



Specific Strategies for Promotion of Physical Activity in Kids—Which Ones Work? A Systematic Review of the Literature

Abstract: *The purpose of this systematic review was to summarize and evaluate the impact of physical activity (PA) interventions that were implemented in specific school settings on children's PA in those settings. Four research databases were searched to identify PA interventions. Of the 13 706 articles identified, 1352 abstracts were screened and 32 intervention studies were reviewed. Five intervention settings were identified (active travel, after school, classroom, physical education, and recess). Among these settings, a greater proportion of positive findings (ie, significant increase in PA) were found in the classroom (75%) and active travel (67%) settings. Additionally, a higher proportion of interventions implemented in these settings were of high methodological quality (active travel [33%] and classroom [33%]). These findings indicate that interventions in active travel and classrooms settings positively influence youth PA. Importantly, as evidenced in this review, evaluating intervention effects in the targeted setting may provide unique information for*

future researchers to consider when developing school-based multicomponent PA interventions.

Keywords: physical activity; intervention; school; youth

with this recommendation.⁴ To address this deficiency, many authorities have called for implementation of interventions to increase PA in youth.^{5,6} Because most young people spend large amounts of time in school, the

 Among the many approaches that have been tested, multicomponent school-based interventions have been most consistently successful in increasing students' PA [physical activity] 

Considerable evidence suggests that engaging in physical activity (PA) provides important health benefits for children and adolescents.^{1,2} Given this, the 2008 Physical Activity Guidelines for Americans indicate that youth should participate in 60 minutes of moderate-to-vigorous PA per day.³ However, less than 50% of American youth comply

with this recommendation.⁴ To address this deficiency, many authorities have called for implementation of interventions to increase PA in youth.^{5,6} Because most young people spend large amounts of time in school, the school setting is seen as an attractive one for implementing PA interventions.^{7,8}

Over the past 2 decades numerous school-based PA interventions have been evaluated.^{9,10} Among the many approaches that have been tested, multicomponent school-based interventions have been most consistently successful in increasing

DOI: 10.1177/1559827615616381. Manuscript received June 5, 2015; revised October 17, 2015; accepted October 19, 2015. From the Department of Exercise Science, Arnold School of Public Health, University of South Carolina, Columbia, South Carolina. Address correspondence to Samantha M. McDonald, MS, Department of Exercise Science, Arnold School of Public Health, University of South Carolina, 921 Assembly Street Suite 212, Columbia, SC 29208; e-mail: mcdona84@email.sc.edu.

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students' PA.¹¹ Such interventions typically have combined strategies in school settings such as physical education classes, transport to school, recess, classroom activities, and after-school programs. While multicomponent interventions have been successful in modifying youth PA, these changes are modest, at best.¹² These small changes may be a result of the study designs employed, which have possibly been limited to the measurement of PA across the school day or entire day.¹³ Consequently, evaluating the intervention effects across an extended period of time potentially results in diluted changes in youth PA.

An optimal multicomponent school-based intervention would combine intervention strategies, each of which is known to substantially increase students' PA in the targeted setting. However, because previous reviews on school-based PA interventions have likely focused on the impact of such interventions on overall daily PA,¹³ the effectiveness of these interventions on youth PA in the setting in which the intervention was implemented has not yet been evaluated. To our knowledge, no previous review has been designed to assess the effectiveness of setting-specific interventions on children's PA levels when observed in those settings. Accordingly, the purpose of this review was to summarize and evaluate the impact of PA interventions that were implemented in specific school settings on children's PA in those settings.

Methods

Search Strategy and Selection of Articles

The literature search for this review was conducted with the purpose of identifying interventions aimed at promoting PA among youth in various school settings. Five school settings were identified prior to the literature search: active travel, after school, classrooms, physical education, and recess; however, the search was not restricted to these settings, allowing for others to potentially be discovered.

Four electronic research databases were searched (PubMed, Web of Science, Academic Search Premiere, and PsychInfo) to identify interventions aimed at increasing PA among youth. Various combinations of the following keywords were used to identify full-text peer-reviewed articles: ("physical activity" OR "exercise") AND ("interventions" OR "trials" OR "programs" OR "school interventions") AND ("afterschool" OR "classroom" OR "breaks" OR "recess" OR "active travel" OR "active transport" OR "physical education"). Bibliographies of articles and review papers identified by the searches were scanned to ensure a thorough collection of the literature. There were no restrictions placed on date of publication or location of the study; however, in order to be included in this review, studies had to meet the following inclusion criteria:

1. Included a control condition
2. Evaluated PA as the primary outcome
3. Implemented in a school setting
4. Measured PA at baseline and postintervention in the intervention setting
5. Included participants between ages 3 and 18 years of age

In addition, studies that exclusively measured total day PA were excluded as the intervention effects on youth PA in the setting (eg, active travel, after school, classroom) in which the intervention was implemented could not be ascertained.

Data Extraction

Data extracted from the selected articles included country, study design, sample size, participant characteristics, intervention details (ie, duration, setting, and components), methods used to measure PA, and primary outcomes. Participant information gathered from the studies included age, grade level, and sex and racial/ethnic composition of the sample. The intervention details included information on the duration (eg, number of weeks), the setting where

the intervention took place (eg, recess), and the major components of the intervention and any variations across the experimental conditions. Data collected on the methods used to measure PA included all objective (eg, accelerometer) or subjective (eg, survey) tools used to measure PA in the intervention setting. For the primary outcomes, information regarding the intervention effects on PA was extracted for only the setting in which the intervention was implemented. Additionally, if the intervention was effective at increasing PA for the whole sample, the findings were reported as "positive." If significant intervention effects were specific to a group (eg, males, normal weight) or were not sustained over multiple time periods, the findings were reported as "mixed." Last, if the intervention did not result in any significant effects on PA the findings were reported as "null." Following data extraction, the studies were grouped by the settings the interventions targeted (eg, recess), and the methodological quality and levels of evidence were assessed separately for each of the identified settings.

Methodological Quality

Methodological quality was assessed using an established scale,¹⁴ which has been used previously to determine the strength of evidence for the effectiveness of PA interventions among youth. Criteria for the quality assessment can be found in Table 1. Two researchers (SM, MC) independently evaluated each study and scored each criterion (10 criteria for randomized controlled trials [RCTs] and 9 criteria for quasi-experimental studies) as "positive," "negative," or "insufficiently described." Studies receiving a score of "negative" or "insufficiently described" were eventually collapsed into one category for ease of reporting. If any disagreements arose during the process, the authors reached a consensus by discussion.

After the methodological quality assessment was completed, 2 of the criteria from the assessment tool,

Table 1.Methodological Quality Assessment Criteria^a.

Criteria	Description
Randomization	<i>Positive</i> if a random assignment to the research groups was performed and had been described explicitly.
Control condition	<i>Positive</i> if the control group is from the same setting as the experimental group and (1) an alternate treatment was given (ie, attention control), (2) if there was a comparable condition that controlled for part of the intervention, (3) if standard practice was given (ie, standard PE curriculum, or if nothing was done).
Comparable groups	<i>Positive</i> if the comparability of the research groups was statistically tested before the start of the intervention and the tests showed that the experimental group and control group did not differ with respect to age and gender (if applicable), and at least one of the relevant outcome measures (PA). In case that the groups differ, <i>Positive</i> if this difference was corrected for in the analysis.
Dropout	<i>Positive</i> if (selective) dropout was described and when dropout was <20% for short-term follow-up (≤6 months) and <30% for long-term follow-up (>6 months) and methods for handling missing data were described.
Investigator blindness	<i>Positive</i> if the measurements were conducted by a person blind for group assignment or if data collection was done with questionnaires that the respondent could fill out in a situation not influenced by the researcher.
Respondent blindness	<i>Positive</i> if the respondent had (or could have had) no knowledge on the results of the group assignment.
Timing of measurements	<i>Positive</i> if the measurements were conducted at comparable moments for both the control group and the experimental group.
Follow-up	<i>Positive</i> if a follow-up of 6 months or longer and was described.
Intention-to-treat analysis	<i>Positive</i> if all initially included and group-assigned participants are mentioned and analyzed in the same groups.
Control of confounders	<i>Positive</i> if the analysis controlled for potential confounders and an adequate justification was provided, unless confounders are well-established in the literature (ie, age and sex).

^aAdapted from Van Sluijs and colleagues.¹⁴

“blinding (investigator)” and “blinding (respondent),” were dropped due to the difficulty of blinding in school settings. As a result, a total of 8 criteria were used to assess methodological quality for RCTs and 7 criteria for quasi-experimental studies. After all the criteria were scored, only the criteria with a “positive” score were tallied for each study. Methodological quality was categorized as either “high” (score ≥5 for RCTs and ≥4 for quasi-experimental designs) or “low” (score <5 for RCTs and <4 for quasi-experimental studies)

based on the total number of “positive” scores.

Levels of Evidence

To evaluate the level of evidence for the impact of interventions on youth PA across different settings, a previously established process developed by Van Sluijs et al¹⁴ was used. In addition to assessing the intervention effects, this process also considered the study design, methodological quality, and sample size of the intervention studies. There were 5 possible levels of

evidence that could be achieved in this process: strong, moderate, limited, inconclusive, or no. For each of these levels, certain criteria must have been met for the selected intervention studies. First, in order to reach a “strong” level of evidence, 2 or more large (>250 participants) high-quality RCTs with consistent positive findings were needed. Consistent negative findings yielded a “No,” whereas mixed findings resulted in an “inconclusive” level of evidence. If there was only one large high-quality RCT, findings from large

low-quality or small (≤ 250 participants) high-quality RCTs or large high-quality quasi-experimental studies were considered. However, given the less rigorous nature of these studies, consistent positive findings among these studies resulted in only a “moderate” level of evidence. If none of these types of studies were available, then in addition to the *one* large high-quality RCT, large low-quality and small high-quality quasi-experimental studies were considered. However, only a “limited” level of evidence could be obtained for consistent positive findings. If none of these studies were available for review, then the level of evidence for the effects of PA interventions on youth PA was considered “inconclusive.”

If *no* large high-quality RCTs were available for review, large high-quality quasi-experimental, low-quality RCT, or small high-quality RCT studies were considered. If there were *2 or more* of these studies with consistent positive findings, then the level of evidence was “limited.” If there was only *one* of these studies available, regardless of the findings (positive, negative, or mixed), the evidence was deemed “inconclusive.” Last, if *none* of these studies were available for review, then small high-quality and low-quality quasi-experimental studies were considered, and irrespective of the results, the level of evidence was determined to be “inconclusive.” If *none* of these studies existed in the literature, then it was determined that there was no evidence available to suggest that PA-promoting interventions were effective at influencing PA among youth.

Results

The systematic literature search identified 13 706 unique records, and all titles were screened for relevancy. Of the 13 706 titles screened, 12 354 were excluded because they were irrelevant to the purpose of the review, resulting in 1352 abstracts available for screening. Of the 1352 abstracts screened, 919 were excluded due to irrelevancy, yielding 433 studies available for eligibility screening. Of these, 359

studies were excluded for the following reasons: only assessed total PA ($n = 184$), no control group ($n = 58$), nonexperimental design ($n = 30$), nonspecific setting ($n = 11$), no PA assessment ($n = 48$), and other ($n = 28$). The remaining 74 studies were selected for the initial review. An additional 29 studies were identified through reference tracking, yielding 103 studies. Seventy-one of these studies were excluded as they failed to meet the inclusion criteria on further review: only assessed total day ($n = 16$), no control group ($n = 6$), nonspecific setting ($n = 39$), nonexperimental design ($n = 2$), and other ($n = 8$), resulting in 32 studies deemed eligible for final review. For further details on the study selection and ascertainment process, see Figure 1.

Overall Study Characteristics

Fifty-percent of the intervention studies employed an RCT study design (see Table 2).^{15-17, 19-30, 32} Seventeen studies were conducted in the United States,* 12 in Europe (Amsterdam [$n = 1$],²⁴ Belgium [$n = 2$],^{16,30} Cypress [$n = 1$],²³ England [$n = 6$],^{26,38-42} and Scotland [$n = 2$]^{43,44}), and 3 in Australia.^{15,45,46} A majority of the studies (97%) were implemented in samples consisting of boys and girls aged 5 to 13 years. One study was conducted in females only.²⁶ Fourteen studies reported the racial/ethnic composition of their sample (predominantly White [$n = 7$][†] and mostly non-White [$n = 7$]).^{18,22,27,31-34} The intervention studies were published between 1993 and 2013.

Active Travel

Seven intervention studies aimed to increase PA in youth through active travel[‡] to and from school. RCTs were employed in 3 studies,^{15,17,32} and the remaining 4 used a quasi-experimental design.^{18,35,43,44} Sample sizes ranged from 60 to 1966. All studies were conducted in elementary school-aged children (5-11 years). The duration of

the active travel interventions ranged from 1 month¹⁷ to 2 years.³⁵ Interventions in 3 studies consisted of providing education materials (eg, packets, lessons) to children and/or parents regarding active travel to and from school.^{15,43,44} The remaining 4 interventions implemented the Walking School Bus Program, which provided transportation to specific “drop-off” locations where students walked on predetermined routes to and from school with supervised personnel.^{17,18,32,35} Three intervention studies utilized objective measures of PA (eg, accelerometers [$n = 3$]),^{17,32,43} and the remaining 4 used self-report measures.^{15,18,35,44} Four of the intervention studies reported significant increases in PA outcomes (ie, % active travelling to school, PA, moderate-to-vigorous PA [MVPA], distance walked to school).^{17,18,35,44} Two studies reported no statistically significant changes in PA,^{32,43} and 1 study reported mixed findings.¹⁵

Results of the methodological assessment for each criterion can be found in Table 3. Briefly, 2 of the 3 RCTs provided sufficient information on randomization procedures.^{15,32} Seventy-one percent of all active travel studies used an appropriate control condition.^{15,17,18,32,44} A majority (57%) did not provide or insufficiently described attrition rates and/or methods for handling missing data.^{18,35,43,44} Only 14% of studies had a follow-up period (≥ 3 measurements and ≥ 6 months). More than half (57%) of the studies either failed to control for important confounding variables (eg, age, sex) or provided inadequate information on potential covariates.^{17,18,43,44} Two of the 3 RCT studies were considered high quality,^{15,32} and all 4 quasi-experimental studies were of low quality.^{18,35,43,44}

After School

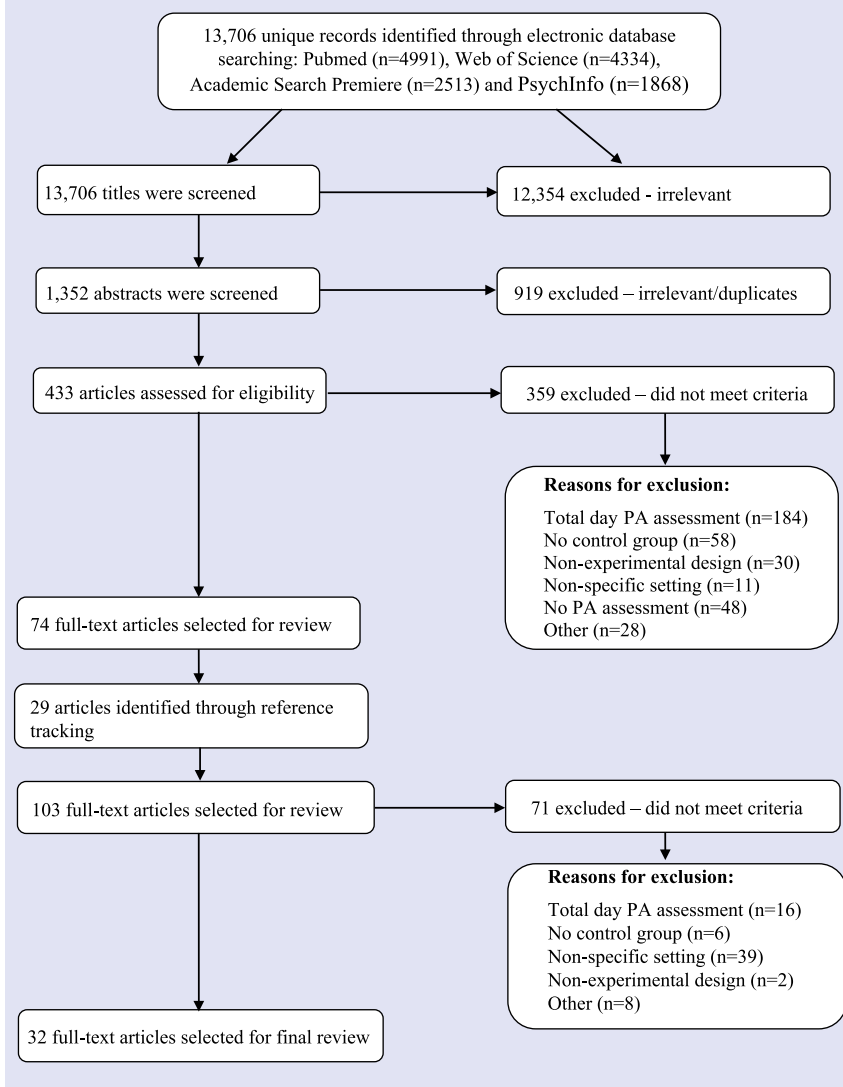
Three studies were conducted in the after-school setting,^{22,28,33} of which 2 employed an RCT design.^{22,28} Sample sizes varied from 156 to 273 participants aged 9 and 10 years. The duration of the interventions ranged from 6 months to 3 years. All 3 studies

[‡]References 15, 17, 18, 32, 35, 43, 44.

*References 17-22, 25, 27-29, 31-37.

[†]References 19, 24, 28, 29, 35-37.

Figure 1.
Study Selection and Ascertainment Process.



utilized a multicomponent approach to increase PA in this setting (eg, goal setting, skill training, education). Two of the intervention studies created objectives that included engaging youth in 30 minutes of PA,^{28,33} while the remaining study used the game of soccer as a means to increase PA.²² All 3 studies used an objective method to measure PA (accelerometers [n = 2], SOFIT [n = 1]). One study reported statistically significant increases in the percent of time spent in MVPA,³³ and the other 2 studies reported mixed findings.^{22,28}

Both studies employing an RCT design provided adequate information on randomization procedures.^{22,28} All 3 studies either did not describe or insufficiently described their control condition. Two of the 3 studies tested for baseline differences in participant characteristics between the experimental conditions.^{22,28} No studies provided information on attrition rates or had a follow-up period (≥ 3 observations and ≥ 6 months). Based on the methodological assessment, all studies received a low-quality rating.^{22,28,33}

Classroom Breaks

Four studies implemented interventions designed to increase PA during classroom breaks.^{29,31,36,37} Two studies used an RCT design.^{29,31} All studies were conducted in elementary school-aged children. The duration of the classroom break interventions ranged from 4 months³¹ to 3 years.²⁹ Sample sizes varied considerably, from 106 to 4599 children. All 3 intervention studies educated teachers on how to integrate PA breaks into their classrooms. PA goals varied greatly across the studies. One study only required teachers to implement a single 10-minute bout of PA each day³⁶; one study suggested implementing 10-minute bouts of PA throughout the day “as desired,”³¹ while the remaining 2 studies trained the classroom teachers to provide at least 30 minutes of PA on at least 3 days of the week.^{29,37} All 4 studies used objective measures of PA (SOFIT [n = 3]^{29,31,37} and pedometers [n = 1]³⁶). Three studies reported statistically significant increases in PA,^{29,36,37} and 1 study reported null findings.³¹

One of the 2 studies employing an RCT design sufficiently reported randomization procedures.²⁹ All 4 studies reported adequate information on their control condition. Only 25% of the studies tested for baseline differences in participant characteristics between the experimental conditions.²⁹ In addition, only 1 study provided information on attrition rates.³¹ Three studies either did not control for important confounding variables or did not adequately describe the methods for handling potential covariates.^{31,36,37} Only 1 study received a high-quality rating,²⁹ while the remaining studies received a low-quality score.^{31,36,37}

Physical Education (PE)

Five intervention studies were conducted in physical education classes.^{19-21,26,46} Four studies employed an RCT design.^{19-21,26} The interventions were implemented among youth aged 8 to 13 years, and sample sizes ranged from 1

Table 2.
Characteristics of Youth PA Interventions Among School Settings.

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
<i>Active Travel</i>						
Heelan ³⁵ (2009)	Quasi; 3 ES; N = 220	Age: 8.1 years (INT); 8.4 years (CON)	2 years	<i>Walking School Bus (WSB):</i> <ul style="list-style-type: none"> Dropped kids at designated stops 	Self-report log	The prevalence of children actively commuting to school was significantly higher in the WSB schools and effects maintained for 2 years. <i>Finding:</i> Positive
		<i>Race/ethnicity:</i> 90% White, 7% Hispanic <i>Sex:</i> % Female—52.7% (INT); 59.3% (CON)		<ul style="list-style-type: none"> Kid walked/supervised to and from school 		
McKee ⁴⁴ (2007)	Quasi; 2 ES; N = 60	<i>Total group:</i> Age: 9 years	10 weeks	The intervention comprised 2 components <ul style="list-style-type: none"> <i>Curriculum:</i> Designed for teachers to deliver active travel projects in class and to integrate into varying topic areas. <i>Child/parent resource:</i> Packet contained several components including interactive tools, maps, walking routes to school, locations of crosswalks, distance and time charts for various routes to school. Goal setting activities were included to prepare children for walking to school. 	Questionnaires	Mean distance travelled by walking increased significantly from in the intervention schools compared to the control schools. Mean distance travelled by car decreased significantly in the intervention school compared the control schools. <i>Finding:</i> Positive
		<i>Sex:</i> Males—40%				

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
McMinn ⁴³ (2002)	Quasi; 5 ES; N = 166	Age: 8.7 years (INT); 8.6 years (CON)	6 weeks	<i>Travelling Green:</i> <ul style="list-style-type: none"> Teacher handbook containing activities and 13 lessons covering topics such as (road safety, healthy lifestyle and how the body functions). The students packet contained materials that promoted walking to school (eg, goal setting and logbook). 	Accelerometers	No significant group × time interactions for morning, afternoon or total commuting steps and MVPA. There were no significant group main effects for any commuting times or MVPA <i>Finding:</i> Null
Mendoza ¹⁸ (2009)	Quasi; 3 ES	<i>Sex:</i> Males—57% (INT); 62% (CON) <i>Total group:</i> Age: 5-11 years <i>Race/ethnicity:</i> INT—50% AA, 21% Asian, 20% Latino, 5% Caucasian, 4% AI CON: 67% AA, 18% Latino, 12% Asian, 3% Caucasian, 0% AI	1 year	<i>Walking School Bus Program (WSB):</i> <ul style="list-style-type: none"> WSB routes and recruited adult volunteers/students to walk students to school. Materials were distributed to intervention schools related to walking to school and pedestrian safety. 	Proportion assessed via a classroom survey	Significantly greater proportion of students walking to school in the intervention group at 1 month, 6 months, and 12 months, compared to the control condition. <i>Finding:</i> Positive

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
		CON2: 80% AA, 8% Caucasian, 8% Latino, 3% AI, 2% Asian		<ul style="list-style-type: none"> • Presentations on walking to school were given in the classrooms by local police department. 		
		Sex: Female—44% (INT); 43% (CON1); 52% (CON2)		<ul style="list-style-type: none"> • Two-Foot Tuesday—a weekly walk to school day. 		
Mendoza ³² (2011)	Cluster RCT; 8 ES; N = 149	Total Group: Age: 9.7 years Race/ethnicity: 1.3% NH White, 31.6% NH AA, 61.1% Hispanic, 4.0% Other, 3% Missing	5 weeks	Walking School Bus Program (WSB):	Self-report: % actively commuting; Accelerometers	Significant increase in the percent of children reporting active commuting in the intervention school compared to the control school. No significant between-group differences were found.
				<ul style="list-style-type: none"> • WSB routes and recruited adult volunteers/students to walk students to school. 		Finding: Null
				<ul style="list-style-type: none"> • Materials were distributed to intervention schools related to walking to school and pedestrian safety. 		
				<ul style="list-style-type: none"> • Presentations on walking to school were given in the classrooms by local police department. 		
				<ul style="list-style-type: none"> • Two-Foot Tuesday—a weekly walk to school day. 		

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
Stard ¹⁷ (2008)	RCT; 1 ES; N = 12	Total group: Age: 3rd to 5th grade	1 month	Walking School Bus (WSB): <ul style="list-style-type: none"> • Dropped kids at designated stops. • Kid walked/supervised to and from school. • The route mapped was the safest route relative to the students' homes and school. • A wagon carried the students' backpacks and instruments. 	Accelerometers	Significant increases in total PA and % time spent in MVPA for the intervention before school. Significant increase in total PA and % time spent in MVPA in the intervention during the general commute time compared to the control. <i>Finding: Positive</i>
Wen ¹⁵ (2008)	Cluster RCT; 24 ES; N = 1966	Total group: Age: 5th to 6th grade	2 years	Intervention <ul style="list-style-type: none"> • Professional development days for teachers • Resources to assist classroom learning • Monthly newsletters for parents • Pedometer-based walking activities 	Self-report: Parent and child	Student reported: No significant between-group differences in % walking to/from school. Parent reported: Significant increase the number of walking trips compared to the control. At 1 year, effects maintained. Significant between-group differences for the number of walking trips for those who live > 1 km from home to school. <i>Finding: Mixed</i>

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
<i>After School</i>						
Dzewaltowski ²⁸ (2010)	Nested cross-sectional group RCT; N = 273	Age: 9.34 (INT); 9.19 (CON)	3 years	Three-level intervention approach:	Accelerometers	Normal weight: Significantly increased MVPA from baseline to year 1 and decreased at year 3.
		Race/ethnicity: 53% White, 28% AA, 10% AI, 5% Hispanic, 1% Asian, 1% PI, 2% Other		<ul style="list-style-type: none"> Community and government 		Overweight/obese: Non-significant increase in MVPA
		Total group: Sex: Males—54% (total)		<ul style="list-style-type: none"> After-school staff training 		Total group: Significant between-group differences in total PA and MVPA (only at year 1) in mean minutes in active recreation time were. No significant between-group differences in the proportion of time spent in LPA, MPA, MVPA or VPA
				<ul style="list-style-type: none"> After-school program quality elements 		Finding: Mixed
				Quality elements:		
				<ul style="list-style-type: none"> Organized PA session for at least 30 minutes 		
				<ul style="list-style-type: none"> Healthy snacks 		

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
Kelder ³³ (2005)	Quasi; 16 ASPs; N = 157	Total group: Age: 9.0 years (total)	6 months	<ul style="list-style-type: none"> Weekly nutrition and PA education Intervention: 3 program elements 	SOFIT	Significant increases in % of time spent in MVPA for the intervention sites compared to the control sites.
		Race/ethnicity: 43% White, 34% Hispanic, 17% AA, 6% Other		<ul style="list-style-type: none"> 5-module education component focused on healthy food choices, prevention of chronic disease, and increasing MVPA at school and home. Goal setting, modelling, skills training and reinforcement were used. PA component: 4 objectives <ul style="list-style-type: none"> Engage students in 30 min of PA MVPA for at least 40% of the time Provide opportunities to practice skills for PA Provide enjoyable physical activities Snack component: To introduce healthful foods and teach skills on selecting and preparing snack foods. 		Finding: Positive
Madsen ²² (2013)	Cluster RCT; 6 ES; N = 156	Total group: Age: 9.8 years	9 months	SCORES: Program goals		BMI <85th percentile: No significant changes in MVPA during after-school program were found.

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
		Race/ethnicity: 12% AA, 32% Asian, 42% Latino, 0% White, 14% Other		<ul style="list-style-type: none"> Build competencies and skills supporting overall development (teamwork, leadership and academic commitment). 		BMI ≥ 85 percentile: Significant increases in MVPA during the after-school program on weekdays and Saturday.
		Sex: Females—40%		<ul style="list-style-type: none"> Children spend 2 days/week in soccer drill or games (~1 hour) 		Total group: No significant between-group differences for MVPA were found.
				<ul style="list-style-type: none"> On 2 non-soccer days students develop creative writing and performance skills (~1 hour) 		Finding: Mixed
				<ul style="list-style-type: none"> Organized soccer games Saturdays (~1 hour) 		
Classroom Breaks						
Donnelly ²⁹ (2009)	Cluster RCT; 24 ES, N = 1490	Total group: Age: 7.7 years Race/ethnicity: 77.4% Caucasian, 6.2% AA, 10.1% Hispanic, 1.6% NA, 1.2% Asian, 3.6% Multi-ethnic Sex: Males—48.8%	3 years	Intervention: <ul style="list-style-type: none"> 6-hour in-service training for teachers to develop competency and strategies 	SOFIT	Significantly higher intensities during classroom time in PAAC schools compared to control schools. Finding: Positive
				<ul style="list-style-type: none"> Deliver 90-minutes of MVPA in PAAC lessons per week 		
				<ul style="list-style-type: none"> PAAC lessons sought to integrate PA into academic lessons 		

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
Erwin ³⁶ (2011)	Quasi; 2 ES; N = 106	Total group: Age: 10.1 years Race/ethnicity: INT: 78% White, 8% AA, 3% Hispanic, 8% Asian	7 months	Intervention: • Provide one classroom PA break per day	Pedometers	Significant group × time interaction between compliant intervention group and control group. Intervention effects were sustained at 3-month follow-up.
		CON: 91% White, 4% AA, 1% Hispanic, 2% Asian		• Activity cards were provided to teachers to freely choose which activities best suited their classroom • Teachers were given autonomy on the frequency, duration and type of activity		Finding: Positive
				• Teachers were trained during two 30-minute sessions		
				○ Benefits of PA		
				○ Activities		
				○ Classroom management		
				○ Incorporating PA into academic setting		
Whitt-Glover ³¹ (2011)	Quasi; 7 ES; N = 4599	Total group: Age: 3rd to 5th grade Race/ethnicity: 21.8% Hispanic, 28.1% AA, 42.7% White	4 months	Instant recess: • Promotes 10-minute bouts of PA	SOFIT	Between-group differences were not tested. Finding: Null

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
				<ul style="list-style-type: none"> • Consisting of basic aerobic dance, callisthenics and sport movements • Low-impact moderate intensity and set to music • Teacher workshop provided discussions childhood obesity, Instant Recess and lesson plan development 		
Donnelly ³⁷ (1996)	Quasi; 2 school districts; N = 338	Total group: Age: 9.2 years	2 years	<p><i>Intervention:</i></p> <ul style="list-style-type: none"> • <i>Nutrition: LunchPower!</i> <ul style="list-style-type: none"> ○ Meals consisted of reduced energy, fat and sodium ○ 18 grade-specific nutrition education modules • <i>PA:</i> classroom teachers delivered activities utilizing large muscle groups for 30-40 min, 3 days/week 	SOFIT	Significant increases SOFIT scores the intervention compared to the controls.
		Race/ethnicity: 94.3% (INT), 93.6% (CON)				<i>Finding: Positive</i>
<i>Physical Education</i>						
Fairclough ²⁶ (2006)	RCT; 2 classes; N = 30-32	Total group: Age: 11-12 years	6 weeks	<p><i>Intervention:</i></p> <ul style="list-style-type: none"> • <i>PA:</i> classroom teachers delivered activities utilizing large muscle groups for 30-40 min, 3 days/week 	PA: SOFIT	Significant between-group differences in time spent in MVPA.

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
		Sex: Female only		<ul style="list-style-type: none"> • Modify lesson context and teaching behaviors to increase PA • 10 components were addressed: <ul style="list-style-type: none"> ◦ Organization of groups ◦ Use of space ◦ Equipment and resources ◦ Teaching approaches ◦ Lesson pace ◦ Teacher position ◦ Active learning ◦ Having fun ◦ Minimize instruction time ◦ Emphasizing inclusion 		<p><i>Finding: Positive</i></p>
McKenzie ²¹ (1993)	RCT; 7 ES; N = 28	Total group. Age: 4th grade	10 months	<p>SPARK:</p> <ul style="list-style-type: none"> • Promotion of high levels PA and skills practice • The curriculum was divided into 2 units: 	SOFIT	<p>Significant (PES vs TT and CON) were found for minutes of Very Active PA, NOT found for MVPA. No significant between-group differences for the proportion of time spent in MVPA and Very Active PA.</p> <p><i>Finding: Mixed</i></p>

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
				<ul style="list-style-type: none"> ○ Fitness (15 min) and sport skill development (15 min) 		
				<ul style="list-style-type: none"> ○ Lessons were 30 min; 3 days/week 		
				<ul style="list-style-type: none"> ● Teachers were provided detailed lesson plans details. 		
				<i>Trained Teachers Condition (TT):</i>		
				<ul style="list-style-type: none"> ● Teachers received 32 hours of curriculum training focusing on 3 goals: 		
				<ul style="list-style-type: none"> ○ Commitment to the PE curriculum 		
				<ul style="list-style-type: none"> ○ Comprehension of the units and activities 		
				<ul style="list-style-type: none"> ○ Develop class management and instructional skills to effectively implement SPARK 		
				<i>PE Specialists Condition (PES):</i>		
				<ul style="list-style-type: none"> ● PE specialists taught PE class rather than trained teachers 		
				<i>Control Condition:</i>		
				<ul style="list-style-type: none"> ● PE classes followed usual curriculum 		

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
McKenzie ²⁰ (1997)	RCT; 7 ES; N = 28	Total group: Age: 4th grade	3 years	SPARK:	SOFIT	<i>Long-term effect:</i> Significant between-group differences (PES vs TT and CON) for MVPA and Very Active PA. No significant between-group differences for the proportion of time spent in MVPA during PE lessons. Significant between-group differences (PES and TT vs CON) the proportion of time spent in Very Active PA.
				<ul style="list-style-type: none"> Promotion of high levels PA and skills practice 		<i>Termination:</i> Significant negative between-group differences (TT vs PES) for mins of MVPA and VPA in PE. Significant declines in PES for mins of MVPA and Very Active PA. TT non-significant declines in % time spent in Very Active PA.
				<ul style="list-style-type: none"> The curriculum was divided into 2 units: <ul style="list-style-type: none"> Fitness (15 min) and sport skill development (15 min) Lessons were 30 minutes; 3 days/week Teachers were provided detailed lesson plans details 		<i>Finding:</i> Mixed
				<i>Trained Teachers Condition (TT):</i>		
				<ul style="list-style-type: none"> Teachers received 32 hours of curriculum training focusing on 3 goals: <ul style="list-style-type: none"> Commitment to the PE curriculum 		

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
				<ul style="list-style-type: none"> Comprehension of the units and activities Develop class management and instructional skills to effectively implement SPARK 		
				<p><i>PE Specialists Condition (PES):</i></p> <ul style="list-style-type: none"> PE specialists taught PE class rather than trained teachers <p><i>Control Condition:</i> PE classes followed usual curriculum</p>		
McKenzie ¹⁹ (2004)	RCT; 24 MS	Total group: Age: 6th to 8th grade	2 years	<p><i>M-SPAN:</i></p> <ul style="list-style-type: none"> Professional development: 5-3 h sessions Designed to introduce active health-related PE Assist the design and implementation of an active PE curricula Develop teachers' class management and instructional skills to enhance PA 	PA: SOFIT	There was a significant group × time interaction for MVPA. Intervention effects were sustained for 2 years. No significant between-group differences for overall trend in the proportion of time spend in MVPA. Significant intervention effects were only found in boys.
		Race/ethnicity: 45% non-White			Teacher debriefing; Self-report	Finding: Mixed

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
		Sex: Males—52%		<ul style="list-style-type: none"> • <i>Playground Markings</i> <ul style="list-style-type: none"> ◦ Markings (trails, rivers, hopscotch) were painted on the playgrounds • <i>Play Equipment</i> <ul style="list-style-type: none"> ◦ Recess play equipment (eg, balls, discs, rings, wipes, bags) were provided • <i>Playground Markings + Equipment</i> <ul style="list-style-type: none"> ◦ Playground markings and equipment provided 		<i>Finding: Null</i>
Efrat ²⁷ (2013)	RCT; 3 ES; N = 161	<p><i>Total group:</i> Age: 4th grade</p> <p><i>Race/ethnicity:</i> Social: 31.0% White, 43.3% Latino, 12.1% AA, 8.6% Asian</p> <p><i>Model:</i> 34.7% White, 49.0% Latino, 8.2% AA, 8.2% Asian</p> <p><i>CON:</i> 21.3% White, 48.9% Latino, 14.9% AA, 14.9% Asian</p>	12 weeks	<p><i>Intervention:</i></p> <ul style="list-style-type: none"> • <i>Social prompting:</i> <ul style="list-style-type: none"> ◦ Discussed benefits of MVPA with kids prior to recesses • <i>Modelling:</i> 	Accelerometers	<p>Significant between-group differences (Model vs Control and Social vs Control) in change in MVPA. No significant differences in PA between Social and Model intervention groups.</p> <p><i>Finding: Mixed</i></p>

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
		Sex: Males—Social: 36.2%		<ul style="list-style-type: none"> Children learned 8 active-recess games 		
		Model: 40.8%				
		CON: 51.1%				
Huberty ³⁴ (2011)	Quasi; 4 ES; N = 262	Total group: Age: 3rd to 6th grade	9 months	<p><i>Ready for Recess:</i></p> <ul style="list-style-type: none"> • <i>Staff Training(ST):</i> 	Accelerometers	<p><i>Healthy boys:</i> Significant between-group differences in MVPA (EQ + ST vs others)</p> <p><i>Overweight boys:</i> Significant between-group differences (ST vs others) in MVPA</p>
		Race/ethnicity: 40% Caucasian, 28% AA, 29% Hispanic, 2% Asian, 1% Other		<ul style="list-style-type: none"> Organizing active games 		<p><i>Healthy girls:</i> Significant decrements in MVPA across all 4 conditions</p>
		Sex: Males—46%		<ul style="list-style-type: none"> Maximizing PA 		<p><i>Overweight girls:</i> Significant between-group differences (EQ + ST vs others) in MVPA</p>
				<ul style="list-style-type: none"> Managing misbehavior 		<p><i>Finding:</i> Mixed</p>
				<ul style="list-style-type: none"> Motivating PA 		
				<ul style="list-style-type: none"> • <i>Equipment (EQ):</i> 		
				<ul style="list-style-type: none"> Provided recreational equipment (eg, basketballs, Frisbees, beach balls, hula hoops, racquet nets, bowling balls) 		
				<ul style="list-style-type: none"> • <i>ST + EQ:</i> 		
				<ul style="list-style-type: none"> Received both staff training and equipment 		

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
Huberty ²⁵ (2013)	RCT; 8 ES; N = 667	Total group: Age: 9.7 years Sex: Females—53.8%	9 months	Ready for Recess: <ul style="list-style-type: none"> • Staff Training (ST): <ul style="list-style-type: none"> ◦ Organizing active games ◦ Maximizing PA ◦ Managing misbehavior ◦ Motivating PA • Equipment (EQ): <ul style="list-style-type: none"> ◦ Provided recreational equipment (eg, basketballs, Frisbees, beach balls, hula hoops, racquet nets, bowling balls) • ST + EQ: <ul style="list-style-type: none"> ◦ Received both staff training and equipment 	Accelerometers SOPLAY	Boys: Significant between-group differences (ST + EQ vs CON and ST vs CON) in MVPA. Girls: Significant negative between-group differences (ST vs CON). No significant between-group differences (EQ vs CON) in MVPA for boys or girls. Finding: Mixed
Janssen ²⁴ (2013)	RCT; 8 ES; N = 2310	Age: 8.6 (INT); 8.7 (CON) Race/ethnicity: INT: 8.1% Western, 91.9% non-Western; CON: 8.6% Western, 91.4% non-Western	10 months	Intervention: <ul style="list-style-type: none"> • Playground Markings: 	Accelerometers SOPLAY	Significant between-group intervention effects were found. Intervention effects were stronger for 10-12-year-old girls. Finding: Positive

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
		Sex: Males—56% (INT); 55.4% (CON)		<ul style="list-style-type: none"> Multicolored lines were painted on playgrounds to designate specific play areas (eg, soccer field, dance area). To encourage the use of play, only 2 classes were permitted to use the playground at one time. 		
				<ul style="list-style-type: none"> <i>Equipment</i> 		
				<ul style="list-style-type: none"> Play equipment was provided (eg, balls, Frisbees, ropes, gloves) 		
				<ul style="list-style-type: none"> PE teachers were encouraged to provide game rules, ideas and to engage in PA 		
Kelly ⁴⁵ (2012)	Quasi; 4 ES; N = 126	Total group: Age: 1st to 2nd grade	14 weeks	<i>Intervention:</i> <ul style="list-style-type: none"> Playground markings Game resources Ongoing support from project manager. Games included: Alphabet hopscotch, scattergories and number race 	Accelerometers; CAST 3 Observation Tool	No significant between-group differences for MVPA were found.
				<ul style="list-style-type: none"> Playground markings 		<i>Finding:</i> Null
				<ul style="list-style-type: none"> Game resources 		
				<ul style="list-style-type: none"> Ongoing support from project manager. 		
				<ul style="list-style-type: none"> Games included: Alphabet hopscotch, scattergories and number race 		
Loucaides ²³ (2009)	RCT; 3 ES; N = 247	Total group: Age: 11.1 years	3 months	<i>Intervention:</i>	Pedometers	Significant group × time interaction (CON-1 and CON-2 vs Control).

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
				<ul style="list-style-type: none"> • <i>CON-1: Playground Markings</i> 		No significant differences in PA were found between CON-1 and CON-2 groups.
				<ul style="list-style-type: none"> ○ Hopscotch, animals, trails were painted on playgrounds 		<i>Finding: Mixed</i>
				<ul style="list-style-type: none"> ○ Long and short jump ropes were provided 		
				<ul style="list-style-type: none"> ○ Focused on allocating space for team games 		
				<ul style="list-style-type: none"> ○ Teachers were instructed to not encourage PA 		
				<ul style="list-style-type: none"> • <i>CON-2:</i> 		
				<ul style="list-style-type: none"> ○ Focused on the allocation of play space for team games without playground markings or jump ropes. 		
Ridgers ⁴⁰ (2007)	Quasi; 26 ES; N = 298	Age: Boys: 8.3 years (INT); 7.8 years (CON); Girls: 8.3 years (INT); 7.9 years (CON) Sex: Males—51% (INT); 50% (CON)	6 weeks	<ul style="list-style-type: none"> • <i>Playground markings and Equipment:</i> <ul style="list-style-type: none"> ○ Multicolor playground markings • <i>Activity Zones</i> <ul style="list-style-type: none"> ○ Red Zone (sports) ○ Blue Zone (fitness and skills) 	Accelerometers	No significant intervention effects for MVPA or VPA were found. The intervention had a stronger effect on younger children.
						<i>Finding: Null</i>

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
				<ul style="list-style-type: none"> Yellow Zone (chill out) Games were provided for each zone Sports equipment were provided to all schools 		
Ridgers ⁴¹ (2007)	Quasi; 26 ES; N = 470	Age: Boys: 8.4 years (INT); 7.9 years (CON); Girls: 8.1 years (INT); 8.1 years (CON)	6 months	<p>Intervention</p> <ul style="list-style-type: none"> Playground markings and Equipment: <ul style="list-style-type: none"> Multicolor playground markings Activity Zones <ul style="list-style-type: none"> Red Zone (sports) Blue Zone (fitness and skills) Yellow Zone (chill out) Sports equipment were provided to all schools 	Accelerometers HR monitors	Significant group × time intervention effects were found for both MVPA and VPA between 6 weeks and 6 months measurement periods.
		Sex: Males—51% (INT); 48% (CON)				Finding: Positive
Ridgers ⁴² (2010)	Quasi; 26 ES; N = 470	Age: Boys: 8.4 years (INT); 7.9 years (CON); Girls: 8.1 years (INT); 8.1 years (CON)	12 months	<p>Intervention</p> <ul style="list-style-type: none"> Sports equipment were provided to all schools 	Accelerometers; HR monitors	Significant positive intervention effects found at 6 months were not sustained at 12 months.

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
		Sex: Males: 51% (INT); 48% (CON)		<ul style="list-style-type: none"> Playground Markings and Equipment: <ul style="list-style-type: none"> Multicolor playground markings Activity Zones <ul style="list-style-type: none"> Red Zone (sports) Blue Zone (fitness and skills) Yellow Zone (chill out) Games were provided for each zone Sports equipment were provided to all schools 		Finding: Null
Stratton ³⁹ (2000)	Quasi; 2 ES; N = 60	Total group: Age: 5 to 7 years Sex: Males—50% (INT); 50% (CON)	4 months	Intervention: <ul style="list-style-type: none"> 10 markings painted playgrounds (castle, dragon, pirate ship, clock face, flower maze, fun trail and dens, hopscotch, letter squares, snakes/ladders and circular maze 	HR monitors	No significant between-group differences were found for MVPA or VPA. Finding: Null
Stratton ³⁸ (2005)	Quasi; 8 ES; N = 99	Age: Early primary: 4 to 7 years; Late primary: 7 to 11 years	4 months	Intervention: (Same as above study)	HR monitors	Significant between-group differences were found for time spent in MVPA and VPA for both early and late primary youth.

(continued)

Table 2. (continued)

Author	Study Design and Sample Size	Sample Characteristics	Duration	Intervention	PA Measure	Outcomes
		Sex: % Males—INT: 47% (EARLY); 58% (LATE); CON: 44% (EARLY); 57% (LATE)		<ul style="list-style-type: none"> • <i>Early Primary:</i> 		<i>Finding:</i> Positive
				<ul style="list-style-type: none"> ○ 10 markings were painted playgrounds (castle, pirate ship, clock face, flower maze) 		
				<ul style="list-style-type: none"> • <i>Late Primary:</i> 		
				<ul style="list-style-type: none"> ○ Markings for netball, football, short tennis and targets for game related skills were painted on playgrounds. 		
				<ul style="list-style-type: none"> • Limited game equipment was provided 		
Verstraete ¹⁶ (2006)	RCT; 7 ES; N = 235	Age: 10.8 years (INT); 10.9 years (CON)	3 months	<i>Intervention:</i>	Accelerometers	<i>Morning recess:</i> Significant between-group differences were found for time spent in moderate PA. Significant negative between-group differences were found for time spent in MVPA. No significant between-group differences were found for VPA.
		Sex: Males—61.4% (INT); 41% (CON)		<ul style="list-style-type: none"> • Game equipment 		<i>Lunch break:</i> Significant between-group differences were found for MPA, MVPA and VPA.
				<ul style="list-style-type: none"> • Activity cards 		<i>Finding:</i> Mixed
				<ul style="list-style-type: none"> • Equipment included: jump ropes, double Dutch ropes, scoop sets, plastic hoops, super grips, etc 		

Abbreviations: ES, elementary school; MS, middle school; PS, primary school; ASP, after-school program; NH, non-Hispanic; AA, African American; AI, American Indian; NA, Native American; PI, Pacific Islander; INT, intervention condition; CON, control condition; PA, physical activity; MPA, moderate physical activity; MVPA, moderate-to-vigorous physical activity; VPA, vigorous physical activity; HR, heart rate; BMI, body mass index. "Finding" = the intervention effects were categorized as "positive," "mixed," or "null."

Table 3.Methodological Study Quality Assessment of Physical Activity Interventions by School Setting^a.

	Active Travel (n = 7)	After School (n = 3)	Classroom (n = 4)	Physical Education (n = 4)	Recess (n = 11)
Criteria ^b	Positive	Positive	Positive	Positive	Positive
Randomization ^c	67%	100%	50%	33%	33%
Control condition	71%	0%	100%	75%	55%
Comparable groups	23%	67%	25%	0%	27%
Dropout	43%	0%	25%	25%	36%
Timing of measurements	71%	67%	75%	0%	0%
Follow-up	23%	0%	25%	50%	82%
Intention-to-treat analysis	14%	0%	0%	0%	0%
Control for confounders	43%	33%	25%	25%	64%

^aStudies reporting on the effects of the same intervention across multiple publications were condensed for the methodological assessment.^bOnly the percentages of studies reporting a positive score for each criterion are presented. Studies that scored either a “negative” or “insufficiently described” were collapsed into one group.^cRandomization criteria excluded quasi-experimental studies; the number of randomized controlled trials for each setting is as follows: Active travel (n = 3); After school (n = 2); Classroom (n = 2); Physical Education (n = 3); Recess (n = 6).

school²⁶ to 24 schools.¹⁹ The duration of the interventions ranged from 6 weeks²⁶ to 3 years.²⁰ One study consisted of a female-only sample.²⁶ Two studies assessed the short-term²¹ and long-term effects²⁰ of the SPARK intervention, which focused on developing PE curricula designed to increase PA through fitness and sport skill development. One intervention study consisted of modifying current PE curricula to increase MVPA,¹⁹ and one trained teachers to modify lesson objectives to increase PA (eg, equipment use, group organization, active learning).²⁶ Another study used a multicomponent approach to increase PA (eg, education, equipment, workshops).⁴⁶ All 5 studies used an objective measurement tool for PA (SOFIT [n = 5]). One study reported positive significant findings for increases in MVPA,²⁶ and the remaining 4 studies reported mixed results.^{19,21,46}

Because 2 studies reported on the same intervention^{20,21} (ie, short-term and long-term effects), only one of these studies was used for the methodological

assessment.²⁰ Only one study reported adequate information regarding its randomization procedures.²⁰ Twenty-five percent of the studies provided details on study attrition rates.¹⁹ Half of the studies included a follow-up period,^{19,20} and 75% did not provide sufficient information or did not control for important covariates.^{19,20,26} None of the studies reported on or tested baseline differences in participant characteristics. All 4 studies received a low-quality rating.

Recess

Thirteen studies implemented interventions in the recess setting.* Six intervention studies employed a, RCT design.^{16,23-25,27,30} Three of the 13 studies assessed the effects of the same intervention over time (6 weeks, 6 months, and 12 months).⁴⁰⁻⁴² Sample sizes ranged from 60 to 2310 children aged 5 to 11 years. The duration of the interventions ranged from 4 weeks³⁰ to 12 months.⁴²

*References 16, 23-25, 27, 30, 34, 38-42, 45.

Two interventions consisted of training teachers to maximize PA opportunities during recess (eg, organized games, behavior management) and provided recess equipment (eg, balls, Frisbees, hula hoops).^{25,34} Seven intervention studies restructured playgrounds with markings (eg, activity zones) and provided equipment.[†] Two studies only provided play equipment as the intervention.^{16,39} One study employed an intervention that educated children on the benefits of MVPA and taught children active recess games.²⁷ All intervention studies used one or more objective measures of PA (accelerometers [n = 10],[‡] heart rate monitors [n = 3],^{38,39} pedometers [n = 1],⁴⁵ SOPLAY [n = 2],^{24,25} and CAST 3 [n = 1]⁴⁵). Three studies reported positive significant findings for PA during recess.^{24,38,41} Five studies reported mixed results,^{16,23,25,27,34} and the remaining 5 studies found no significant intervention effects.^{30,39,40,42,45}

[†]References 23, 24, 30, 38, 40-42.

[‡]References 16, 24, 25, 27, 30, 34, 40-42, 45.

Three of the 13 studies reported on short-term (ie, 6 weeks and 6 months) and long-term effects (ie, 12 months) on the same intervention; therefore, methodological quality was assessed once for the 3 studies, yielding 11 studies for the methodological quality assessment for recess interventions. Sixty-seven percent of the studies employing an RCT design provided either no or insufficient information regarding their randomization procedures.^{16,23,25,30} A majority (73%) of the studies either did not test or report baseline differences in participant characteristics.⁸ Only 36% of intervention studies reported study attrition rates.^{16,30,34,39} Eighteen percent of the recess intervention studies included a follow-up period,^{24,42} and 64% of the studies reported controlling for important covariates.¹¹ One of the 6 RCT studies was considered to have high methodological quality.²⁴ In addition, 1 of the 5 quasi-experimental studies received a high-quality rating.³⁸ The remaining 9 studies received low-quality ratings.

Effectiveness of Physical Activity Interventions

Only 38% (n = 12) of all the intervention studies reported significant positive changes in PA levels.⁴ Active travel and classroom break interventions reported the greatest number of positive findings, 75% and 67%, respectively. Significant positive changes in PA were found in less than 40% of the interventions implemented in physical education classes (25%), after-school settings (33%), and recess (27%). Similarly, only 17% (n = 5) of all intervention studies were considered to have high methodological quality, and 80% of these employed a randomized controlled trial design. Additionally, intervention studies conducted in the active travel and classroom settings included the greatest number of high-quality studies (33%). Only 22% of

studies implemented in the recess setting had high methodological quality, while no intervention studies conducted in the after-school or physical education settings received a high methodological quality rating. The level of evidence for the effectiveness of PA interventions on youth PA was deemed “inconclusive” for each of the intervention settings after accounting for the intervention effects, study design, methodological quality, and sample sizes of the intervention studies.

Discussion

The purpose of this review was to summarize and evaluate the impact of PA interventions that were implemented in specific school settings on children's PA in those settings. The major findings of this review include the following: (a) interventions implemented in the classroom and active travel settings were consistently found to produce increases in youth PA, (b) less than 20% of studies were of high methodological quality, (c) less than half of PA interventions resulted in significant positive changes in PA, and (d) the level of evidence regarding the effectiveness of PA interventions on youth PA was deemed inconclusive for each specific setting.

One of the unique aspects of this review was determining whether interventions were successful at increasing PA in their targeted settings. Using this approach allowed for the discovery of 2 settings (ie, active travel and classroom) that may provide the best opportunity for PA interventions to succeed. The “successfulness” of the interventions in these settings may be, in part, attributable to the intervention approach used. For example, of the 4 intervention studies conducted in the active travel setting that reported positive effects, 3 used the Walking School Bus program. This program consisted of school buses dropping students off at designated locations and groups of students then walking on predetermined routes to and from school with supervised personnel. Some attributes of this program, which may have contributed to its positive impact on PA,

are the use of existing resources (eg, school buses), limited training for volunteers, and ability of the intervention to be integrated into a child's daily routine (ie, getting to and from school). Similar to the intervention approaches used in the active travel setting, the interventions implemented in the classrooms were of comparable intensity, which may also explain their positive findings. These interventions required teachers to integrate PA into the classroom lessons throughout the school day. While these studies required slightly more training, specifically for the teachers, only a few resources (eg, activity cards, active videos) and little equipment were necessary for implementation. Given the decreased burden (eg, few resources and training) of the interventions in these 2 settings, teachers, volunteers, parents, and children may have been more receptive and compliant, potentially explaining the positive influence on youth PA.

Contrary to recent reviews,^{47,48} the findings from this review identified physical education and recess settings to be less consistent in producing increases youth PA. And, consistent with the findings from Pate and O'Neill,⁴⁹ the effectiveness of PA interventions in the after-school setting were limited. These findings do not suggest that future interventions should not be implemented in these settings, as evidence indicates that schools are an efficient vehicle for intervention implementation,^{7,50} but rather that the intervention approaches used and methodological study quality should be improved. In contrast to the intervention approaches used in the active travel and classroom settings, the strategies used in after-school and physical education interventions, in general, were more burdensome. These interventions generally required more intensive training of teachers and staff members, curriculum modifications, professional development workshops, and so on. The increased burden of these interventions may have led to decreased teacher and staff compliance and a reduction in the intervention dose delivered, which may have resulted in a

[§]References 16, 23, 25, 30, 34, 39, 42, 45.

^{||}References 24, 25, 27, 30, 38, 42, 45.

[†]References 17, 18, 24, 26, 29, 33, 35-38, 41, 44.

modest influence on youth PA. Similar to the active travel and classroom intervention studies, recess intervention approaches were fairly straightforward, as a majority of them consisted of playground renovation (eg, playground markings and play equipment). Despite the simple nature of these approaches, only 27% of recess interventions resulted in positive effects on youth PA. It is possible that only providing equipment and the opportunity for PA may be insufficient to influence PA. Previous studies suggest that other factors, such as adult participation and encouragement of PA, may be necessary.⁵¹

An additional explanation for the increased reporting of positive findings among active travel and classroom intervention studies may be the dichotomous behaviors (active vs sedentary) to which the intervention and control groups are exposed. For example, in the active travel and classroom settings, participants in the intervention groups are exposed to the active behavior of walking to school or engaging in short bouts of activity while participants in the control groups continue to engage in sedentary activities such as riding on a school bus, travelling in a car to school, or sitting at a desk. As a result, because of the distinct differences in these behaviors, changes in PA may be more pronounced and easier to detect. Conversely, in settings where PA opportunities already exist (ie, recess, physical education, and after school), the differences in the behaviors to which each group (intervention vs control) are exposed may be considerably less. For example, in physical education settings, participants in the intervention may engage in a PE lesson aimed at enhancing the quality of PA offered via strategies such as curriculum modification or providing additional equipment, while the control subjects continue participating in their existing physical education curriculum. As a result, because both groups are engaging in an active behavior (ie, PE lesson), detecting substantial changes in PA may be more challenging.⁵²

Consistent with previous systematic reviews,^{14,53} a majority of PA interventions among youth had low

methodological quality. In this review, only 20% of the intervention studies received a high-quality score. Specifically, interventions implemented in the active travel and classroom settings included the greatest proportion of high-quality studies, mostly RCTs, which may in part explain their increased effectiveness on youth PA. While all the interventions could have improved on at least one criterion on the methodological assessment, in this review, most studies failed to report study attrition rates, which is consistent with previous reviews.⁵³ Additionally, contrary to other reviews^{12,14} only one study performed an intention-to-treat analysis. Future studies should report study attrition rates, as they provide valuable information about the intervention, such as which population finds the intervention more attractive or useful (eg, younger, White, healthy) and the degree of burden imposed on participants. Likewise, future researchers should consider performing an intention-to-treat analysis, as this may provide important information about what dose of the intervention may be necessary to create positive effects (eg, number of PA sessions).

Given that nearly 80% of studies achieved a low methodological quality rating and only 38% reporting positive findings, it is not surprising that the level of evidence for the effectiveness of PA interventions on youth PA was deemed “inconclusive.” However, despite the fact that a majority of active travel (67%) and classroom (75%) interventions reported positive effects on PA and had a greater proportion of high-quality studies (33%), the level of evidence for these settings was “inconclusive.” In this case, considering the majority of the studies reported positive findings in these interventions, it seems that the large proportion of low-methodological quality studies may have been responsible for reducing the level of evidence for these settings.

There are strengths to the current systematic review, including the approach used to evaluate the effectiveness of PA interventions. In contrast to previous reviews,^{12,13,53} this review systematically assessed the

influence of PA interventions on youth PA in their targeted settings. Using this approach allowed for a more direct evaluation of the intervention effects on youth PA compared to the effects on PA throughout the day, which may be influenced by factors outside of the intervention. Another strength of this review was the established¹⁴ process for determining the level of evidence used which resulted in a more thorough evaluation of the effectiveness of PA interventions on youth PA.

As with any review, there are some limitations that warrant attention. First and foremost, the findings from this review on the effectiveness of interventions implemented in active travel, after school, classroom, physical education, and recess settings, are reflective of those intervention studies that measured PA in their specific setting. As a result, we cannot extend the conclusions drawn from this review on to intervention studies that solely assessed intervention effects on overall (or total day) PA. Second, it is possible that intervention studies may have been missed or excluded if the authors did not clearly state when PA was measured or in which setting the intervention was implemented. Third, the high level of heterogeneity of the measurements and expressions of PA (eg, minutes of MVPA, percent of time spent in PA, distance walked to school) precluded our ability to state the magnitude of the changes in PA found among the different settings. Fourth, in this review, the effects of an intervention were only considered “positive” if they were reflective of the entire sample, which may conflict with previous reviews. Using these criteria may have unfairly assessed the effectiveness of PA interventions, as it may be unlikely that a single intervention will elicit positive effects across all subgroups (eg, Black/White, male/female) of a particular sample. Nonetheless, it may also be argued while reaching all subgroups of a population is important, the implementation of several interventions to accomplish this may not be feasible.

The findings from this review suggest that interventions implemented in the active travel and classroom settings consistently resulted in positive influences

on PA among youth, and future researchers should continue to develop interventions in these settings. Although the after-school, recess, and physical education settings were found to be less consistent in producing increased youth PA, more research in these areas is warranted. Collectively, for the school settings identified in this review, the level of evidence regarding the effectiveness of interventions on youth PA was deemed “inconclusive,” in addition to a large proportion of the intervention studies achieving low methodological quality. Because of this, it is strongly recommended that more large-scale, rigorously designed intervention studies are needed. Importantly, the results of this review highlight the necessity for researchers to evaluate the impact of their intervention in the targeted setting. By doing so, this allows intervention settings that result in positive influences of PA levels among youth to be identified and enable researchers to develop more robust interventions, especially those using a multicomponent approach.

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Informed Consent

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Trial Registration

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