Effective physical education and school sport: A systematic review of physical education and school sport…

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A systematic review of the effectiveness of physical education and school sport interventions targeting physical activity, movement skills and enjoyment of physical activity

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Abstract

This article presents a systematic review of published literature on the effectiveness of physical education in promoting participation in physical activity, enjoyment of physical activity and movement skill proficiency in children and adolescents. The review utilized a literature search, specifically publications listed in Ovid, A+ Education, ERIC, Sports Discus, Science Direct, PsychInfo from 1990 to June 2010. The literature search yielded 27,410 potentially relevant publications. Twenty-three articles met the inclusion criteria established for this review and applied by three independent reviewers. Articles were rated independently by three reviewers

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using a 10-item methodological quality scale derived from the CONSORT 2010 statement. The results of the review detail the nature, scope and focus of intervention strategies reported, and reported outcomes of interventions. The most effective strategies to increase children's levels of physical activity and improve movement skills in physical education were direct instruction teaching methods and providing teachers with sufficient and ongoing professional development in using these physical education (PE) instruction methods. However, the review revealed a lack of high quality evaluations and statistical power to draw conclusions concerning the effectiveness of interventions conducted in physical education and school sport to improve enjoyment outcomes. It is argued that adequately powered interventions that target movement skills in secondary schools and evaluate school sport curriculum are urgently needed.

Keywords
adolescents, enjoyment, fundamental movement skills, intervention, physical activity, school

Background

Most young people participate in some type of organized physical education (PE) during their primary and secondary school education. Effective use of time in PE is considered to be important for many reasons; not least because it may help young people make informed lifestyle choices, develop proficiency in movement skills, and encourage lifelong participation in physical activity (Kay, 2005; Kirk, 2005; Morgan et al., 2005; Bailey, 2006). The recent *Strategies to Improve the Quality of Physical Education* (US Department of Health and Human Services, 2010) statement in the United States called for well-designed PE curriculum to maximize physical activity during lessons (the target being 50 percent of PE class time spent in moderate-to-vigorous physical activity [MVPA]). In addition, two recent Australian publications have called for a greater awareness of, and support for, the role of PE and sport in schools. *Australia: The Healthiest Country by 2020* (Australian Government Preventative Health Taskforce, 2010) and *The Future of Sport in Australia* (Australian Independent Sport Panel, 2009) both argued for adequate time for physical education and sport within school time as a way of improving the nation's health. In addition to these goals, a key strategy in achieving long-term health improvements has been to promote the development of movement skill in youth (Australian Government Preventative Health Taskforce, 2010). The Center for Disease Control and Prevention (CDC) (1997) has also stressed the importance of physical education and school sport (PESS) being enjoyable to young people and recommended the use of active learning strategies to facilitate this.

Based on this literature from leading researchers and policymakers, a definition of what constitutes effective PESS in relation to health and lifestyle outcomes can be proposed. This would probably include observable elements of instruction time dedicated to:

1. Promoting high levels of physical activity participation;
2. Movement skill instruction and practice; and
3. Active learning strategies with an emphasis on enjoyment.

These components are also consistently found in many PESS curricula across developed countries including, but not limited to, the United Kingdom, France, Belgium, Canada, Australia, and the United States.

The United Nations (2010) has recently called for universal access to quality and effective PE for all school-aged children, suggesting it is timely to review the evidence-base for effective PE. Previous systematic reviews conducted by Stone et al. (1998) and Kahn et al. (2002) included studies of physical activity in school settings. The purpose of this article is to systematically review the evidence from experimental and quasi-experimental studies of curriculum interventions using PESS that aimed to promote physical activity, increase movement skill proficiency and enjoyment of physical activity in children and youth. The review was not concerned with interventions that primarily sought to change school policy or the physical school environment. Furthermore, it is the first systematic review to examine the three outcome variables of physical activity, movement skill development, and enjoyment of physical activity simultaneously in order to inform specific PESS pedagogy, practice and research. The article provides a synthesis of evidence and identifies gaps in the literature to indicate where future research is needed.

Methods

Search protocol

A literature search of PESS interventions that aimed to promote physical activity, increase movement skill proficiency and enjoyment of physical activity in children and adolescents was conducted in six electronic databases (Ovid, A+ Education, ERIC, Sports Discus, Science Direct, PsychInfo) published between the 1 January 1990 up to and including 30 June 2010. The search strategy focused on paediatrics (key words: children, adolescents, youth), physical education (key words: physical education, school sport), movement skill outcomes (key words: fundamental movement skill, movement skill, movement skill acquisition, motor skill), physical activity outcomes (key words: physical activity, sport, exercise), enjoyment-related outcomes (key words: enjoyment, fun), intervention (key words: program, trial, intervention) and intervention type (key words: randomized controlled trials, controlled trials, evaluations). Retrieved articles were cross-referenced for additional inclusions as a further search strategy. Once a list of possible inclusions had been retrieved, the references were sent to several leading international researchers who were asked to identify any possible studies that may not have been already sourced via database or cross-referencing searches.

Inclusion criteria

Articles were included in the review if they reported on a curriculum-based intervention where PESS was used as the medium. They had to target school-aged children and youth with a mean age between 5 and 18 years and report movement skill proficiency, and/or physical activity participation, and/or enjoyment of physical activity. Included were experimental pilot studies (if they included a control group), controlled trials, randomized controlled trials and cluster randomized trials. Only studies that used experimental or quasi-experimental designs were included because in a world of 'evidence-informed' education (Hattie, 2009) experimentally designed studies are still considered to provide the best evidence as to causation in research (Popper, 1968; Scriven, 2005). Studies were excluded if (a) they were published in a language other than English; (b) the intervention was implemented as a community-based program, an extra/non-curricular program or outside a school setting; or (c) there was no control group. Articles were initially excluded by screening the title and abstract and when appropriateness could not be determined, the full article was scrutinized. Three reviewers independently evaluated full text copies of all obtained articles using a standardized checklist, to determine whether they met the inclusion criteria. Where opinions differed, a consensus was reached through discussion.

Table 1. Methodological quality assessment items

Item	Description
A	Key baseline characteristics are presented separately for treatment groups (age) and one relevant outcome (physical activity, movement skills, instruction time, enjoyment) and for randomized controlled trials and controlled trials, positive if baseline outcomes were statistically tested and results of tests were provided.
B	Randomization procedure clearly and explicitly described and adequately carried out (generation of allocation sequence, allocation concealment and implementation).
C	Validated measures of physical activity and/or movement skills and/or enjoyment (validation in same age group reported and/or cited).
D	Drop out reported and <20 percent for <6-month follow-up or <30 percent for >6-month follow-up.
E	Blinded physical activity and/or movement skills and/or enjoyment assessments.
F	Physical activity and/or movement skills, instruction time, enjoyment assessed a minimum of 6 months after pre-test.
G	Intention to treat analysis for physical activity and/or movement skills, and/or enjoyment outcomes(s) (participants analysed in group they were originally allocated to, and participants not excluded from analyses because of non-compliance to treatment or because of some missing data).
H	Potential confounders accounted for in physical activity and/or movement skills and/or enjoyment analysis (e.g. baseline score, group/cluster, age).
I	Summary results for each group + treatment effect (difference between groups) + its precision (e.g. 95 percent confidence interval).
J	Power calculation reported, and the study was adequately powered to detect hypothesized relationships.

Source: Adapted from van Sluijs et al., 2007.

Assessment of methodological quality

Included articles were then assessed for methodological quality using a 10-item quality assessment scale derived from van Sluijs et al. (2007) (See Table 1). For each article, three reviewers independently assessed whether the article scored positively (i.e. the assessed item was present) or negatively (i.e. the assessed item was absent) for each item. Where an item was insufficiently described it was allocated a negative (absent) score. Agreement between reviewers for each article was set *a priori* at 80 percent (van Sluijs et al., 2007; Alderson et al., 2005). That is, for each article, reviewers were required to agree that the items were either present or absent for 8 of the 10 items. In the case of less than 80 percent agreement, consensus was reached by further discussion. The scores were then summed to determine the overall quality of the article. In accordance with van Sluijs et al., (2007) and Alderson at al., (2005), a article was deemed to have high methodological quality if it scored 5 or more for a controlled trial or 6 or more for a randomized controlled trial.

Comparing results

To facilitate comparison, studies were divided according to their outcome measure: physical activity participation, movement skill proficiency, or enjoyment of physical activity.

Results

Identification and selection of the literature

The literature search in the various databases yielded 27,410 potentially relevant publications. After the titles and abstract of publications were screened, 54 references were confirmed as potentially relevant and retrieved in full text. Reference checking and expert input revealed another nine potentially relevant publications. Forty publications identified from the search were excluded from our review because they; a) were duplicate articles; b) did not meet the age requirements; c) had no physical activity, movement skill, or enjoyment outcome; d) were conducted as part of an extra-curricular program or non-curricular program; or e) had no control group.

A total of 23 studies provided information on the effect of PESS interventions on physical activity participation (19 studies), movement skill proficiency (4 studies), and enjoyment of physical activity (7 studies) and were selected for inclusion in this review (See Tables 2, 3, and 4, respectively). Most of the included studies (n = 15) were published after 2000, the remaining studies (n = 8) were published between 1990 and 2000. The 23 studies included in the review are referenced numerically using superscript (1 to 23) in text from here on in this article, and are detailed in a separate reference list in Appendix 1. Referenced articles were ordered from those reporting on two or more outcomes (1–4), physical activity only (5–19), movement skill only (20–21), and enjoyment only (22–23).

Methodological quality assessment

The methodological quality of the included studies is presented in Table 5. The scoring of the 23 publications led to an overall initial disagreement between the reviewers of 10 percent. Most disagreements were on the 'Intention to treat' item (criterion 7) and resulted from incomplete description or interpreting errors. The three reviewers reached consensus on all initial disagreements. The quality score of the publications ranged from one to nine. Based on the assessment scale used, two (20 percent) of the 10 controlled trials had a score of more than five[8, 12] and were thus considered to be of high methodological quality. Six (46 percent) of the 13 randomized controlled trials had a score of more than six.[1, 2, 10, 16, 17, 19] The percentages on each criterion are reported in Table 5.

Comparing results

To facilitate comparison between studies, we extracted the following data from each article: (a) design, including randomization procedures and settings; (b) methodological quality; (c) intervention components, including sample size, length of the intervention, and curriculum medium; and (d) effectiveness of the intervention (i.e. having a positive influence on the targeted outcome[s]) immediately after intervention and at subsequent follow-up (if any).

PESS interventions with physical activity as an outcome

Methodological Quality. Agreement was 89 percent on the 190 items (19 published articles x 10 items used to assess methodological quality for each article). Two of the controlled trials[8, 12] and six of the randomized, controlled trials[1, 2, 10, 16, 17, 19] had high methodological quality. Of the 10 items assessed for methodological quality, four were consistently present: a minimum of six

months elapsing before post-testing conducted (68 percent), accounting for confounders in the analyses (68 percent), the use of validated measures (74 percent), and providing a summary of results that included treatment effect and precision (84 percent). Only three studies (16 percent)[1, 2, 10] adequately and explicitly described the randomization procedure. Two studies (11 percent)[10, 19] conducted blinded assessments and one study (5 percent)[2] performed a power calculation.

Description of interventions. The sample sizes varied considerably across the studies (38–25000 participants) as did the instruments used to assess physical activity. Eleven studies (58 percent)[1, 2, 3, 5, 7, 8, 13, 15, 17, 18, 19] used objective measures of physical activity (seven used direct observation, two accelerometry, two pedometers) and nine studies (47 percent)[4, 6, 9, 10-14, 16] used self-report measures (McKenzie at al., 1996 [13] used both objective and self-report measures). Thirteen studies (68 percent)[2, 3, 5, 6, 8, 9, 10, 12, 13, 14, 17, 18, 19] had a treatment period of 6 months. Thirteen studies (68 percent)[2, 3, 5, 8, 9, 10-15, 17, 18] had co-educational samples and five studies (26 percent)[1, 4, 6, 7, 16] involved only girls.

In regard to the curriculum medium used for the interventions, 12 of the studies (63 percent)[3–7, 10, 11, 13, 16–19] were conducted as part of school PE, one study (5 percent)[1] as part of the school sport curriculum, four (21 percent)[8, 9, 12, 14] adopted a cross-curricular approach, and two (11 percent)[2, 15] were conducted in addition to existing PESS during curriculum time. Twelve studies (63 percent)[2, 3, 8-15, 17, 18] were conducted in primary schools and seven (37 percent) in secondary schools.[1, 4–7, 16, 19] Pedagogically, with the exception of one study[2] all studies[1, 3–19] were delivered by trained classroom teachers or specialist PE teachers, and ten (53 percent) of these[3, 5, 8, 10, 13, 14, 16–19] provided ongoing professional development and support for teachers in their delivery of the intervention. The other study[2] used an external PE teacher in the delivery of the curriculum without any professional development being provided to the school or teachers. Thirteen (68 percent)[2–7, 10, 11, 13, 16–19] provided a prescribed curriculum to be taught. Two (11 percent)[1, 4] adopted a negotiated approach to the PESS curriculum (Jamner et al., 2004[4] used a combination of prescribed and negotiated PESS curriculum). Six (32 percent)[2, 3, 5, 10, 13, 17] stated that direct or explicit teaching strategies were used in the intervention, or were based on models that had used direct/explicit teaching strategies. Finally, three studies (16 percent)[3, 8, 13] provided Web-based support for teachers in the form of activities and lesson plans.

Intervention efficacy. Fifteen studies (79 percent) were effective in increasing physical activity participation and 13 (68 percent) reported statistically significant findings (see Table 2). Four (21 percent) reported results separately for both boys and girls. The two studies (11 percent)[2, 6] that included follow-up measures post-intervention reported differences between the intervention group and the control group at both time points but only one showed statistically significant differences at both time points.[2]

PESS interventions with movement skills as an outcome

Methodological quality. Agreement was 93 percent on the 40 items (4 published articles x 10 items used to assess methodological quality for each article). None of the controlled trials and only one of the randomized, controlled trials[2] had high methodological quality. Of the 10 items assessed for methodological quality, only two were consistently present: minimum post-test period of > 6 months (100 percent) and accounting for confounders in the analyses (75 percent). The study by Salmon et al. (2008)[2] was the only one that reported using an intention-to-treat analysis, described

Table 2. Description of curriculum-based interventions targeting physical activity participation

Author, year, country	Design	Sample	Treatment length	Intervention groups	Treatment content	Outcomes and instrument (relevant for review)	Post-intervention and follow-up DURATION	Results (PA)	Statistical significance
Dudley et al. (2010) Australia	RCT	n = 38, Mean age 16.5 yrs Girls	11 weeks	(1) Intervention students × 17 (2) Control students × 21	(1) **NSW School Sport** intervention - 90 min participant designed SS curriculum with PE teacher. Focus on interest and non-competitive activities. (2) Usual SS sessions with or without a PE teacher	PA (AC)	11 weeks (PI)	PI: (1) less decline in PA than (2)	NS
Fairclough and Stratton. (2006) UK	CT	n = 62 Mean age NR (Grade 7 11–12 yrs) Girls	6 lessons	(1) Intervention class × 1 (2) Control class × 1	(1)**UK Active Gym** intervention - 82 min modified gymnastics unit focussing on PA. All girls class (2) 76 min usual PE gymnastics unit. Co-ed class	PA (DO)	6 lessons (PI)	PI: (1) > (2) in VPA PI: (1) > (2) in MVPA	$p = 0.05$ NS
Gorely et al. (2009) UK	CT	n = 589 Mean age 8.1 yrs Co-ed	10 months	(1) Intervention schools × 4 (2) Control schools × 4	(1) **GreatFun2Run intervention** - CD resource, Website, two high-light PA events, media campaign, summer activity planner (2) Usual HPE curriculum	PA (PM)	10 months (PI)	PI: (1) > (2) (1) Increase in MVPA (2) Decrease in MVPA	$p = 0.01$
Gortmaker et al. *Planet Health* (1999) USA	RCT	n = 1295 Mean age 11.7 yrs Co-ed	2 years	(1) Intervention schools × 5 (2) Control schools × 5	(1) **Planet Health intervention** - teacher training, PE materials, wellness sessions and fitness funds. PE materials focused on activity and inactivity themes, student self-assessments of activity, goal setting, evaluations for reducing inactivity, replacing inactive time with MVPA (2) Usual school curriculum	PA (SR)	2 years (PI)	PI: Increase in boys MVPA (1) and (2) PI: Decrease in girls MVPA (1) and (2)	NS NS
Gortmaker et al. *Eat Well, Keep Moving* (1999) USA	CT	n = 479 Mean age 9.1 yrs Co-ed	2 years	(1) Intervention schools × 6 (2) Control schools × 8	(1) **The Eat Well and Keep Moving Program** – PD for teachers in math, science, language arts, and social studies classes focused on decreasing consumption of foods high in fat, increasing fruit and vegetable intake, reducing TV viewing and increasing PA. (2) Usual school curriculum	PA (SR)	2 years (PI)	PI: Decrease in VPA (1) and (2)	NS

(continued)

Table 2 (continued)

Author, year, country	Design	Sample	Treatment length	Intervention groups	Treatment content	Outcomes and instrument (relevant for review)	Post-intervention and follow-up DURATION	Results (PA)	Statistical significance
Harrell et al. (1996) USA	RCT	n = 1274 Mean age 8.9 yrs Co-ed	8 weeks	(1) Intervention schools × 6 (2) Control schools × 6	(1) **Cardiovascular Health in Children intervention** - PA three times a week. Twenty-four lessons in total which included a 20 minutes of various fun, non-competitive aerobic activities to work the major muscle groups. (2) Usual HPE instruction	PA (SR)	8 weeks (PI)	PI: (1) > (2) increase in PA	$p = 0.05$
Jamner, et al. (2004) USA	CT	n = 47 Mean age 14.9 yrs Girls	4 months	(1) Intervention students × 25 (2) Control students × 22	(1) **Project FAB intervention** - 60 mins of PE daily. Participant directed curriculum with one day p/w devoted to health benefits of PA and exercise. Girls-only PE class, NO PE uniform or 1-mile fitness test. (2) Usual PE curriculum	PA (SR)	4 months (PI)	PI: (1) > (2) in daily METs expended in MVPA PI: (1) less decline than (2) in MVPA 30 min blocks	$p = 0.007$ $p = 0.009$
Jurg, et al. (2006) Netherlands	CT	n = 510 Mean age NR (Grades 4,5, and 6) Co-ed	12 months	(1) Intervention schools × 4 (2) Control schools × 2	(1) **Jump-In intervention** - SS activities, breaks for PA, relaxation and posture exercises during class, PA assignments to be done in the class and at home, parental information service, activity-week event (2) Usual school curriculum	PA (SR)	12 months (PI)	PI: (1) and (2) decrease in PA in Grade 6	(1) NS (2) $p = 0.01$
McKenzie et al. (1996) USA	RCT	n = 5106 Mean age 8.76 yrs Co-ed	2.5 years	(1) Intervention schools × 28 (2) Control schools × 40	(1) **Child and Adolescent Trial for Cardiovascular Health (CATCH) intervention** – PE curriculum and materials, teacher PD, on-site teacher consultation service (2) Usual school curriculum	PA (DO, SR)	2.5 years (PI)	PI: (1) >(2) increase in MVPA during PE (DO) PI: (1) >(2) min of PE p/w (SR) PI: (1)>(2) VPA min per day (SR)	$p = 0.001$ NS $p = 0.003$
McKenzie et al. (2004) USA	RCT	n = approx 25000 Mean age NR (Grades 6 to 8 Middle schools) Co-ed	2 years	(1) Intervention schools × 12 (2) Control schools × 12	(1) **Middle School Physical Activity and Nutrition (M-SPAN) intervention**- consisted of a voluntary PD program for PE teachers to use sample and revise existing PE materials, revise instructional strategies to increase MVPA and improve class management (2) Usual school curriculum	PA (DO)	2 years (PI)	PI : (1) >(2) time spent in MVPA during PE	$p = 0.02$ for boys NS for girls

(continued)

Table 2 (continued)

Author, year, country	Design	Sample	Treatment length	Intervention groups	Treatment content	Outcomes and instrument (relevant for review)	Post-intervention and follow-up DURATION	Results (PA)	Statistical significance
Naylor et al. (2006) Canada	RCT	n = 42 teachers Mean age of students NR (Teachers reporting on grades 4-6 classes) Co-ed	11 months	(1) Intervention [Champion] schools × 3 (2) Intervention [Liaison] schools × 4 (3) Control schools × 3	**Action Schools BC intervention** - generalist teachers with training and resources. (1) ***Champion Schools (CS)*** were given PE resources. initial training and support to 'champion' teacher. Support was not provided to each classroom in CS. (2) ***Liaison schools*** had weekly contact in the classroom with PE specialist to provide mentorship and demonstrate activities to the teacher. Also, PE resources were enhanced with specific resources as requested. (3) Usual PE or PA curriculum	PA (SR)	11 months (PI)	PI : (1) and (2) > (3) in PA mins p/w	$p = 0.05$
Neumark-Sztainer et al. (2003) USA	RCT	n = 201 Mean age 15.4 yrs Girls	5 months	(1) Intervention schools × 3 (2) Control schools × 3	(1) **New Moves intervention** - substituted existing PE with PA sessions 4 times p/w, and nutrition and social support sessions every 2nd week. Community guests, strength training, and a variety of activities selected by the PE teacher. PA sessions promoted lifelong activities for girls within a non-competitive environment. (2) Control schools received a minimal intervention of written materials on health and PA at the baseline assessment.	PA (SR)	5 months (PI) 8 months (FU)	PI and FU: (1) > (2) PA min p/w	NS
Pangrazi et al. (2003) USA	CT	n = 606 Mean age 9.8 yrs Co-ed	12 weeks	(1) PLAY Only (Int) schools × 9 (2) PLAY + PE (Int) schools × 10 (3) PE only (Con) schools × 10 (4) No treatment (Con) schools × 6	**Promoting Lifestyle Activity for Youth (PLAY) intervention** - focuses on PA and does not teach physical skills; it was not intended to replace a PE program. PLAY supplements a daily PE program. Places responsibility for PA on the classroom teacher, who becomes a model for helping children develop active lifestyles.	PA (PM)	12 weeks (PI)	PI : (1) > (4) steps per day (All) PI : (2) > (4) steps per day (All) PI : (2) and (3) > (4) steps per day (Girls)	NS $p = 0.01$ $p = 0.006$

(continued)

Table 2 (continued)

Author, year, country	Design	Sample	Treatment length	Intervention groups	Treatment content	Outcomes and instrument (relevant for review)	Post-intervention and follow-up DURATION	Results (PA)	Statistical significance
Pate et al. (2005) USA	RCT	n = 2744 Mean age 13.6 yrs Girls	12 months	(1) Intervention schools × 12 (2) Control schools × 12	(1) **Lifestyle Education Activity Program (LEAP) intervention** - included gender-specific PE, choice-based instructional program to build activity skills and reinforce participation in PA. Activities included aerobics, dance, walking, self-defence, martial arts, and weight training in addition to competitive sports and traditional PE. Headed by 'Champion', who was responsible for girls' PE. PD and instructional materials provided. (2) Usual school PE program	PA (SR)	12 months (PI)	PI: (1) had 1 more block of VPA/day than (2) PI: (1) had 2 more blocks of VPA/day than (2)	$p = 0.05$ NS
Sallis et al. (1997) USA	RCT	n = 955 Mean age 9.49 to 9.62 yrs Co-ed	2 years	(1) Intervention schools (PE Specialist-led) × 2 (2) Intervention schools (Trained classroom teacher led) × 2 (3) Control schools × 3	**Sport, Play, Activity, and Recreation for Kids (SPARK) PE intervention** - 30 min of PE (15 min of health-fitness activities/ 15 min of skill-fitness activities) at least 3 days p/w. Also includes homework, newsletters and a student self-management program (1) **PE specialist-led:** PE teachers taught PE and self-management whilst receiving ongoing PD and supervision from investigators. PE teacher received regular feedback and videotaped lessons (2) **Trained classroom teacher-led:** Classroom teachers received PD in PE curriculum, class management and instructional techniques. Thirty-two hrs of professional development. Feedback from investigators on supervised lessons. (3) Usual school PE curriculum	PA (DO- class level)	2 years (PI)	PI : (1) > (2) > (3) in PE MVPA (DO) PI:(1) > (2) > (3) minutes of PE per week	$p = 0.001$ $p = 0.001$

(continued)

Table 2 (continued)

Author, year, country	Design	Sample	Treatment length	Intervention groups	Treatment content	Outcomes and instrument (relevant for review)	Post-intervention and follow-up DURATION	Results (PA)	Statistical significance
Salmon et al. (2008) Australia	RCT	n = 311 Mean age 10.8 yrs Co-ed	6 months	(1) Intervention class (BM) × 3 classes (66 students) (2) Intervention class (FMS) × 3 classes (74 students) (3) Intervention class (BM+FMS) × 3 classes (93 students) (4) Control class × 3 classes (62 students)	**Switch Play intervention** - adapted from **SPARK PE**, **Planet Health** and the Victorian Fundamental Motor Skills programme. Delivered in addition to SS and PE (1) **Behaviour modification (BM):** Aimed to reduce the time spent on TV viewing. Comprised 19 sessions of 40–50 min duration taught across 3 school terms by PE teacher. (2) **Fundamental Movement Skills (FMS):** Comprised 19 sessions of 40–50 min duration taught across 3 school terms by PE teacher that delivered the BM intervention. Focused on six skills, 3 object control skills (overhand throw, kick and strike) and 3 locomotor skills (run, dodge and vertical jump). (3) **BM plus FMS group:** Received both interventions (4) Usual school PE curriculum	PA (AC)	6 month (PI) 12 month (FU)	PI and FU: (1) and (2) increase in PA counts per day for boys PI and FU: (1) increase in PA counts per day for girls	PI: (1) $p = 0.01$ FU: $P = 0.05$ PI and FU: (2) $p = 0.001$ PI and FU: $p = 0.05$
Simons-Morton et al. (1993) USA	CT	Number of participants NR Mean age NR (3rd and 4th grade) Co-ed	3 years	(1) Intervention schools × 2 (2) Control schools × 2	(1) **Go for Health intervention** - based on **Go for Health** and Children's Active Physical Education curriculum. Teacher's received PD in implementing the intervention. (2) Usual daily PE curriculum	PA (DO)	3 years (PI)	PI : (1) and (2) increase mean minutes of MVPA during PE	(1) $p = 0.05$ (2) NS
van Beurden et al. (2003) Australia	RCT	n = 1045 Mean age NR (Grades 3 and 4) Co-ed	18 months	(1) Intervention schools × 9 (2) Control schools × 9	(1) **Move it groove it (MIGI) intervention** - consisted of school project teams in order to have a 'whole school approach', buddy program involving classroom teachers partnered with pre-service PE teachers, teacher PD, web site containing lesson plans and FMS activities, funding for PE equipment ($AU375.00) (2) Usual school PE curriculum	PA (DO)	18 months (PI)	PI: (1) > (2) in MVPA during PE	NS

(continued)

Table 2 (continued)

Author, year, country	Design	Sample	Treatment length	Intervention groups	Treatment content	Outcomes and instrument (relevant for review)	Post-intervention and follow-up DURATION	Results (PA)	Statistical significance
Webber et al. (2008) USA	RCT	n = 1721 at baseline n = 3504 at PI Mean age NR (6th Grade at baseline, 8th grade at PI) Girls	2 years	(1) Intervention schools × 18 (2) Control schools × 18	(1) **Trial of Activity for Adolescent Girls PE (TAAG) intervention** - promoted MVPA for at least 50 percent of class time and encouraged teachers to promote PA outside of class. PE teachers were trained in class management strategies, skill-building activities, the importance of engaging girls in MVPA during class, and the provision of appropriate equipment and choices of PA. (2) Usual PE curriculum	PA (DO)	2 years (PI)	PI : (1) > (2) in MVPA during PE	$p = 0.05$

Notes: CT: Controlled trial; RCT: Randomized controlled trial; Co-ed: Both boys and girls; NR: Not reported; Int: Intervention; Con: Control; SS: School sport; PE: Physical education; HPE: Health and physical education; PA: Physical activity; AC: Accelerometery; DO: Direct observation; PM: Pedometers; SR: Self report; FMS: Fundamental movement skills; PD: Professional development; PI: Post-intervention; FU: Follow-up; VPA: Vigorous physical activity; MVPA: Moderate to vigorous physical activity; MET's: Metabolic equivalent tasks; Min(s): Minutes; p/w: per week; NS: Not significant.

participant drop out and the randomization procedure adequately, and reported a power calculation. Three quarters of the studies[2, 3, 20] compared baseline characteristics between groups. Half of the studies[2, 3] used validated measures or presented a summary of results that included treatment effect and precision. [3, 20]

Description of interventions. The sample sizes varied across the studies (311–1131 participants), as did the number of movement skills assessed (3, 6, 8, and 36). All four studies[2, 3, 20, 21] had a treatment period of 6 months or longer and a co-educational sample. In regard to the curriculum medium used for the interventions, three of the studies (75 percent) were conducted as part of school PE[3, 20, 21] and one study (25 percent)[2] was conducted in addition to existing PESS during curriculum time. All four studies[2, 3, 20, 21] were conducted in primary schools. Pedagogically, all four studies[2, 3, 20, 21] provided a prescribed curriculum to be taught, with three of them[3, 20, 21] being delivered by classroom teachers or specialist PE teachers receiving ongoing professional development and support in the delivery of the curriculum. The fourth study[2] used an external PE teacher in the delivery of the curriculum without any professional development being provided to the school or teachers. Three studies (75 percent)[2, 3, 21] stated that the intervention used direct or explicit teaching strategies. Finally, one study (25 percent)[3] provided Web-based support for teachers in the form of activities and lesson plans.

Intervention efficacy. All four studies[2, 3, 20, 21] were efficacious in improving movement skill proficiency and reported statistically significant findings. The one study[2] that included follow-up measures post-intervention, reported no differences between the intervention group and the control group at 6-month post-intervention and 12-month follow-up, however, it did report statistically significant changes among girls only at both time points. Three quarters of the studies (75 percent) reported the results separately for boys and girls (See Table 3).

PESS interventions with an enjoyment of physical activity as an outcome

Methodological quality. Agreement was 89 percent on the 70 items (7 published articles x 10 items used to assess methodological quality for each article). None of the controlled trials and only two of the randomized, controlled trials[1, 2] had high methodological quality. Of the 10 items assessed for methodological quality, only two were consistently present: the use of validated measures (100 percent) and accounting for confounders (71 percent). There were three studies (57 percent)[1, 2, 5] that used intention-to-treat analysis and described the drop-outs from the study.[1, 2, 6] Only two studies[1, 2] described the randomization procedure adequately and compared baseline characteristics between groups.[1, 4] These were also the only studies deemed by the reviewers to have adequately described and explained the randomization procedure.[1, 2]

Description of interventions. The sample sizes varied considerably across the studies (38–1578 participants) as did the intervention length provided to participants and the number of enjoyment items assessed. Three of the studies (43 percent)[1, 4, 6] had less than six month treatment periods. The other four studies (57 percent)[2, 5, 22, 23] had treatment periods of six months or longer. Three of the studies (43 percent)[2, 4, 22] had follow-up periods at least three months post-intervention, four studies were co-educational samples[2, 5, 22, 23] and three studies were single-sex.[1, 4, 6]

Regarding the curriculum medium used for the interventions, five of the studies (71 percent)[4, 5, 6, 22, 23] were conducted as part of school PE, one study (14 percent)[1] as part of the school sport program

Table 3. Description of curriculum-based interventions targeting movement skills

Author, year, country	Design	Sample	Treatment length	Intervention groups	Treatment content	Outcomes (relevant for review)	Post-intervention and follow-up duration	Results (MS)	Statistical significance
McKenzie et al. (1998) USA	RCT	n = 709 Mean age not reported (Grades 4 and 5) Co-ed	6 months	(1) Intervention students (PE Specialist-led) × 201 (2) Intervention students (Trained classroom teacher led) × 242 (3) Control students × 266	**SPARK PE** intervention as discussed in Table 1 earlier for (1) and (2) (3) Usual PE curriculum	MS (3 skills)	3 months (PI)	PI: (1) and (2) > (3) in kick PI: (1) and (2) > (3) in catch and throw	NS $p = 0.005$ (Catch) $p = 0.008$ (Throw)
Pieron et al. (1996) Belgium	CT	n = 1131 Mean age not reported (Grades K-6) Co-ed	3 years	(1) Intervention students × 635 (2) Control students × 496	(1) **Daily PE Intervention** - received daily PE classes from a prescribed curriculum. Collaboration between classroom teacher and PE specialists. (2) Usual PE curriculum	MS (36 skills)	3 years (PI)	PI: (1) > (2) in catching, rotation, and throwing (Grades K-4) PI: (2) > (1) in handstand (Grade 4)	$p = 0.05$ $p = 0.05$
Salmon et al. (2008) Australia	RCT	n = 311 Mean age 10.8 yrs Co-ed	6 months	(1) Intervention class (BM) × 3 classes (66 students) (2) Intervention class (FMS) × 3 classes (74 students) (3) Intervention class (BM+FMS) × 3 classes (93 students) (4) Control class × 3 classes (62 students)	**Switch Play** intervention as discussed previously in Table 1 for (1), (2), and (3) (4) Usual PE curriculum	MS (6 skills)	6 month (PI) 12 month (FU)	PI and FU: (1) positive effect > (2), (3) and (4) positive effect on FMS z-scores PI and FU: (1) and (2) positive effect > (3) and (4) on FMS z-scores among girls	NS (1) $p = 0.05$ (2) $p = 0.01$
van Beurden et al. (2003) Australia	RCT	n = 1045 Mean age not reported (Grades 3 and 4) Co-ed	18 months	(1) Intervention schools × 9 (2) Control schools × 9	(1) **MIGI** intervention as discussed previously in Table 1 (2) Usual PE curriculum	MS (8 skills)	18 month (PI)	PI: (1) > (2) improvement in all skills for boys and girls (1) > (2) in master + near mastery in sprint, side gallop, kick, throw, jump, catch for boys (1) > (2) in master + near mastery in side gallop, kick, throw, jump, hop, catch for girls	$p = 0.0001$ $p = 0.034$ $p = 0.042$

Notes: CT: Controlled trial; RCT: Randomised controlled trial; Co-ed: Both boys and girls; PE; Physical education; PA: Physical activity; MS/FMS: Movement skills; PI: Post-intervention; FU: Follow-up; NS: Not significant.

and one (14 percent)[2] was conducted in addition to PESS during curriculum time. Six (86 percent)[1, 4, 5, 6, 22, 23] were based in secondary schools and one study (14 percent)[2] in a primary school. Pedagogically, six studies (86 percent)[1, 4, 5, 6, 22, 23] used a specialist PE teacher in delivering the intervention. The other study[2] used an external PE teacher in the delivery of the curriculum without any professional development being provided to the school or teachers. Six studies[2, 4, 5, 6, 22, 23] provided a prescribed curriculum for teachers to follow. Two studies (29 percent)[1, 4] developed a negotiated curriculum with the study participants (Jamner et al., 2004[4] used a combination of prescribed and negotiated PESS curriculum). Likewise, two studies[22, 23] stated that one or more of Mosston and Ashworth's (1986) *teaching styles* were deliberately used by the PE teachers in the intervention. Two other studies[2, 6] adopted direct or explicit teaching approaches in their intervention delivery or were based on a direct instruction model. Finally, three studies (43 percent)[1, 4, 6] highlighted having a non-competitive learning environment as a focus of their intervention and targeted only female participants.

Intervention efficacy. Three studies (43 percent) reported improved enjoyment in physical activity but only one of these studies (14 percent) reported statistically significant findings (See Table 4). The one study[2] that included follow-up measures post-intervention reported significant differences between the intervention and the control group at 6-month post-intervention and 12-month follow-up, but only among boys at both collection intervals. Four studies (57 percent) reported that the intervention had no effect on enjoyment (See Table 4).

Discussion

Fifteen studies reported a statistically significant intervention effect on physical activity participation.[2–5, 7, 8, 11–19] Four studies reported a statistically significant intervention effect on movement skill development[2, 3, 20, 21] and one study reported a statistically significant effect on enjoyment of physical activity.[2]

In the interventions that targeted physical activity and movement skills outcomes, the evidence suggests that those that adopted direct or explicit teaching strategies were most effective. This finding is consistent with research by Rink and Hall (2008), which states that effective physical education programs will target the development of a physically active lifestyle and motor skill development directly. Concurrently, a recent meta-analysis suggests that direct-instruction teaching strategies have medium effect sizes on targeted intervention groups in educational settings (Hattie, 2009). In many cases, direct instruction provides very specific learning targets and outcomes and is a classic process-product teaching model. It clearly distinguishes between process variable (in this case, the teaching method) and affords a great deal of teacher influence in manipulating the product variable being examined (in this case, physical activity participation, movement skill competency, and even enjoyment of physical activity). Almost all experimental studies, reviews and meta-analysis of school, teacher, and teacher effectiveness, have been based on a process-product model (Siedel and Shavelson, 2007), which may go some way to explaining their efficacy in this review.

Another component of the most effective interventions that targeted physical activity and movement skills was the provision of professional development programs for teachers using a well-designed prescribed curriculum. The prescribed PESS curriculum was often supported with additional resources such as PE equipment, lesson plans, web-support and, in the case of primary schools, mentors or in-school consultants. These features all appear to be consistent with

Table 4. Description of curriculum-based interventions targeting an enjoyment outcome

Author, year, country	Design	Sample	Treatment length	Intervention groups	Treatment content	Outcomes (Relevant for review)	Post-intervention and follow-up duration	Results (Enjoyment of PE or PA)	Statistical significance
Christodoulidis et al. (2001) Greece	CT	n = 634 Mean age NR (Grade 10) Co-ed	9 months	(1) Intervention students x 105 (2) Control students x 529	(1) **TARGET intervention -** PE teacher PD, cooperative activities, student goal setting, using different TS in PE lessons. (2) Usual school curriculum	Enjoyment of PE (5-point LS – 10 items)	9 months (PI) 19 months (FU)	No change	N/A
Digelidis et al. (2003) Greece	CT	n = 782 Mean age 12.0 yrs Co-ed	9 months	(1) Intervention students x 262 (2) Control students x 520	(1) **Greek High School intervention -** PE teacher PD, cooperative activities, student goal setting, health and exercise curriculum integration, increasing student interactions, using TS in PE lessons. (2) Usual school curriculum	Enjoyment of PE (5-point LS – 10 items)	9 months (PI)	No change	N/A
Dudley et al. (2010) Australia	RCT	n = 38, Mean age 16.5 yrs Girls	11 weeks	(1) Intervention students x 17 (2) Control students x 21	(1) **NSW School Sport** intervention as discussed previously in Table 1 (2) Usual school sport sessions with or without a PE teacher	Enjoyment of PA (5 point LS – 12 items)	11 weeks (PI)	PI: (1) > (2) enjoy of PA	NS
Jamner et al. (2004) USA	CT	n = 47 Mean age 14.9 yrs Girls	4 months	(1) Intervention students x 25 (2) Control students x 22	(1) **Project FAB intervention** school as discussed previously in Table 1 (2) Usual school PE curriculum	Enjoyment of PA (5 point LS – 18 items)	4 months (PI)	No change	N/A

(continued)

Table 4 (continued)

Author, year, country	Design	Sample	Treatment length	Intervention groups	Treatment content	Outcomes (Relevant for review)	Post-intervention and follow-up duration	Results (Enjoyment of PE or PA)	Statistical significance
McKenzie et al. (2004) USA	RCT	n = 1578 Mean age NR (Grades 6 to 8) Co-ed	2 years	(1) Intervention schools x 12 (2) Control schools x 12	(1) **M-SPAN** intervention as discussed previously in Table 1 (2) Usual school curriculum	Enjoyment of PE (5 point LS – 1 item)	2 years (PI)	No change	N/A
Neumark-Sztainer et al. (2003) USA	RCT	N = 201 Mean age 15.4 yrs Girls	5 months	(1) Intervention schools x 3 (2) Control schools x 3	(1) **New Moves intervention** schools as discussed previously in Table 1 (2) Control schools as discussed previously	Enjoyment of PA (4 point LS - 4 items)	5 months (PI) 8 months (FU)	PI: (1) > (2) enjoy of PA at PI and FU	NS
Salmon et al. (2008) Australia	RCT	n = 311 Mean age 10.8 yrs Co-ed	6 months	(1) Intervention class (BM) x 3 classes (66 students) (2) Intervention class (FMS) x 3 classes (74 students) (3) Intervention class (BM+FMS) x 3 classes (93 students) (4) Control class x 3 classes (62 students)	**Switch Play** intervention as discussed previously in Table 1 for (1), (2), and (3) (4) Usual school PE curriculum	Enjoyment of PA (5 point LS – 36 items)	6 months (PI) 12 months (FU)	PI and FU: (2) positive (1), (3) and (4) vs negative on PA enjoy PI and FU: (2) positive > (1), (3) and (4) vs positive on PA enjoy among boys	$p = 0.05$ $p = 0.01$

Notes: CT: Controlled trial; RCT: Randomised controlled trial; NR: Not reported; Co-ed: Both boys and girls; PD: Professional development; TS: Teaching styles; PE; Physical education; PA: Physical activity; LS; Likert Scale; PI: Post-intervention; FU; Follow-up;

Table 5. Publication criterion and quality

Paper No.	Paper authors and year – *Paper title*	1 Key baseline characteristics are presented separately for treatment groups	2 Randomization procedure clearly and explicitly described and adequate	3 Validated measures	4 Drop out described	5 Blinded assessments	6 Min 6 month post test	7 Intention to treat analysis	8 Co-founders accounted for	9 Summary of results + treatment effect + its precision	10 Power calculation reported	Metho-dological quality score	Agreement (%)
1	Dudley et al. (2010)	Y	Y	Y	Y	N	N	Y	Y	Y	N	7	100
2	Salmon et al. (2008)	N	Y	Y	Y	N	Y	Y	Y	N	Y	7	90
3	van Beurden et al, (2003)	Y	N	Y	N	N	Y	N	Y	Y	N	5	80
4	Jamner at al. (2004)	Y	N	Y	Y	N	N	Y	N	N	N	4	90
5	McKenzie et al. (2004)	N	N	Y	N	N	Y	Y	N	Y	N	4	80
6	Neumark-Sztainer et al. (2003)	N	N	Y	Y	N	Y	N	Y	N	N	4	80
7	Fairclough & Stratton (2006)	N	N	Y	N	N	N	N	N	Y	N	2	90
8	Gorely et al. (2009)	Y	N	Y	Y	N	Y	Y	Y	Y	N	7	90
9	Gortmaker et al. (1999) *Eat Well, Keep Moving*	N	N	N	N	N	Y	Y	Y	Y	N	4	70
10	Gortmaker et al. (1999) *Planet Health*	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	9	100
11	Harrell et al. (1996)	Y	N	N	N	N	N	N	Y	Y	N	3	90
12	Jurg et al. (2006)	Y	N	N	Y	N	Y	N	Y	Y	N	5	80
13	McKenzie et al. (1996)	N	N	Y	Y	N	Y	N	Y	Y	N	5	90
14	Naylor et al. (2006)	N	N	N	N	N	Y	N	N	Y	N	2	90
15	Pangrazi et al. (2003)	N	N	Y	N	N	N	N	N	Y	N	2	80
16	Pate et al. (2005)	Y	N	Y	N	N	Y	Y	Y	Y	N	6	90

(continued)

Table 5 (continued)

Paper No.	Paper authors and year – *Paper title*	1 Key baseline characteristics are presented separately for treatment groups	2 Randomization procedure clearly and explicitly described and adequate	3 Validated measures	4 Drop out described	5 Blinded assessments	6 Min 6 month post test	7 Intention to treat analysis	8 Co-founders accounted for	9 Summary of results + treatment effect + its precision	10 Power calculation reported	Metho-dological quality score	Agreement (%)
17	Sallis et al. (1997)	Y	N	Y	Y	N	Y	N	Y	Y	N	6	80
18	Simons-Morton et al. (1991)	N	N	Y	N	N	Y	N	N	Y	N	3	100
19	Webber et al. (2008)	N	N	Y	N	Y	Y	Y	Y	Y	N	6	100
20	McKenzie et al. (1998)	Y	N	N	N	N	Y	N	Y	Y	N	4	100
21	Pieron et al. (1996)	N	N	N	N	N	Y	N	N	N	N	1	100
22	Christodoulidis et al. (2001)	N	N	Y	N	N	Y	N	Y	N	N	3	80
23	Digelidis et al. (2003)	N	N	Y	N	N	Y	N	Y	Y	N	4	100
	Papers with positive score (% of papers)	10 (43%)	3 (13%)	17 (74%)	9 (39%)	2 (9%)	18 (78%)	9 (39%)	16 (70%)	18 (78%)	1 (4%)		
	Controlled trials with score > than 5	2											
	Randomized controlled trials with a score > 6	6											

improving the effectiveness of physical education in achieving health outcomes (Lee et al., 2007) and improve the efficacy of interventions in general. Hattie (2009) suggests that professional development programs also have a medium effect size on student achievement. Professional development programs work when they create expert teachers rather than selling the latest fad or gimmick in physical education. An expert teacher (PE or otherwise) becomes so in the way they present the learning experience to the student, the degree of challenges they present, and the depth of processing that their students attain (Hattie, 2003). Furthermore, Armour and Yelling (2007) claim that professional development of teachers involved in the delivery of PESS curriculum should be founded on an understanding of teacher learning in order to have an impact on student learning. In other words, there needs to be a 'learning space' for teachers, and professional development should not be seen as a 'bolted on' aspect of teaching practice. Professional development of this nature combined with the resources and support to deliver a PESS curriculum appear highly effective.

The lack of efficacious studies targeting enjoyment of physical activity or PE as an outcome makes it difficult to draw conclusions about the attributes of an effective PESS intervention capable of influencing this outcome. This is consistent with literature that discusses the subjective interpretations of what is described as enjoyable physical activity, as the construct is frequently used interchangeably with other constructs such as interest, fun, liking, and intrinsic motivation (Wiersma, 2001). This limits our understanding of the construct of enjoyment of physical activity, and more importantly, our ability to measure it as exemplified in this review.

Strengths and limitations

There are four main strengths to this review. First, published studies were retrieved over a 20-year period. Second, to allow comparison between studies, we extracted an extensive range of detailed information from each article. Third, three different outcome variables pertinent to PESS were reviewed. Finally, the inclusion criteria allowed for the inclusion of studies from a variety of countries and for studies with a range of experimental methodological designs.

Several limitations of the review are also acknowledged. Only studies published in English, based in schools and involved curricula, and that included a control group were reviewed. Also, we were only able to compare the studies broadly; we were not able to determine whether physical activity participation, movement skill proficiency and enjoyment of physical activity were differentially affected by the interventions. Direct comparison, calculating an effect size via meta-analysis or conducting a mediation analysis between quantitative data was not possible because a diverse range of physical activity, movement skill and enjoyment instruments were used. Moreover, studies that used similar instruments reported different outcomes. Finally, enjoyment of physical activity and enjoyment of PE were both used as interchangeable concepts in this review as they were both a focus in studies that had enjoyment outcomes.

As discussed earlier, experimental and quasi-experimental studies are considered to provide the highest quality of scientific evidence in education (Davies, 1999). However, a counter commentary argues that scientific experimentation alone is not appropriate in educational research due to problems associated with matching of experiment groups with controls and potential isolating effects of programs on control groups (Kemper, 1990; Tinning and Kirk, 1991; Sparkes, 1992). As such, while not strictly a limitation of this review, it is important to note that qualitative and non-experimental studies may also provide relevant information into the pedagogy, practice and future research of PESS.

Recommendations for pedagogy, practice and future PESS intervention research

In light of this review, several recommendations can be made in relation to pedagogy, practice and future PESS intervention research.

Pedagogy

It is clear from this review and other research that movement skill development needs to remain a key focus of PE curriculum for children and adolescents to acquire the movement skills necessary to lead physically active lives (Sallis and McKenzie, 1991; Pate et al., 1995). Three of the four movement skill interventions also reported significant increases in physical activity participation (McKenzie at al., 1998;[20] van Beurden et al., 2003;[3] Salmon et al., 2008[2]). In this light, movement skill competency in conjunction with physical activity participation and enjoyment should be part of a range of indicators of an effective PE curriculum and of effective PE pedagogy.

In terms of pedagogically effective teaching strategies, direct and explicit teaching strategies, when combined with a detailed curriculum, are capable of increasing physical activity participation and movement skill proficiency in children and adolescents. However, it is commonly accepted within the PE teaching and research community that focussing solely on direct instruction teaching strategies could be potentially problematic when seeking to develop wider learning skills and independent learning. Therefore, more research is needed into which *teaching strategies* are capable of improving physical activity, movement skill development and student enjoyment of physical activity. The absence of popular PE curriculum instruction/pedagogical models that advocate teaching strategies other than direct instruction, such as Teaching Games for Understanding (Bunker and Thorpe, 1982), Sport Education (Siedentop, 1994) and other constructivist-based PE curriculum models, from this review invite the opportunity for further research that can investigate their effects on physical activity, movement skill and enjoyment using experimental and quasi-experimental designs.

Practice

Given the number of effective physical activity interventions adopting cross-curricular approaches, it may be pertinent for education and health decision makers to view physical activity in schools through a whole-school approach. In other words, share the responsibilities of physical activity across the entire school community and across the curriculum. Much in the same way as numeracy and literacy are areas of focus in Mathematics and English, respectively, but are also cross-curricular in nature and can/have been explored in other curriculum areas. Advocating for a whole-school approach to physical activity is by no means a new concept and has been supported by numerous studies (Sallis and Owen, 1999; Cale, 2000; Biddle at al., 2004). Yet the absence of PESS curriculum that explicitly adopt whole school approaches to physical activity or provide training to teachers in how to do so, suggest that the recommendations proposed in the previous studies have gone unheeded.

This review also shows that substantial and quality professional development for teachers should be included in PESS programs. In accordance with numerous other studies (Sallis et al., 1997; McKenzie et al., 2003; McKenzie et al., 2004; Armour and Yelling, 2007; Jago et al., 2009; Armour et al., 2010), ongoing teacher professional development and support is a key element of an effective PESS curriculum. Given their appearance in the reviewed articles, more interventions

could be conducted using web-based professional development and teacher support that provides lessons plans and teaching strategies employed in PESS classes.

Design of future PESS interventions

In terms of design and methodology for future PESS research, the review findings reaffirm that sample size calculations should be completed before recruitment to ensure that studies are adequately powered to detect statistically significant differences between groups. Whole schools or even school districts may need to be recruited to maximize sample size or group. PESS interventions that focus on physical activity, movement skill or enjoyment outcomes should also be methodologically sound and follow well-established guidelines to ensure transparent reporting (e.g. CONSORT 2010 [Moher et al., 2010] and TREND [Des Jarlais et al., 2004] statements). Attention should be given to longer interventions and follow-up periods, randomization procedures, and using assessors who are blind to group allocation. Furthermore, movement skill interventions that focus on secondary school PESS curriculum are needed, especially in early secondary school. Their absence from the literature limits education and health policymakers from justifying the compulsory inclusion of PESS in secondary curriculum. In addition, more experimental studies testing the effectiveness of school sport in secondary schools are needed to ascertain whether this aspect of the curriculum can effect physical activity participation, movement skill proficiency, and enjoyment of physical activity. The lack of statistical power in studies conducted during school sport make it difficult to substantiate its contribution to these outcomes. This premise is supported by Bailey's (2006) review that the scientific evidence does *not* support that the claimed effects of PESS curriculum occur automatically. More evidence is needed to ascertain the contribution that positive PESS experiences, characterized by enjoyment, diversity, engagement, and well-trained teachers with sufficient and ongoing professional development can make to achieve the claim benefits of a PESS curriculum. Finally, given that 13 of the 23 studies included in this review were conducted in the United States, there is a strong case for more experimental studies to be conducted in other developed and developing nations.

Conclusions

Evidence was found that the most effective teaching strategy to increase children's levels of physical activity and improve movement skill proficiency in primary schools was direct instruction, a prescribed curriculum, adopting a whole-school approach to physical activity and providing teachers with sufficient, ongoing professional development in using PE instruction methods and curriculum. For secondary schools, using a combination of prescribed PESS curriculum with elements of student choice and substantial teacher professional development combined with sufficient teaching resources have the potential to make important differences to levels of physical activity participation and should be promoted.

During the primary and secondary years of education, it is important to promote movement skill development and physical activity participation through PE and school sport programs. It is clear from the evidence presented in this review that primary school classroom teachers and PE specialist teachers alike are capable of making substantial improvements in these outcomes. Yet, a lack of high quality evaluations and adequate statistical power hampers conclusions concerning the effectiveness of interventions to improve enjoyment of physical activity in PESS. PE teachers,

researchers, and education and health policy makers need more evidence on how the diverse nature of PESS practice and pedagogy can play a central role in positively influencing young people's physical activity participation, movement skill proficiency and enjoyment of physical activity, which in turn may then be capable of influencing health and educational policy internationally.

Appendix 1. Articles included in the review and assigned code numbers for referencing purposes in text

1. Dudley D, Okely A, Pearson P, and Peat J (2010) Engaging adolescent girls from linguistically diverse and low income backgrounds in school sport: A pilot randomised controlled trial. *Journal of Science and Medicine in Sport* 13(2): 217–224.
2. Salmon J, Ball K, Hume C, Booth M, and 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. *International Journal of Obesity* 32(4): 601–612.
3. van Beurden E, Barnett L, Zask A, Dietrich U, Brooks L, and Beard J (2003) Can we skill and activate children through primary school physical education lessons? 'Move it Groove it' – a collaborative health promotion intervention. *Preventive Medicine* 36(4): 493–501.
4. Jamner MS, Spruit-Metz D, Bassin S, and Cooper DM (2004) A controlled evaluation of a school-based intervention to promote physical activity among sedentary adolescent females: Project FAB. *Journal of Adolescent Health,* 34(4): 279–289.
5. McKenzie TL, Sallis J, Prochaska J, Conway T, Marshall S, and Rosengard P (2004) Evaluation of a two-year middle-school physical education intervention: M-SPAN. *Medicine and Science in Sports and Exercise* 36(8): 1382–1388.
6. Neumark-Sztainer D, Story M, Hannan P, and Rex J (2003) New Moves: A school-based obesity prevention program for adolescent girls. *Preventive Medicine* 37(1): 41–51.
7. Fairclough SJ, Stratton G (2006) Effects of a physical education intervention to improve student activity levels. *Physical Education & Sport Pedagogy* 11(2): 29–44.
8. Gorely T, Nevill M, Morris J, Stensel D, and Nevill A (2009) Effect of a school-based intervention to promote healthy lifestyles in 7–11 year old children. *International Journal of Behavioral Nutrition and Physical Activity* 6(5): 1–12.
9. Gortmaker S, Cheung L, Peterson K, Chomitz G, Cradle J, Dart H, et al. (1999) Impact of a school-based interdisciplinary intervention on diet and physical activity among urban primary school children – Eat Well and Keep Moving. *Archives of Pediatric Adolescent Medicine* 153(9): 975–983.
10. Gortmaker SL, Peterson K, Wiecha J, Sobol AM, Dixit S, Fox MK, and Laird N (1999) Reducing obesity via a school-based interdisciplinary intervention among youth: Planet health. *Archives of Pediatrics and Adolescent Medicine* 153(4): 409–418.
11. Harrell JS, McMurray RG, Bangdiwala SI, Frauman AC, Gansky SA, and Bradley CB (1996) The effects of a school-based intervention to reduce cardiovascular disease risk factors in elementary school children: The Cardiovascular Health in Children (CHIC) Study. *The Journal of Pediatrics* 128(6): 797–805.

12. Jurg ME, Kremers SPJ, and Van Der Wal MF (2006) A controlled trial of a school-based environmental intervention to improve physical activity in Dutch children: JUMP-in, kids in motion. *Health Promotion International* 21(4): 320–330.
13. McKenzie TL, Nader PR, Strikmiller PK, Yang M, Stone EJ, Perry CL, et al. (1996) School physical education: Effect of the child and adolescent trial for cardiovascular health. *Preventive Medicine* 25(4): 423–431.
14. Naylor P, Macdonald H, Zebedee J, Reed K, and McKay H (2006) Lessons learned from Action Schools! BC – An 'active school' model to promote physical activity in elementary schools. *Journal of Science and Medicine in Sport* 9(5): 413–423.
15. Pangrazi R, Beighle A, Vehige T, and Vack C (2003) Impact of Promoting Lifestyle Activity for Youth (PLAY) on children's physical activity. *Journal of School Health* 73(8): 317–321.
16. Pate R, Ward D, Saunders R, Felton G, Dishman R, and Dowda M (2005) Promotion of physical activity among high-school girls: A randomized controlled trial. *American Journal of Public Health* 95(9): 1582–1587.
17. Sallis J, McKenzie TL, Alcaraz J, Kolody B, Faucette N, and Hovell M (1997) The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. Sports, Play and Active Recreation for Kids. *American Journal of Public Health* 87(8): 1328–1334.
18. Simons-Morton B, Parcel GS, Baranowski T, Forthofer R, and O'Hara NM (1991) Promoting physical activity and a healthful diet among children: Results of a school-based intervention study. *American Journal of Public Health* 81(8): 986–991.
19. Webber L, Catellier D, Lytle L, Murray D, Pratt C, Young D, et al. (2008) Promoting physical activity in middle school girls: Trial of activity for adolescent girls. *American Journal of Preventive Medicine* 34(3): 173–184.
20. McKenzie TL, Alcaraz J, Sallis J, and Faucette N (1998) Effects of a physical education program on children's manipulative skills. *Journal of Teaching Physical Education* 17(3): 327–341.
21. Pieron M, Cloes M, Delfosse C, and Ledent M (1996) An investigation of the effects of daily physical education in kindergarten and elementary schools. *European Physical Education Review* 2(2): 116–132.
22. Christodoulidis T, Papaioannou A, and Digelidis N (2001) Motivational climate and attitudes towards exercise in Greek senior high school: A year-long intervention. *European Journal of Sport Science* 1(4): 1–12.
23. Digelidis N, Papaioannou A, Laparidis K, and Christodoulidis T (2003) A one-year intervention in 7th grade physical education classes aiming to change motivational climate and attitudes towards exercise. *Psychology of Sport and Exercise* 4(3): 195–210.

References

Alderson P, Green S, and Higgins JP (eds) (2005) Assessment of study quality [Cochrane Review] In: *The Cochrane Library.* Issue 1. Chichester: John Wiley & Sons.

Armour KM, Makopoulou F, Chambers F, and Duncombe R (2010) Career-long professional development learning for the professional physical education teacher. In: Bailey R (ed) *Physical Education for Learning: A Guide for Secondary Schools.* Continuum International Publishing: London.

Armour KM, Yelling M (2007). Effective professional development for physical education teachers: The role of informal, collaborative learning. *Journal of Teaching in Physical Education* 26(2): 177–200.

Australian Government Preventative Health Taskforce (2010) *Australia: The healthiest country by 2020 Discussion Paper.* Australian Government: Canberra.

Australian Government Independent Sport Panel (2009) *The Future of Sport in Australia (Crawford Report)*. Australian Government: Canberra.

Bailey R (2006) Physical education and sport in schools: A review of benefits and outcomes. *Journal of School Health* 76(8): 397–401.

Biddle SJH, Gorely T, and Stensel DJ (2004) Health-enhancing physical activity and sedentary behaviour in children and adolescents. *Journal of Sports Sciences* 22(8): 679–701.

Bunker D, Thorpe R (1982) A model for teaching games in secondary schools, *Bulletin of Physical Education* 18(1): 5–8.

Cale L (2000) Physical activity promotion in secondary schools. *European Physical Education Review* 6(1): 71–90.

Center for Disease Control and Prevention (1997) Guidelines for school and community programs to promote lifelong physical activity among young people. *Morbidity and Mortality Weekly Report*: 46.

Davies P (1999) What is evidence-based education? *British Journal of Educational Studies* 47(2): 108–121.

Des Jarlais DC, Lyles C, Crepaz N, et al. (2004) Improving the reporting of quality of nonrandomized evaluations of behavioural and public health interventions: The TREND statement. *American Journal of Public Health* 94(3): 361–366.

Hattie J (2003) Teachers make a difference. What is the research evidence? *Presentation made for Australian Council of Educational Research.* Canberra: October 2003.

Hattie JAC (2009) *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement.* London: Routledge.

Jago R, McMurray RG, Bassin S, Pyle L, Bruecker S, Jakicic JM, et al. (2009) Modifying middle school physical education: Piloting strategies to increase physical activity. *Pediatric Exercise Science* 21(2): 171–85.

Kay W (2005) Physical Education - Quality: A quality experience for all pupils. URL (consulted 13 October 2006): http://www.ccpr.org.uk/dyncat.cfm?catid=15898.

Kahn EB, Ramsey LT, Brownson RC, et al. (2002) The effectiveness of interventions to increase physical activity. *American Journal of Preventive Medicine*. 22(4S): 73–107.

Kemper HCG (1990) Exercise and training in childhood and adolescence. In: Torg J, Welsh P and Shephard RJ (eds) *Current therapy in sports medicine 2*. Philadelphia, BC: Decker, 11–17.

Kirk D (2005) Physical Education, Youth sport and lifelong participation: The importance of early learning experiences. *European Physical Education Review* 11(3): 239–255.

Lee SM, Burgeson CR, Fulton JE, Spain CG (2007) Physical education and physical activity: Results from the school health policies and programs study 2006. *Journal of School Health* 77(8): 435–463.

McKenzie TL, Li D, Derby CA, Webber LS, Luepker RV, Cribb P (2003) Maintenance of effects of the CATCH physical education program: Results from the CATCH-ON study. *Health Education Behaviour* 30(4): 447–462.

McKenzie TL, Sallis JF, Prochaska JJ, Conway TL, Marshall SJ, Rosengard P (2004) Evaluation of a two-year middle-school physical education intervention: M-SPAN. *Medicine Science Sports and Exercise* 36(8): 1382–1388.

Moher D, Hopewell S, Schulz KF, et al. (2010) CONSORT 2010 explanation and elaboration: Updated guidelines for reporting parallel group randomised trials. *British Journal of Medicine* 340: 1–28.

Morgan K, Kingston K, and Sproule J (2005) Effects of different teaching styles on the behaviours that influence motivational climate and pupils' motivation in physical education. *European Physical Education Review* 11(3): 257–285.

Mosston M, Ashworth S (1986) *Teaching physical education.* Merill: Ohio.

Pate RR, Pratt M, Blair SN, et al. (1995) Physical activity and public health: A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of American Medical Association* 273(5): 402–407.

Popper KR (1968) *The LOGIC of scientific Discovery* (3rd Ed.). London: Hutchinson.

Rink JE, Hall TJ (2008) Research on effective teaching in elementary school physical education. *Elementary School Journal* 108(3): 207–218.
Sallis J, Mckenzie TL (1991) Physical education's role in public health. *Research Quarterly in Exercise and Sport* 62(2): 124–137.
Sallis J, McKenzie TL, Alcaraz J, Kolody B, Faucette N, and Hovell M (1997) The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. Sports, Play and Active Recreation for Kids. *American Journal of Public Health* 87(8): 1328–1334.
Sallis JF, Owen N (1999) *Physical Activity and Behavioural Medicine.* Thousand Oaks, CA: SAGE.
Scriven M (2005) Causation. In: Mathison S (Ed) *Encyclopedia of evaluation.* Thousand Oaks, CA: SAGE.
Seidel T, Shavelson RJ (2007) Teaching effectiveness research in the past decade: The role of theory and research design in disentangling meta-analysis results. *Review of Educational Research* 77(4): 454–499.
Siedentop D (1994) *Quality PE through positive sport experiences: Sport education*. Champaign, Il: Human Kinetics.
Sparkes A (1992) The paradigms debate: An extended review and a celebration of difference. In: Sparkes AC (ed.), *Research in Physical Education and Sport: Exploring Alternative Visions*. London: The Falmer Press, 9–60.
Stone EJ, McKenzie TL, Welk GJ, and Booth ML (1998) Effects of physical activity intervention in youth. Review and synthesis. *American Journal of Preventive Medicine* 15(4): 298–315.
Tinning R, Kirk D (1991) *Daily physical education*. Collected papers on health based physical education in Australia. Geelong, Australia: Deakin University Press.
United Nations Educational, Scientific, and Cultural Organization (2010) URL: http://www.unesco.org/new/en/social-and-human-sciences/themes/sport/physical-education-and-sport/quality-physical-education/.
US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Adolescent and School Health (2010) *Strategies to Improve the Quality of Physical Education*. Washington, DC: United States Government.
van Sluijs EM, McMinn AM, and Griffin SJ (2007) Effectiveness of interventions to promote physical activity in children and adolescents: Sytematic review of controlled trials. *British Medical Journal* 335(7622): 703.
Wiersma LD (2001) Conceptulization and development of the sources of enjoyment in youth sport questionnaire. *Measurement in Physical Education and Exercise* 5(3): 153–177.

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