2011[a]; Herbert et al., 2013; Kiran and Knights, 2010; Levy et al., 2012; Puma et al., 2013; Warren et al., 2003)		n = 1 (Chin and Ludwig, 2013[a])	n = 4 (Armitage and Sprigg, 2010[a]; Digelidis et al., 2003; Farley et al., 2007[a]; McNeil et al., 2009[a])
Counts per minute n = 7 (57.1% reported significant outcomes)	n = 4 (Grydeland et al., 2013[a]; Morrison et al., 2013; Olvera et al., 2010; Taylor et al., 2007[a])	n = 3 (Kelly et al., 2012; Magnusson et al., 2011[a]; Meyer et al., 2014[a])		
Steps (per day, unless otherwise specified) n = 10 (90% reported significant outcomes)	n = 6 (Butcher et al., 2007[a]; Chen et al., 2010[a]; Gentile et al., 2009; Horne et al., 2009[a]; Morgan et al., 2011[a]; Pangrazi et al., 2003[a])	n = 2 (Erwin et al., 2011[a]; Mahar et al., 2006[a])	n = 1 (Loucaides et al., 2009 [per minute][a])	n = 1 (Trost et al., 2009 [per minute][a])
PA duration and intensity (reported as: time engaged in PA, exercise, or specific intensity of PA; or, percent of time engaged in specific intensity of PA) n = 41 (73.2% reported significant outcomes)	n = 19 (Barr-Anderson et al., 2012[a]; Cradock et al., 2014[a]; Fairclough et al., 2013[a]; Goran and Reynolds, 2005[a]; Gorely et al., 2009[a]; Gortmaker et al., 2012[a]; Hands et al., 2011[a]; Harrison et al., 2006[a]; Hovell et al., 2009; Jurg et al., 2006[a]; Kipping et al., 2014; Muth et al., 2008; Roemmich et al., 2004[a]; Salmon et al., 2005[a]; Salmon et al., 2011; Spiegel and Foulk, 2006; Wilson et al., 2011[a]; Wilson et al., 2005[a]; Williamson et al., 2007)	n = 4 (Coleman et al, 2005[a]; Kain et al., 2014; van Beurden et al., 2003[a]; Verstraete et al., 2007a,b[a]) n = 4 (Michaud et al., 2012[a]; Naylor et al., 2006[a]; Verstraete et al., 2006[a]; Yıldırım et al., 2013[a])	n = 5 (Efrat, 2013; Huberty et al., 2014[a]; Ridgers et al., 2007[a]; Stratton and Mullan, 2005[a]; Wood et al., 2014[a])	n = 9 (Angelopoulos et al., 2006[a]; Christodoulos et al., 2006[a]; Herrick et al., 2012; Kafatos et al., 2007[a]; Kelder et al., 2005[a]; Mark and Rhodes, 2013[a]; Pate et al., 2003; Rosenkranz et al., 2010[a]; Sharpe et al., 2011)
Active transportation n = 3 (33.3% reported significant outcomes)				n = 3 (Jordan et al., 2008; Rowland et al., 2003; Wen et al., 2008[a])
Energy expenditure (METS) n = 4 (75% reported significant outcomes)	n = 3 (Boyle-Holmes et al., 2010[a]; French et al., 2005; Gao and Xiang, 2014[a])		n = 1 (Janssen et al., 2011[a])	

METS: metabolic equivalents.
[a]Reported a statistically significant difference compared with a control or comparison condition.

References

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. 50, 179–211.

Akers, J.D., Estabrooks, P.A., Davy, B.M., 2010. Translational research: bridging the gap between long-term weight loss maintenance research and practice. J. Am. Diet. Assoc. 110, 1511–1522.

Allen, K., Zoellner, J., Motley, M., Estabrooks, P.A., 2011. Understanding the internal and external validity of health literacy interventions: a systematic literature review using the RE-AIM framework. J. Health Commun. 16, 55–72.

Angelopoulos, P.D., Milionis, H.J., Moschonis, G., Manios, Y., 2006. Relations between obesity and hypertension: preliminary data from a cross-sectional study in primary schoolchildren: the children study. Eur. J. Clin. Nutr. 60, 1226–1234.

Angelopoulos, P.D., Milionis, H.J., Grammatikaki, E., Moschonis, G., Manios, Y., 2009. Changes in BMI and blood pressure after a school based intervention: the children study. Eur. J. Pub. Health 19, 319–325.

Antikainen, I., Ellis, R., 2011. A RE-AIM evaluation of theory-based physical activity interventions. J. Sport Exerc. Psychol. 33, 198–214.

Armitage, C.J., Sprigg, C.A., 2010. The roles of behavioral and implementation intentions in changing physical activity in young children with low socioeconomic status. J. Sport Exerc. Psychol. 32, 359–376.

Atkin, A.J., Gorely, T., Biddle, S.J.H., Cavill, N., Foster, C., 2011. Interventions to promote physical activity in young people conducted in the hours immediately after school: a systematic review. Int. J. Behav. Med. 18, 176–187.

Bailey, R., Hillman, C., Arent, S., Petitpas, A., 2013. Physical activity: an underestimated investment in human capital? J. Phys. Act. Health 10, 289–308.

Bandura, A., 1998. Health promotion from the perspective of social cognitive theory. Psychol. Health 13, 623–649.

Baranowski, T., Anderson, C., Carmack, C., 1998. Mediating variable framework in physical activity interventions. How are we doing? How might we do better? Am. J. Prev. Med. 15, 266–297.

Barr-Anderson, D., Laska, M.N., Veblen-Mortenson, S., Farbakhsh, K., Dudovitz, B., Story, M., 2012. A school-based, peer leadership physical activity intervention for 6th graders: feasibility and results of a pilot study. J. Phys. Act. Health 9, 492–499.

Bellicha, A., Kieusseian, A., Fontvieille, A.M., Tataranni, A., Charreire, H., Oppert, J.M., 2015. Stair-use interventions in worksites and public settings—a systematic review of effectiveness and external validity. Prev. Med. 70, 3–13.

Bergh, I.H., Bjelland, M., Grydeland, M., et al., 2012. Mid-way and post-intervention effects on potential determinants of physical activity and sedentary behavior, results of the HEIA study — a multi-component school-based randomized trial. Int. J. Behav. Nutr. Phys. Act. 9, 63.

Biddiss, E., Irwin, J., 2010. Active video games to promote physical activity in children and youth: a systematic review. Arch. Pediatr. Adolesc. Med. 164, 664–672.

Biddle, S.J., Braithwaite, R., Pearson, N., 2014. The effectiveness of interventions to increase physical activity among young girls: a meta-analysis. Prev. Med. 62, 119–131.

Blackman, K.C., Zoellner, J., Berrey, L.M., et al., 2013. Assessing the internal and external validity of mobile health physical activity promotion interventions: a systematic literature review using the RE-AIM framework. J. Med. Internet Res. 15, e224.

Boreham, C., Riddoch, C., 2001. The physical activity, fitness and health of children. J. Sports Sci. 19, 915–929.

Boyle-Holmes, T., Grost, L., Russell, L., et al., 2010. Promoting elementary physical education: results of a school-based evaluation study. Health Educ. Behav. 37, 377–389.
Brown, T., Summerbell, C., 2009. Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence. Obes. Rev. 10, 110–141.
Brown, H., Hume, C., Pearson, N., Salmon, J., 2013. A systematic review of intervention effects on potential mediators of children's physical activity. BMC Public Health 13, 165–175.
Butcher, Z., Fairclough, S., Stratton, G., Richardson, D., 2007. The effect of feedback and information on children's pedometer step counts at school. Pediatr. Exerc. Sci. 19, 29–38.
Caballero, B., Davis, S., Davis, C.E., et al., 1998. Pathways: a school-based program for the primary prevention of obesity in American Indian children. J. Nutr. Biochem. 9, 535–543.
Caballero, B., Clay, T., Davis, S.M., et al., 2003. Pathways: a school-based, randomized controlled trial for the prevention of obesity in American Indian schoolchildren. Am. J. Clin. Nutr. 78, 1030–1038.
Cale, L., 1994. Self-report measures of children's physical activity: recommendations for future development and a new alternative measure. Health Educ. J. 53, 439–453.
Caperchione, C.M., Duncan, M., Kolt, G.S., et al., 2015. Examining an Australian physical activity and nutrition intervention using RE-AIM. Health Promot. Int. 1, 9.
Cardon, G.M., Haerens, L.L., Verstraete, S., de Bourdeaudhuij, I., 2009. Perceptions of a school-based self-management program promoting an active lifestyle among elementary schoolchildren, teachers, and parents. J. Teach. Phys. Educ. 28, 141–154.
Chen, J., Weiss, S., Heyman, M.B., Lustig, R.H., 2010. Efficacy of a child-centred and family-based program in promoting healthy weight and healthy behaviors in Chinese American children: a randomized controlled study. J. Public Health 32, 219–229.
Chin, J.J., Ludwig, D., 2013. Increasing children's physical activity during school recess periods. Am. J. Public Health 103, 1229–1234.
Christodoulos, A.D., Douda, H.T., Polykratis, M., Tokmakidis, S.P., 2006. Attitudes towards exercise and physical activity behaviours in greek schoolchildren after a year long health education intervention. Br. J. Sports Med. 40, 367–371.
Cleland, V., Crawford, D., Baur, L.A., Hume, C., Timperio, A., Salmon, J., 2008. A prospective examination of children's time spent outdoors, objectively measured physical activity and overweight. Int. J. Obes. 32, 1685–1693.
Coleman, K.J., Tiller, C.L., Sanchez, J., et al., 2005. Prevention of the epidemic increase in child risk of overweight in low-income schools: the El Paso coordinated approach to child health. Arch. Pediatr. Adolesc. Med. 159, 217–224.
Cradock, A.L., Barrett, J.L., Carter, J., et al., 2014. Impact of the Boston Active School Day Policy to promote physical activity among children. Am. J. Health Promot. S54–S64.
Currie, C., Zanotti, C., Morgan, A., et al., 2012. Social Determinants of Health and Well-being Among Young People. Health Behaviour in School-aged Children (HBSC) Study: International Report From the 2009/2010 Survey. World Health Organization, Copenhagen URL: www.hbsc.org/publications/international.
Davis, S.M., Clay, T., Smyth, M., et al., 2003. Pathways curriculum and family interventions to promote healthful eating and physical activity in American Indian schoolchildren. Prev. Med. 37, S24–S34.
De Meij, J.S.B., Chinapaw, M.J.M., Kremers, S.P.J., Van der wal, M.F., Jurg, M.E., Van Machelen, W., 2010. Promoting physical activity in children: the stepwise development of the primary school-based JUMP-in intervention applying the RE-AIM evaluation framework. Br. J. Sports Med. 44, 879–887.
De Meij, J.S., Chinapaw, M.J., van Stralen, M.M., van der Wal, M.F., van Dieren, L., vanMechelen, W., 2011. Effectiveness of JUMP-in, a Dutch primary school-based community intervention aimed at the promotion of physical activity. Br. J. Sports Med. 45, 1052–1057.
DerAnanian, C.A., Desai, P., Smith-Ray, R., Seymour, R.B., Hughes, S.L., 2012. Perceived versus actual factors associated with adoption and maintenance of an evidence-based physical activity program. Transl. Behav. Med 2, 209–217.
Digelidis, N., Papaioannou, A., Laparidis, K., Christodoulidis, T., 2003. A one-year intervention in 7th grade physical education classes aiming to change motivational climate and attitudes towards exercise. Psychol. Sport Exerc. 4, 195–210.
Duffy, S.A., Ewing, L.A., Louzon, S.A., Ronis, D.L., Jordan, N., Harrod, M., 2015. Evaluation and costs of volunteer telephone cessation follow-up counseling for Veteran smokers discharged from inpatient units: a quasi-experimental, mixed methods study. Tob. Induc. Dis. 13, 1–8.
Dunton, G.F., Lagloire, R., Robertson, T., 2009. Using the RE-AIM framework to evaluate the statewide dissemination of a school-based physical activity and nutrition curriculum: "exercise your options". Am. J. Health Promot. 23, 229–232.
Dzewaltowski, D.A., Estabrooks, P.A., Klesges, L.M., Bull, S., Glasgow, R.E., 2004. Behavior change intervention research in community settings: how generalizable are the results? Health Promot. Int. 19, 235–245.
Efrat, M.W., 2013. Exploring effective strategies for increasing the amount of moderate-to-vigorous physical activity children accumulate during recess: a quasi-experimental intervention study. J. Sch. Health 83, 265–272.
Erwin, H.E., Beighle, A., Morgan, C.F., Noland, M., 2011. Effect of a low-cost, teacher-directed classroom intervention on elementary students' physical activity. J. Sch. Health 81, 455–461.
Estabrooks, P., Dzewaltowski, D.A., Glasgow, R.E., Klesges, L.M., 2002. School-based health promotion: issues related to translating research into practice. J. Sch. Health 73, 21–28.
Fairclough, S.J., Hackett, A.F., Davies, I.G., et al., 2013. Promoting healthy weight in primary school children through physical activity and nutrition education: a pragmatic evaluation of the CHANGE! randomised intervention study. BMC Public Health 13, 1–14.
Farley, T.A., Meriwether, R.A., Baker, E.T., Watkins, L.T., Johnson, C.C., Webber, L.S., 2007. Safe play spaces to promote physical activity in inner-city children: results from a pilot study of an environmental intervention. Am. J. Public Health 97, 1625–1631.
Flay, B.R., 1986. Efficacy and effectiveness trials (and other phases of research) in the development of health promotion programs. Prev. Med. 15, 451–474.
French, S.A., Story, M., Fulkerson, J.A., et al., 2005. Increasing weight-bearing physical activity and calcium-rich foods to promote bone mass gains among 9-11 year old girls: outcomes of the cal-girls study. Int. J. Behav. Nutr. Phys. Act. 2 (8-8).
Gabriel, K.K.P., DeBate, R.D., High, R.A., Racine, E.F., 2011. Girls on the run: a quasi-experimental evaluation of a developmentally focused youth sport program. J. Phys. Act. Health 8, S285–S294.
Gao, Z., Xiang, P., 2014. Effects of exergaming based exercise on urban children's physical activity participation and body composition. J. Phys. Act. Health 11, 992–998.
Gao, Z., Chen, S., Stodden, D.F., 2015. A comparison of children's physical activity levels in physical education, recess and exergaming. J. Phys. Act. Health 12, 349–354.
Gentile, D.A., Welk, G., Eisenmann, J.C., et al., 2009. Evaluation of a multiple ecological level child obesity prevention program: switch what you do, view, and chew. BMC Med. 7, 49.
Glasgow, R.E., Vogt, T.M., Boles, S.M., 1999. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. Am. J. Public Health 89, 1322–1327.
Glasgow, R.E., Lichtenstein, E., Marcus, A., 2003. Why don't we see more translation of health promotion research to practice? Rethinking the efficacy to effectiveness transition. Am. J. Public Health 93, 1261–1267.
Glasgow, R.E., Klesges, L.M., Dzewaltowski, D.A., Bull, S.S., Estabrooks, P., 2004. The future of health behavior change research: what is needed to improve translation of research into health promotion practice? Ann. Behav. Med. 27, 3–12.
Going, S., Thompson, J., Cano, S., et al., 2003. The effects of the Pathways Obesity Prevention Program on physical activity in American Indian children. Prev. Med. 37, S62–S69.
Goran, M.I., Reynolds, K., 2005. Interactive multimedia for promoting physical activity (IMPACT) in children. Obes. Res. 13, 762–771.
Gorely, T., Nevill, M.E., Morris, J.G., Stensel, D.J., Nevill, A., 2009. Effect of a school-based intervention to promote healthy lifestyles in 7-11 year old children. Int. J. Behav. Nutr. Phys. Act. 6, 5.
Gortmaker, S.L., Lee, R.M., Mozaffarian, R.S., et al., 2012. Effect of an after-school intervention on increases in children's physical activity. Med. Sci. Sports Exerc. 44, 450–457.
Gray, C., Gibbons, R., Larouche, R., et al., 2015. What is the relationship between outdoor time and physical activity, sedentary behaviour, and physical fitness in children? A systematic review. Int. J. Environ. Res. Public Health 12, 6455–6474.
Grydeland, M., Bergh, I.H., Bjelland, M., et al., 2013. Intervention effects on physical activity: the HEIA study — a cluster randomized controlled trial. Int. J. Behav. Nutr. Phys. Act. 10, 17–29.
Hands, B., Larkin, D., Rose, E., Parker, H., Smith, A., 2011. Can young children make active choices? Outcomes of a feasibility trial in seven-year-old children. Early Child Dev. Care 181, 625–637.
Harrison, M., Burns, C.F., McGuinness, M., Heslin, J., Murphy, N.M., 2006. Influence of a health education intervention on physical activity and screen time in primary school children: 'switch off—get active'. J. Sci. Med. Sport 9, 388–394.
Herbert, P.C., Lohrmann, D.K., Seo, D., Stright, A.D., Kolbe, L.J., 2013. Effectiveness of the Energize Elementary School Program to improve diet and exercise. J. Sch. Health 83, 780–786.
Herrick, H., Thompson, H., Kinder, J., Madsen, K.A., 2012. Use of SPARK to promote after-school physical activity. J. Sch. Health 82, 457–461.
Horne, P.J., Hardman, C.A., Lowe, C.F., Rowlands, A.V., 2009. Increasing children's physical activity: a peer modelling, rewards and pedometer-based intervention. Eur. J. Clin. Nutr. 63, 191–198.
Hovell, M.F., Nichols, J.F., Irvin, V.L., et al., 2009. Parent/child training to increase preteens' calcium, physical activity, and bone density: a controlled trial. Am. J. Health Promot. 24, 118–128.
Huberty, J.L., Siahpush, M., Beighle, A., Fuhrmeister, E., Silva, P., Welk, G., 2011. Ready for recess: a pilot study to increase physical activity in elementary school children. J. Sch. Health 81, 251–257.
Huberty, J.L., Beets, M.W., Beighle, A., Saint-Maurice, P.F., Welk, G., 2014. Effects of ready for recess, an environmental intervention, on physical activity in third-through sixth-grade children. J. Phys. Act. Health 11, 384–395.
Jago, R., Baranowski, T., 2004. Non-curricular approaches for increasing physical activity in youth: a review. Prev. Med. 39, 157–163.
Janssen, M., Toussaint, H.M., Van Willem, M., Verhagen, E.A., 2011. PLAYgrounds: effect of a PE playground program in primary schools on PA levels during recess in 6 to 12 year old children. Design of a prospective controlled trial. BMC Public Health 11, 282.
Janssen, M., Toussaint, H.M., van Mechelen, W., Verhagen, E.A., 2013. Translating the PLAYgrounds program into practice: a process evaluation using the RE-AIM framework. J. Sci. Med. Sport 16, 211–216.
Jenkinson, K.A., Naughton, G., Benson, A., 2012. The GLAMA (Girls! Lead! Achieve! Mentor! Activate!) physical activity and peer leadership intervention pilot project: a process evaluation using the RE-AIM framework. BMC Public Health 12, 55–69.
Jordan, K.C., Erickson, E.D., Cox, R., et al., 2008. Evaluation of the Gold Medal Schools program. J. Am. Diet. Assoc. 108, 1916–1920.
Jurg, M.E., Kremers, S., Candel, M., MF, Meij, J., 2006. A controlled trial of a school-based environmental intervention to improve physical activity in Dutch children: JUMP-in, kids in motion. Health Promot. Int. 21, 320–330.
Kafatos, I., Manios, Y., Moschandreas, J., Kafatos, A., 2007. Health and nutrition education program in primary schools of Crete: changes in blood pressure over 10 years. Eur. J. Clin. Nutr. 61, 837–845.
Kain, J., Concha, F., Moreno, L., Leyton, B., 2014. School-based obesity prevention intervention in Chilean children: effective in controlling, but not reducing obesity. J. Obes. 2014, 8 pages (Article ID 618293).

Keihner, A.J., Meigs, R., Sugerman, S., Backman, D., Garbolino, T., Mitchell, P., 2011. The "power play! campaign's school idea & resource kits" improve determinants of fruit and vegetable intake and physical activity among fourth- and fifth-grade children. J. Nutr. Educ. Behav. 43, S122–S129.
Kelder, S.H., Perry, C.L., Klepp, K.I., Lytle, L.L., 1994. Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. Am. J. Public Health 84, 1121–1126.
Kelder, S., Hoelscher, D.M., Barroso, C.S., Walker, J.L., Cribb, P., Hu, S., 2005. The CATCH kids club: a pilot after-school study for improving elementary students' nutrition and physical activity. Public Health Nutr. 8, 133–140.
Kellou, N., Sandalinas, F., Copin, N., Simon, C., 2014. Prevention of unhealthy weight in children by promoting physical activity using a socio-ecological approach: what can we learn from intervention studies? Diabetes Metab. 40, 258–271.
Kelly, A., Arjunan, P., van d., P., Rissel, C., Borg, J., Li, M.W., 2012. The implementation of a pilot playground markings project in four Australian primary schools. Health Promot. J. Austr. 23, 183–187.
Kipping, R.R., Howe, L.D., Jago, R., et al., 2014. Effect of intervention aimed at increasing physical activity, reducing sedentary behaviour, and increasing fruit and vegetable consumption in children: Active for Life Year 5 (AFLY5) school based cluster randomised controlled trial. BMJ 348, g3256.
Kiran, A., Knights, J., 2010. Traditional indigenous games promoting physical activity and cultural connectedness in primary schools — cluster randomised control trial. Health Promot. J. Austr. 21, 149–151.
Klesges, L.M., Dzewaltowski, D.A., Glasgow, R.E., 2008. Review of external validity reporting in childhood obesity prevention research. Am. J. Prev. Med. 34, 216–223.
Kriemler, S., Zahner, L., Schindler, C., et al., 2010. Effect of school based physical activity programme (KISS) on fitness and adiposity in primary schoolchildren: cluster randomised controlled trial. BMJ 340, c785.
Kriemler, S., Meyer, U., Martin, E., Van Sluijs, E.M.F., Andersen, L.B., Martin, B.W., 2011. Effect of school-based interventions on physical activity and fitness in children and adolescents: a review of reviews and systematic update. Brit. J. Sports Med. 45, 923–930.
Lai, S.K., Costigan, S.A., Morgan, P.J., et al., 2014. Do school-based interventions focusing on physical activity, fitness, or fundamental movement skill competency produce a sustained impact in these outcomes in children and adolescents? A systematic review of follow-up studies. Sports Med. 44, 67–79.
Lawlor, D.A., Jago, R., Noble, S.M., et al., 2011. The Active for Life Year 5 (AFLY5) school based cluster randomised controlled trial: study protocol for a randomized controlled trial. Trials 12, 181.
Lawlor, D.A., Peters, T.J., Howe, L.D., Noble, S.M., Kipping, R.R., Jago, R., 2013. The Active for Life Year 5 (AFLY5) school-based cluster randomised controlled trial protocol detailed statistical analysis plan. Trials 14, 21.
LeBlanc, A.G., Chaput, J.P., McFarlane, A., et al., 2013. Active video games and health indicators in children and youth: a systematic review. PLoS One 8, e65351.
Levy, S.T., Morales Ruán, C., Amaya Castellanos, C., Salazar Coronel, A., Jiménez Aguilar, A., Méndez Gómez Humarán, I., 2012. Effectiveness of a diet and physical activity promotion strategy on the prevention of obesity in Mexican school children. BMC Public Health 12, 152.
Lien, N., Bjelland, M., Bergh, I.H., et al., 2010. Design of a 20-month comprehensive, multicomponent school-based randomised trial to promote healthy weight development among 11–13 year olds: the HEalth In Adolescents study. Scand. J. Public Health 38, 38–51.
Loef, M., Walach, H., 2015. How applicable are results of systematic reviews and meta-analyses of health behaviour maintenance? A critical evaluation. Public Health 129, 377–384.
Lonsdale, C., Rosenkranz, R.R., Peralta, L.R., Bennie, A., Fahey, P., Lubans, D.R., 2013. A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. Prev. Med. 56, 152–161.
Loucaides, C.A., Jago, R., Charalambous, I., 2009. Promoting physical activity during school break times: piloting a simple, low cost intervention. Prev. Med. 48, 332–334.
Lubans, D.R., Morgan, P.J., Tudor-Locke, C., 2009. A systematic review of studies using pedometers to promote physical activity among youth. Prev. Med. 48, 307–315.
Magnusson, K.T., Sigurgeirsson, I., Sveinsson, T., Johannsson, E., 2011. Assessment of a two-year school-based physical activity intervention among 7–9-year-old children. Int. J. Behav. Nutr. Phys. Act. 8, 138.
Mahar, M.T., Murphy, S.K., Rowe, D.A., Golden, J., Shields, A.T., Raedeke, T.D., 2006. Effects of a classroom-based program on physical activity and on-task behavior. Med. Sci. Sports Exerc. 38, 2086–2094.
Manios, Y., Kafatos, A., 2006. Health and nutrition education in primary schools in Crete: 10 years' follow-up of serum lipids, physical activity and macronutrient intake. Br. J. Nutr. 95, 568–575.
Mark, R.S., Rhodes, R.E., 2013. Testing the effectiveness of exercise videogame bikes among families in the home-setting: a pilot study. J. Phys. Act. Health 10, 211–221.
Martínez-Donate, A.P., Riggall, A.J., Meinen, A.M., et al., 2015. Evaluation of a pilot healthy eating intervention in restaurants and food stores of a rural community: a randomized community trial. BMC Public Health 15, 136.
McGoey, T., Root, Z., Bruner, M.W., Law, B., 2015. Evaluation of physical activity interventions in youth via the Reach, Efficacy/Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework: a systematic review of randomised and non-randomised trials. Prev. Med. 76, 58–67.
McLeroy, K.R., Bibeau, D., Steckler, A., Glanz, K., 1988. An ecological perspective on health promotion programs. Health Educ. Quart. 15, 351–377.
McNeil, D.A., Wilson, B.N., Siever, J.E., Ronca, M., Mah, J.K., 2009. Connecting children to recreational activities: results of a cluster randomized trial. Am. J. Health Promot. 23, 376–387.
Metcalf, B., Henley, W., Wilkin, T., 2012. Effectiveness of intervention on physical activity of children: systematic review and meta-analysis of controlled trials with objectively measured outcomes (EarlyBird 54). Brit. Med. J. 345 (e5888), 1–11.
Meyer, U., Schindler, C., Zahner, L., et al., 2014. Long-term effect of a school-based physical activity program (KISS) on fitness and adiposity in children: a cluster-randomized controlled trial. PLoS One 9, e87929.
Michaud, V., Nadeau, L., Martel, D., Gagnon, J., Godbout, P., 2012. The effect of team pentathlon on ten- to eleven-year-old childrens' engagement in physical activity. Phys. Educ. Sport Pedagog. 17, 543–562.
Michie, S., Fixsen, D., Grimshaw, J.M., Eccles, M.P., 2009. Specifying and reporting complex behaviour change interventions: the need for a scientific method. Implement. Sci. 4, 1–6.
Morgan, P.J., Lubans, D.R., Callister, R., et al., 2011. The 'Healthy Dads, Healthy Kids' randomized controlled trial: efficacy of a healthy lifestyle program for overweight fathers and their children. Int. J. Obes. 35, 436–447.
Morrison, R., Reilly, J.J., Penpraze, V., et al., 2013. Children, parents and pets exercising together (CPET): exploratory randomised controlled trial. BMC Public Health 13, 1096.
Muth, N.D., Chatterjee, A., Williams, D., Cross, A., Flower, K., 2008. Making an IMPACT: effect of a school-based pilot intervention. N. C. Med. J. 69, 432–440.
Naylor, P., Macdonald, H.M., Zebedee, J.A., Reed, K.E., McKay, H.A., 2006. Lessons learned from Action Schools! BC — An 'active school' model to promote physical activity in elementary schools. J. Sci. Med. Sport 9, 413–423.
Naylor, P., Macdonald, H.M., Warburton, D.E.A., Reed, K.E., McKay, H.A., 2008. An active school model to promote physical activity in elementary schools: Action schools! BC. Br. J. Sports Med. 42, 338–343.
Nigg, C., Geller, K., Adams, P., Hamada, M., Hwang, P., Chung, R., 2012. Successful dissemination of Fun 5 — a physical activity and nutrition program for children. Transl. Behav. Med. 2, 276–285.
Norris, E., Shelton, N., Dunsmuir, S., Duke-Williams, O., Stamatakis, E., 2015. Physically active lessons as physical activity and educational interventions: a systematic review of methods and results. Prev. Med. 72, 116–125.
Olvera, N.N., Knox, B., Scherer, R., et al., 2008. A healthy lifestyle program for latino daughters and mothers: the BOUNCE overview and process evaluation. Am. J. Health Educ. 39, 283–295.
Olvera, N., Bush, J.A., Sharma, S.V., Knox, B.B., Scherer, R.L., Butte, N.F., 2010. BOUNCE: a community-based mother–daughter healthy lifestyle intervention for low-income Latino families. Obes. J. 18, S102–S104.
Pangrazi, R.P., Beighle, A., Vehige, T., Vack, C., 2003. Impact of promoting lifestyle activity for youth (PLAY) on children's physical activity. J. Sch. Health 73, 317–321.
Pate, R.R., Saunders, R.P., Ward, D.S., Felton, G., Trost, S.G., Dowda, M., 2003. Evaluation of a community-based intervention to promote physical activity in youth: lessons from active winners. Am. J. Health Promot. 17, 171–182.
Pate, R.R., Davis, M.G., Robinson, T.N., Stone, E.J., McKenzie, T.L., Young, J.C., 2006. Promoting physical activity in children and youth a leadership role for schools: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Physical Activity Committee) in collaboration with the councils on Cardiovascular Disease in the Young and Cardiovascular Nursing. Circulation 114, 1214–1224.
Physical Activity Guidelines Advisory Committee, 2008. Physical Activity Guidelines Advisory Committee Report, 2008. Department of Health and Human Services, Washington, D.C., USA.
Puma, J., Romaniello, C., Crane, L., Scarbro, S., Belansky, E., Marshall, J.A., 2013. Long-term student outcomes of the Integrated Nutrition and Physical Activity Program. J. Nutr. Educ. Behav. 45, 635–642.
Rees, R., Kavanagh, J., Harden, A., et al., 2006. Young people and physical activity: a systematic review matching their views to effective interventions. Health Educ. Res. 21, 806–825.
Ridgers, N.D., Stratton, G., Fairclough, S.J., Twisk, J., 2007. Long-term effects of a playground markings and physical structures on children's recess physical activity levels. Prev. Med. 44, 393–397.
Roemmich, J.N., Gurgol, C.M., Epstein, L.H., 2004. Open-loop feedback increases physical activity of youth. Med. Sci. Sports Exerc. 36, 668–673.
Rosenkranz, R.R., Behrens, T.K., Dzewaltowski, D.A., 2010. A group-randomized controlled trial for health promotion in Girl Scouts: healthier troops in a SNAP (Scouting Nutrition & Activity Program). BMC Public Health 10, 81.
Rowland, D., DiGuiseppi, C., Gross, M., Afolabi, E., Roberts, I., 2003. Randomised controlled trial of site specific advice on school travel patterns. Arch. Dis. Child. 88, 8–11.
Rychetnik, L., Bauman, A., Laws, R., et al., 2012. Translating research for evidence-based public health: key concepts and future directions. J. Epidemiol. Community Health 66, 1187–1192.
Sallis, J.F., 1991. Self-report measures of children's physical activity. J. Sch. Health 61, 215–219.
Sallis, J.F., Prochaska, J.J., Taylor, W.C., 2000. A review of correlates of physical activity of children and adolescents. Med. Sci. Sports Exerc. 32, 963–975.
Salmon, J., Ball, K., Crawford, D., et al., 2005. Reducing sedentary behaviour and increasing physical activity among 10-year-old children: overview and process evaluation of the 'Switch-Play' intervention. Health Promot. Int. 20, 7–17.
Salmon, J., Hume, C., Ball, K., Booth, M., Crawford, D., 2006. Individual, social and home environment determinants of change in children's television viewing: the Switch-Play intervention. J. Sci. Med. Sport. 9, 378–387.
Salmon, J., Booth, M.L., Phongsavan, P., Murphy, N., Timperio, A., 2007. Promoting physical activity participation among children and adolescents. Epidemiol. Rev. 29, 144–159.
Salmon, J., Ball, K., Hume, C., Booth, M., Crawford, D., 2008. Outcomes of a group-randomized trial to prevent excess weight gain, reduce screen behaviours and promote physical activity in 10-year-old children: switch-play. Int. J. Obes. (Lond) 32, 601–612.
Salmon, J., Brown, H., Hume, C., 2009. Effects of strategies to promote children's physical activity on potential mediators. Int. J. Obes. 33, S66–S73.
Salmon, J., Jorna, M., Hume, C., et al., 2011. A translational research intervention to reduce screen behaviours and promote physical activity among children: Switch-2-Activity. Health Promot. Int. 26, 311–321.

Saunders, R.P., Pate, R.R., Felton, G., et al., 1997. Development of questionnaires to measure psychosocial influences on children's physical activity. Prev. Med. 26, 241–247.
Schaefer, L., Plotnikoff, R.C., Majumdar, S.R., et al., 2014. Outdoor time is associated with physical activity, sedentary time, and cardiorespiratory fitness in youth. J. Pediatr. 165, 516–521.
Sharpe, E.K., Forrester, S., Mandigo, J., 2011. Engaging community providers to create more active after-school environments: results from the Ontario CATCH Kids Club implementation project. J. Phys. Act. Health 8, S26–S31.
Spiegel, S.A., Foulk, D., 2006. Reducing overweight through a multidisciplinary school-based intervention. Obesity 14, 88–96.
Steckler, A., Ethelbah, B., Martin, C.J., et al., 2003. Pathways process evaluation results: a school-based prevention trial to promote healthful diet and physical activity in American Indian third, fourth, and fifth grade students. Prev. Med. 37, S80–S90.
Stevens, J., Story, M., Ring, K., Murray, D.M., Cornell, C.E., Juhaeri Gittelsohn, J., 2003. The impact of the Pathways intervention on psychosocial variables related to diet and physical activity in American Indian schoolchildren. Prev. Med. 37, S70–S79.
Stokols, D., 1992. Establishing and maintaining healthy environments: toward a social ecology of health promotion. Am. Psychol. 47, 6–22.
Stone, E.J., Norman, J.E., Davis, S.M., et al., 2003. Design, implementation, and quality control in the Pathways American-Indian multicenter trial. Prev. Med. 37, S13–S23.
Stratton, G., Mullan, E., 2005. The effect of multicolor playground markings on children's physical activity level during recess. Prev. Med. 41, 828–833.
Strong, W.B., Malina, R.M., Blimkie, C.J.R., et al., 2005. Evidence based physical activity for school-age youth. J. Pediatr. 146, 732–737.
Sun, H., 2012. Exergaming impact on physical activity and interest in elementary school children. Res. Q. Exerc. Sport 83, 212–220.
Taylor, R.W., McAuley, K.A., Williams, S.M., Barbezat, W., Nielsen, G., Mann, J.I., 2006. Reducing weight gain in children through enhancing physical activity and nutrition: the APPLE project. Int. J. Pediatr. Obes. 1, 146–152.
Taylor, R.W., McAuley, K.A., Barbezat, W., Strong, A., Williams, S.M., Mann, J.I., 2007. APPLE Project: 2-y findings of a community-based obesity prevention program in primary school age children. Am. J. Clin. Nutr. 86, 735–742.
Teufel, N.I., Perry, C.L., Story, M., et al., 1999. Pathways family intervention for third-grade American Indian children. Am. J. Clin. Nutr. 69, 803S–809S.
Thomas, K., Krevers, B., Bendtsen, P., 2015. Implementing healthy lifestyle promotion in primary care: a quasi-experimental cross-sectional study evaluating a team initiative. BMC Health Serv. Res. 15, 31.
Timperio, A., Salmon, J., Ball, K., 2004. Evidence-based strategies to promote physical activity among children, adolescents and young adults: review and update. J. Sci. Med. Sport 7, 20–29.
Tremblay, M.S., Warburton, D.E., Janssen, I., et al., 2011. New Canadian physical activity guidelines. Appl. Physiol. Nutr. Metab. 36, 36–46.
Tremblay, M.S., Gray, C.E., Akinroye, K.K., et al., 2014. Physical activity of children: a global matrix of grades comparing 15 countries. J. Phys. Act. Health 11, 113–125.
Trost, S.G., Tang, R., Loprinzi, P.D., 2009. Feasibility and efficacy of a church-based intervention to promote physical activity in children. J. Phys. Act. Health 6, 741–749.
van Beurden, E., Barnett, L.M., Zask, A., Dietrich, U.C., Brooks, L.O., Beard, J., 2003. Can we skill and activate children through primary school physical education lessons? "Move it Groove it"—a collaborative health promotion intervention. Prev. Med. 36, 493–501.
van Sluijs, E.M., McMinn, A.M., Griffin, S.J., 2007. Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. BMJ http://dx.doi.org/10.1136/bmj.39320.843947.BE.
van Sluijs, E.M., Kriemler, S., McMinn, E.M., 2011. The effect of community and family interventions on young people's physical activity levels: a review of reviews and updated systematic review. Brit. J. Sports Med. 45, 914–922.
Verstraete, S.J., Cardon, G.M., De Clercq, D., De Bourdeaudhuij, I., 2006. Increasing children's physical activity levels during recess periods in elementary schools: the effects of providing game equipment. Eur. J. Pub. Health 16, 415–419.
Verstraete, S.J., Cardon, G.M., De Clercq, D.L., De Bourdeaudhuij, I.M., 2007a. A comprehensive physical activity promotion programme at elementary school: the effects on physical activity, physical fitness and psychosocial correlates of physical activity. Public Health Nutr. 10, 477–484.
Verstraete, S.J.M., Cardon, G.M., Clercq, De, Dirk, L.R., Bourdeaudhuij, De, Ilse, M.M., 2007b. Effectiveness of a two-year health-related physical education intervention in elementary schools. J. Teach. Phys. Educ. 26, 20–34.
Wallander, J.L., Schmitt, M., Koot, H.M., 2001. Quality of life measurement in children and adolescents: issues, instruments, and applications. J. Clin. Psychol. 57, 571–585.
Warren, J.M., Henry, C.J., Lightowler, H.J., Bradshaw, S.M., Perwaiz, S., 2003. Evaluation of a pilot school programme aimed at the prevention of obesity in children. Health Promot. Int. 18, 287–296.
Wen, L.M., Fry, D., Merom, D., Rissel, C., Dirkis, H., Balafas, A., 2008. Increasing active travel to school: are we on the right track? A cluster randomised controlled trial from Sydney, Australia. Prev. Med. 47, 612–618.
White, S.M., McAuley, E., Estabrooks, P.A., Courneya, K.S., 2009. Translating physical activity interventions for breast cancer survivors into practice: an evaluation of randomized controlled trials. Ann. Behav. Med. 37, 10–19.
Williamson, D.A., Copeland, A.L., Anton, S.D., et al., 2007. Wise mind project: a school-based environmental approach for preventing weight gain in children. Obesity 15, 906–917.
Wilson, D.K., Evans, A.E., Williams, J., Mixon, G., Sirard, J.R., Pate, R., 2005. A preliminary test of a student-centered intervention on increasing physical activity in underserved adolescents. Ann. Behav. Med. 30, 119–124.
Wilson, D.K., Van Horn, M.L., Kitzman-Ulrich, H., et al., 2011. Results of the "active by choice today" (ACT) randomized trial for increasing physical activity in low-income and minority adolescents. Health Psychol. 30, 463–471.
Wood, C., Gladwell, V., Barton, J., 2014. A repeated measures experiment of school playing environment to increase physical activity and enhance self-esteem in UK school children. PLoS One 9, e108701.
World Health Organization (WHO), 2010. Global Recommendations on Physical Activity for Health, Geneva.
Yıldırım, M., Arundell, L., Cerin, E., et al., 2013. What helps children to move more at school recess and lunchtime? Mid-intervention results from Transform-Us! cluster-randomised controlled trial. Br. J. Sports Med. 48, 271–277.
Zahner, L., Puder, J.J., Roth, R., Schmid, M., Guldimann, R., Puhse, U., 2006. A school-based physical activity program to improve health and fitness in children aged 6–13 years ("Kinder-Sportstudie KISS"): study design of a randomized controlled trial [ISRCTN15360785]. BMC Public Health 6, 147.