Review and Special Articles

After-School Program Impact on Physical Activity and Fitness

A Meta-Analysis

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Context: The majority of children do not participate in sufficient amounts of daily, health-enhancing physical activity. One strategy to increase activity is to promote it within the after-school setting. Although promising, the effectiveness of this strategy is unclear. A systematic review was performed summarizing the research conducted to date regarding the effectiveness of after-school programs in increasing physical activity.

Evidence acquisition: Databases, journals, and review articles were searched for articles published between 1980 and February 2008. Meta-analysis was conducted during July of 2008. Included articles had the following characteristics: findings specific to an after-school intervention in the school setting; subjects aged ≤18 years; an intervention component designed to promote physical activity; outcome measures of physical activity, related constructs, and/or physical fitness. Study outcomes were distilled into six domains: physical activity, physical fitness, body composition, blood lipids, psychosocial constructs, and sedentary activities. Effect sizes (Hedge's *g*) were calculated within and across studies for each domain, separately.

Evidence synthesis: Of the 797 articles found, 13 unique articles describing findings from 11 after-school interventions were reviewed. Although physical activity was a primary component of all the tested interventions, only eight studies measured physical activity. From the six domains, positive effect sizes were demonstrated for physical activity (0.44 [95% CI=0.28–0.60]); physical fitness (0.16 [95% CI=0.01–0.30]); body composition (0.07 [95% CI=0.03–0.12]); and blood lipids (0.20 [95% CI=0.06–0.33]).

Conclusions: The limited evidence suggests that after-school programs can improve physical activity levels and other health-related aspects. Additional studies are required that provide greater attention to theoretical rationale, levels of implementation, and measures of physical activity within and outside the intervention.
(Am J Prev Med 2009;xx(x):xxx)

Introduction

Participation in regular physical activity has numerous health benefits for youth, including positive mental health outcomes and a decreased chance for childhood obesity.[1] In addition, the role of physical inactivity in the development of metabolic syndrome in children is becoming increasingly apparent.[2] Despite these well documented associations, the physical activity levels of youth remain unacceptably low.[3] High inactivity levels are attributed to "activity-toxic" environments, which are those that have limited opportunity for physical activity, both inside and outside of school and for the disadvantaged.[4] For these reasons, organizations (e.g., the IOM)[5] and expert panels[6] have identified intervention development designed to increase the physical activity levels of youth as a major public health priority.

Schools are important institutions for physical activity promotion and, in recent years, have been called on to expand their efforts to increase activity-related opportunities for youth.[7,8] The vast majority of youth attend school, and schools have existing facilities and personnel needed to promote physical activity[9] through physical education, recess, classroom-based physical activity, staff wellness, intramural activities, parental involvement, and community collaboration.[10] Not surprisingly, schools have become the focal point for interventions designed to increase the health-enhancing physical activity of children and adolescents.

Despite these advantages, schools do have limitations, the most prominent of which is time constraints. De-

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0749-3797/09/$–see front matter
doi:10.1016/j.amepre.2009.01.033

mand for schools to improve the academic achievement of children has led to decreased amounts of time for physical education, recess, lunch, classroom-based physical activity, and other components of school-based physical activity promotion.[11] Additionally, although physical education is the primary form of activity students receive at school, only a handful of states require daily physical education. Further, physical education programs provide up to only 8%–11% of a student's daily physical activity.[12] Although physical activity interventions during the school day hold great potential and remain important, after-school programs are emerging as potentially useful and feasible locations for physical activity promotion. Recent data show that as many as 6.6 million youth in the U.S. participate in some form of after-school programming, and an additional 22 million families would be interested in after-school programming if it were available.[13] After-school programs do not detract from the school day and can be used to supplement physical activity time for youth. Additionally, these programs offer a safe environment for children to engage in activity and develop lifelong physical activity habits.[14] They can also provide as much as one third of a child's recommended 60 minutes/day of moderate-to-vigorous physical activity (MVPA).[15]

Although after-school physical activity interventions are becoming commonplace, and new research is currently underway,[16,17] the effectiveness of such programs in increasing the physical activity levels of participants is unclear. The purpose of this paper is to provide a systematic review of published research examining after-school programs targeting youth physical activity. Based on the review, implications for future research and program implementation are provided.

Evidence Acquisition

A systematic review of the literature was conducted to identify papers focused on promoting physical activity for children and adolescents, either as a sole intervention or as one component of a multi-component intervention (e.g., nutrition and physical activity), during after-school hours in the school setting. Given the after-school focus of the review, the search strategy targeted four key elements: school-based setting (primary or secondary); after-school program; physical activity behavior; and study design (intervention, quasi, or controlled). The following databases were searched for all relevant articles related to the key elements published between 1980 and February 2008: PubMed, ScienceDirect, and EBSCOhost. Additional searches were carried out on citations of included papers and published reviews on youth physical activity promotion.[18–24] The review was conducted and data were analyzed during July 2008.

Inclusion Criteria

Articles were included in the review if they met the following criteria: findings were specifically related to an after-school intervention; sample population consisted of children or adolescents (aged ≤18 years); the setting of the intervention was a school (public or private); the primary component or one of the components of the intervention was to promote physical activity; and outcome measures of physical activity and/or physical fitness were reported. Physical fitness was included as an outcome based on a number of studies indicating that the use of increased physical activity can promote changes in constructs related to physical activity (e.g., bone mineral density, cardiovascular fitness, blood lipids, and body composition). Studies could have been either quasi-experimental (using pre- and post-tests with no control and no randomization) or RCT. Exclusion criteria were: studies were descriptive in purpose; non-English publications; included an after-school component as one of several arms of an intervention and did not report findings separating the impact of attending an after-school program; were conducted in a nonschool setting (e.g., local health clubs); and/or provided an overview of study design without quantitative outcomes.

Program Outcomes

For the purpose of this review, program outcomes were coded and collapsed into six domains: physical activity, physical fitness, body composition, blood lipids, psychosocial constructs, and sedentary activities. Physical activity was defined as reports of bodily movement related to moderate physical activity (MPA); vigorous physical activity (VPA); total MVPA; total activity counts derived from accelerometers; daily step counts; and self-reported measures of physical activity involvement. Physical fitness was defined as any measure related to cardiovascular fitness (e.g., step test, systolic blood pressure); skeletal health (e.g., bone mineral density); and muscular strength (e.g., sit-ups). Measures of body composition included BMI, percent body fat, waist circumference, fat mass, fat-free mass, and skinfold thickness. Blood lipids included measures of blood lipid profiles (e.g., total cholesterol). Psychosocial measures were subdivided into three categories: measures related to physical activity (e.g., preferences, self-efficacy for); measures related to weight issues (e.g., body dissatisfaction); and nonspecific measures related to mental health (e.g., self-esteem, depression). Sedentary activities included measures related to television, computer, and video-game use.

Extracted Information

Identified study characteristics and relevant information were extracted into standardized forms. Data extracted from each study that were included in the final review were: program/intervention name; experimental design; duration; whether long-term follow-up assessment was conducted; unit of randomization (student, classroom, school); and sample characteristics (sample size; gender and ethnicity percentage; age/grade; location; and milieu [rural, urban, suburban]). These data also included targeted outcomes (physical activity, nutrition, fitness) and intervention characteristics (theoretic foundation; who delivered the intervention [teacher, research staff]; and whether training occurred). Finally, the data included measures and implementation. Information on measures included type of measure (self-report, objective); protocol; and number of measurements (pre-, mid-, post-tests). Implementation data included exposure, adherence, quality of delivery, responsiveness, and program differentiation. Additionally, study results in the form of means and SDs and/or SEs (depending on the reporting of the findings) related to the six domains were extracted. For articles in which insufficient information on program outcomes was reported, repeated attempts were made to contact first authors to request the required statistical information.

Effect Size

Standardized mean difference effect sizes were calculated for each study outcome. Based on the research focus of differences across treatment and control, with the majority of studies (85%) using one type of design (independent groups pre-test/post-test), the raw-score metric effect size definition[25] was used (i.e., the focus is on group differences in the outcome). The steps outlined by Morris and DeShon[25] were used to pool effect size estimates from studies using different designs (independent groups pre-test/post-test; repeated measures single group pre-test/post-test) into a common metric. The first step was identifying each study's design. Second, effect sizes were calculated for each study design. For articles that reported pre-test and post-test scores, the effect sizes using the independent groups (ES_{IG}) pre-test/post-test design were calculated as

$$ES_{IG} = \frac{(M_{post,E} - M_{pre,E})}{SD_{pre,E}} - \frac{(M_{post,C} - M_{pre,C})}{SD_{pre,C}},$$

where E and C refer to experimental and control groups, respectively. For studies using the independent groups pre-test/post-test design that did not report pre-test values, the effect sizes for independent groups were calculated as

$$ES_{IG} = \frac{(M_{post,E} - M_{post,C})}{SD_{post,C}}.$$

For a single study[26] using a repeated measures single group pre-test/post-test design,[27] the effect sizes ES_{RM} were calculated as

$$ES_{RM} = \frac{(M_{post,E} - M_{pre,E})}{SD_{pre,E}}.$$

For another study,[28] in which a binary outcome was reported, the Cox logged OR was computed[29] prior to aggregating this into the overall pooled effect sizes. Hedge's g[30] was used to adjust effect size estimates for small sample sizes by multiplying the effect size with the correction factor $(1-[3/\{4N–9\}])$ (where N is the total sample size). For each study, individual effect sizes and corresponding 95% CIs were calculated for each outcome measure related to the six domains discussed above.

All effect sizes were corrected for differences in the direction of the scales so that positive effect sizes corresponded to improvements in the treatment group, independent of the original scale's direction. This correction was performed for simplicity of interpretive purposes so that all effect sizes could be presented in the same direction and pooled within and across studies for each domain, separately. For studies reporting more than one outcome measure for a domain (e.g., MPA, VPA, and total activity time), a summary effect size was estimated representing the overall effect size for a given domain for each study.

In studies reporting baseline and multiple follow-up analyses, the adjusted effect sizes were estimated for each follow-up analysis, separately, using the follow-up time point and adjusting for baseline differences. For articles in which SEs were reported, SDs were computed as $SD = SE \times \sqrt{n}$. One study[31] reported findings from only the intervention group in five dose–response categories. For this study, effect sizes were calculated using the lowest dosage intervention group as the comparison group from which the additional four remaining dosage group effect sizes were computed. This calculation was based on the assumption that the lowest dosage group exposure would have reflected natural change observed in a control group.

An overall pooled effect size was estimated across all studies for each domain, by weighting the contribution of each study by the study's SD and sample size. Pooled effect sizes were calculated using a random-effects inverse variance[32] (proportional to the study's sample size) model based on the assumption that all studies were estimating different, yet related, treatment effects. The percentage of the total variability in an effect size due to heterogeneity (between-studies variability) was estimated with I-squared (I2).[33] The percentages associated with I2 are interpreted as low (25%), medium (50%), and high (75%) heterogeneity (i.e., between-study variability), respectively.

Sensitivity analyses were conducted on the pooled estimates to determine the influence of any given study's results on the overall effect size by omitting one study and re-estimating the pooled effect sizes. The sensitivity analysis allowed for the examination of the influence of study design, sample size, and outcome measure (i.e., continuous or binary) on the effect size for each domain. Because of the small sample of studies in the review, analyses investigating study characteristics (e.g., length of intervention, sample composition, location) related to treatment effect size were not conducted.

Evidence Synthesis

A total of 797 references met the initial search criteria from across the three databases and the review of references from prior studies. After review of title and abstract, a total of 314 candidate articles were retrieved. Candidate articles were searched by author and excluded if they did not meet the inclusion criteria. This process resulted in a total of 34 articles. Excluding duplicates across the databases, 13 unique articles were retained for the review.[26,28,31,34–43] Of these, a total of 11 different after-school physical activity promotion interventions were evaluated.

Because the purpose of this review is to describe the effects of after-school programs on physical activity, only outcomes associated with physical activity, physical fitness, or measures related to physical activity (i.e., body composition or psychosocial constructs) were reviewed. Information regarding effects on dietary behaviors or diet composition was not reviewed, nor were data related to parental involvement, as only one study reported on this effect.[34]

Intervention Characteristics

All reviewed articles focused on the increase of and/or gave information related to physical activity level as the sole strategy or as one of several strategies to improve the health-related behaviors of youth (Table 1). Additionally, four studies[26,28,34,35] used a combined dietary (e.g., adjusting fruit and vegetable intake or percent kcal from fat) and physical activity intervention. Four studies[34–37] reported on outcomes associated with changes in psychosocial variables related to physical activity (e.g., physical activity preferences), weight-related issues (e.g., body shape dissatisfaction), and/or general psychosocial health indicators (e.g., self-esteem, depression). Another four studies[35–38] reported on outcomes related to changes in sedentary activity involvement (e.g., TV viewing, video-game playing), and 10 studies[26,31,34,36,37,39–43] reported outcomes associated with changes in body composition (e.g., percentage body fat, waist circumference), physical fitness (e.g., cardiovascular fitness), skeletal health (e.g., bone mineral density), or blood lipids (e.g., cholesterol).

A total of nine studies[31,34,36,37,39–43] used an RCT design, with the remaining four studies employing a nonrandomized pre-test/post-test design either with a control group[35,38] or without a control group.[26,28] Of the RCT studies, three[34,36,37] utilized a two-arm parallel treatment design in which the control group participated in after-school clubs[34] or received a health education program focused on healthy eating and physical activity.[36,37] A theoretic framework that was used to guide intervention development and the assessment of outcomes for the tested intervention were discernable in five[26,34–36,43] of the 13 studies.[26,28,31,34–43] The Social Cognitive Theory was used as the theoretic foundation for program development in three studies,[34–36] with the Cognitive Behavior Theory[43] and PRECEDE–PROCEED model[26] used in the other two.

The average post-test sample size of the studies was 217.8±287.6 (median 116), with a range from 21[37] to 1044.[41] The average duration of the interventions was 26.9 weeks (±24.0 weeks) with a range of 9 weeks[43] to 96 weeks[40] (3-year study times estimated as 8 months per year duration as reported in prior publications[31,42]). Only one study[28] did not provide the duration of the intervention. The average contact time devoted to physical activity was 274.5 minutes/week (±125.4 minutes/week) with a range of 42 minutes/week[43] to 400 minutes/week.[31,40,42] If the number of sessions/week was not reported, it was assumed that the after-school program was offered 5 days/week. One study did not report the time frame of the program devoted specifically to physical activity.[28]

Evidence of Intervention Effectiveness

From the 13 articles,[26,28,31,34–43] a total of 153 effect sizes were calculated. Effects from one article[35] were not included because of insufficient information in the original article; repeated attempts were unsuccessful to contact the primary authors to request the additional information. Additionally, a reported finding related to body composition in one study[26] was excluded based on sensitivity analyses indicating the result had a significant negative effect on the pooled effect sizes. In that article,[26] the post-test number appeared to be misreported in the manuscript's table of findings and hence was associated with a large negative effect favoring pre-intervention values. The pooled effect sizes for each study, by domain, are presented in Table 2; the overall domain effect sizes are shown in Figure 1. To investigate the influence of the four studies[26,28,34,35] that used a combined physical activity and diet intervention on the overall effect size estimates, separate effect size analyses were conducted on the body composition, blood lipids, and psychosocial weight concerns domains. No evidence was found that the combined approach was more effective, and therefore, the presented results include all studies, regardless of program components.

The studies[26,28,31,34–43] reporting quantifiable outcomes included in the effect size calculations for each domain are presented in Table 2. The effect size point estimates across domains were mostly positive, with only

Table 1. Intervention characteristics of reviewed after-school studies targeting increases in physical activity

Study	Design; location	Target population	Participants	Intervention description
Slawta (2006)[26]	No control within four elementary schools; Ashland OR	Students aged 6–12 years	Overall: N=91 (pre) n=75 post (41 boys, 34 girls)	Intervention: Three times per week for 12 weeks. Focus on physical activity/exercise, nutrition, and family involvement. Physical activity sessions consisted of fitness activities such as running laps, strength training, and yoga. An incentive program was developed for motivation. Control: not utilized.
Herman (2006)[28]	No control, pre-test/post-test design; Stillwater OK	K–8th-grade students attending after-school program	Overall: N=43 (20 males, 23 females)	Intervention: 1 day per week for 90 minutes. Focus on the impact of an OK Cooperative Extension Services after-school education and gardening program on reported vegetable intake and physical activity among children. Control: not discussed.
Yin, Moore (2005)[31,a]	RCT within 18 schools; Augusta GA	Low-income 3rd-grade students	Intervention: n=278 (nine schools) (pre and post data), (128 boys pre, 132 girls pre)	Intervention: 5 days per week for 8 months. Focus on the effect of the intervention on aerobic fitness and body composition. The 2-hour sessions consisted of 40 minutes of academic time and snack followed by 80 minutes of physical activity. The physical activity environment was designed as a mastery-oriented climate with 40 minutes allocated for VPA. Sessions were supervised by physical education teachers and classroom teachers from schools. Control: not discussed.
Story (2003)[34,b]	Two-arm parallel group, RCT; Minneapolis MN	African-American girls aged 8–10 years, with BMI ≥25th percentile	Intervention: n=26 (all girls) Control: n=28 (all girls) Overall: N=54 pre (all girls) n=53 post (all girls)	Intervention: Two times per week for 12 weeks. Focus on increasing physical activity and healthy eating in girls. The 1-hour sessions were led by trained staff. Trainings emphasized the need and purpose of the intervention, the importance of modeling, and active rehearsal of activities. A family component consisted of family nights and encouraging children to make snacks at home. Control: after-school club; three sessions over 12 weeks; program not related to nutrition or physical activity.
Kelder (2005)[35,b]	Pilot study, quasi-experimental, pre-test/post-test design, two sites. Site 1: all three program components delivered; El Paso TX Site 2: only physical activity component delivered; Austin TX	3rd–5th-grade students	Overall: n=258 (pre), n=182 (post), n=157 (pre and post), 61% retention rate, 101 lost to follow-up El Paso site: n=117 (pre), n=69 (post); 59% retention rate; 48 lost to follow-up	Intervention: Group 1, 5 months duration. Physical activity component aimed to involve students in ≥30 minutes of daily physical activity, ≥40% of which should be MVPA, and to provide student with opportunities to practice physical activity skills to carry over to other times of day. Staff given training and "activity box." Group 2, same as Group 1, plus education and snack components consisting of nutrition activities, modules on healthy food choices, and increasing MVPA at school and home. Control group: no intervention.
Robinson (2003)[36]	RCT; Oakland and East Palo Alto CA	African-American girls aged 8–10 years, with a BMI ≥50th percentile for age or ≥one overweight parent/guardian	Intervention: n=28 (all girls) Control: n=33 (all girls) Overall: N=61 (all girls)	Intervention: 5 days per week for 3 months. Focus on using dance and family activities to reduce television viewing in African-American girls. Sessions lasted up to 2.5 hours and included 1 hour for homework and snack, 45–60 minutes of moderate to vigorous dance, and 30-minute discussions about the importance of dance. Sessions were led by African-American college students or recent college graduates recruited from local dance organizations. Instructors were trained in appropriate warm-ups, exercises, teaching routines, teaching techniques, first aid, and safety procedures. Control: state-of-the-art health education program to promote healthy eating and physical activity.

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Table 1. (*continued*)

Study	Design; location	Target population	Participants	Intervention description
Weintraub (2008)[37]	Two-arm parallel group, RCT; northern CA	Children in grades 4–5 with a BMI at or above the 85th percentile for age and gender	Intervention: n=9 Control: n=12 Overall: N=21 (pre and post)	Intervention: 3 days per week for 4 months, and 4 days per week for the 5th month. Focused on using after-school team sports program for reducing weight gain in low-income overweight children. Sessions of 2.25 hours consisted of homework time and then 75 minutes of physical activity for 2 days. The third day was used for game play. Leaders were Stanford University undergraduate and medical students trained in youth development, group management, and soccer curricula. Matches with parents attending were held quarterly. Control: "active placebo" including health education content.
Lubans (2008)[38]	Quasi-experimental in three secondary schools; New Castle, New South Wales, Australia	Students aged 14–15 years	Intervention: n=50 Control: n=66 Overall: N=116 n=97 (pre) n=87 (post)	Intervention: 8-week duration. Focus on increasing physical activity and decreasing sedentary behaviors of adolescents. Each 70-minute session consisted of 15 minutes of information and 55 minutes of physical activity. Specifically, each session consisted of an exercise (physical activity) component, education on behavior modification, and self-monitoring via pedometry. Participants received a goal-setting handbook and a pedometer. Trained instructors supervised the program and met regularly with researchers. Control: structured exercise only.
Barbeau (2007)[39]	RCT, randomized within each of eight schools to the intervention or control group with a ratio of 3:2; Augusta GA	Black girls aged 8–12 years weighing <300 lbs, not taking any medication known to affect body composition or fat distribution, and able to participate in regular physical activity	Intervention: n=118 (pre and post; all girls) Control: n=83 (pre and post; all girls) Overall: n=309 girls provided consent n=278 girls (pre) n=201 (pre and post)	Intervention: 5 days per week for 10 months (August to May). Focus on decreasing accumulation of adipose tissue in black girls through regular physical activity. Sessions were 110 minutes divided into 30 minutes for homework/snack and 80 minutes for physical activity. Physical activity sessions consisted of 25 minutes on skill development, 35 minutes of MVPA, and 20 minutes of toning and stretching. The MVPA time included sports and games to keep heart rate above 150 beats per minute. Classroom teachers and teacher assistants implemented the program and selected activities for the day. Instructors received training on childhood obesity, physical activity, cardiovascular risk factors, goals of the study, protocol, and activities. Training included role playing to prepare for lesson planning. Transportation was provided after each session. Small prizes were given weekly and monthly to reward behavior, effort, and attendance. Control: no intervention.
Gutin (2008)[40,a]	RCT within 18 schools; Augusta GA	All 3rd graders attending intervention schools	Intervention: n=148 (46% male; 54% female; 67% black) n=42 with >40% attendance (53% male; 47% female; 80% black) Control: n=168 (47% male; 53% female; 59% black) Overall: N=617 n=206 (post, met criteria)	Intervention: 5 days per week for 3 school years. Focus on the effect of the intervention on aerobic fitness. The 2-hour sessions consisted of 40 minutes of academic time and snack followed by 80 minutes of physical activity. Physical activity environment was designed as a mastery-oriented climate with 40 minutes allocated for VPA. Sessions supervised by physical education teachers and classroom teachers from schools. Control: not discussed.

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Table 1. (*continued*)

Study	Design; location	Target population	Participants	Intervention description
Vizcaino (2008)[41]	Cluster RCT with 10 intervention and 10 control schools; Cuenca, Spain	4th- and 5th-grade students	Intervention: n=513 pre (260 boys, 253 girls) n=465 post (234 boys, 231 girls) Control: n=606 pre (296 boys, 310 girls) n=579 post (280 boys, 299 girls) Overall: N=1119 pre (556 boys, 503 girls) n=1044 post (514 boys, 530 girls)	Intervention: 24 weeks with three 90-minute sessions per week. Focus on obesity in children. Sessions consisted of 15 minutes of stretching, 60 minutes of aerobic activity, and 15 minutes of stretching. Aerobic activity included sports, innovative games, and dance. Planned by two qualified physical education teachers and supervised by sports instructors. Instructors attended a 2-day training session and were given a written plan of activities. Small rewards provided for attendance. Control: not discussed.
Yin, Gutin (2005)[42,a]	RCT within 18 schools; Augusta GA	Low-income 3rd-grade students	Intervention: n=312 pre n=275 post, 88% retention rate n=182 (40% attendance rate, pre and post data), 58% retention rate Control: n=289 pre n=265 post, 92% retention rate n=265 (40% attendance rate), 92% retention rate Overall: N=601 pre n=553 post, 92% retention rate	Intervention: 5 days per week for 8 months. Focus on the effect of the intervention on aerobic fitness and body composition. The 2-hour sessions consisted of 40 minutes of academic time and snack followed by 80 minutes of physical activity. The physical activity environment was designed as a mastery-oriented climate with 40 minutes allocated for VPA. Sessions were supervised by physical education teachers and classroom teachers from schools. Academic performance was measured. Control: not discussed.
Melnyk (2007)[43]	Phase I: pre-experimental design Phase II: RCT; upstate NY	Overweight adolescents	Intervention: Phase I: n=11 Phase II: n=7 (1 boy, 6 girls) Control: Phase II: n=5 (0 boys, 5 girls) Overall: N=23	Intervention: 9-week intervention met two times per week for 6 weeks and once per week for 3 weeks. Focus on feasibility and preliminary efficacy of the COPE Health Lifestyles TEEN program. Each session was 60–90 minutes with 20–30 minutes of physical activity led by a trained instructor. Mall gift certificates were used for incentives. Control: not discussed.

[a]Study findings reported from the same intervention—Georgia Get Fit Kids
[b]Information adapted from van Sluijs et al.[23]
MPVA, moderate-to-vigorous physical activity; VPA, vigorous physical activity

the nonspecific psychosocial general domain (i.e., self-esteem, depression) indicating a nonpositive treatment effect size (Figure 1). Despite these positive effect sizes, the lower bounds of the 95% CIs for psychosocial body weight concerns and physical activity, and for sedentary activities, were nonpositive and overlapped zero, suggesting no effect from the interventions on these domains. Important results were the small-to-moderate effect sizes of those interventions measuring physical activity (effect size=0.44 [95% CI=0.28, 0.60]), physical fitness (effect size=0.16 [95% CI=0.01, 0.30]), body composition (effect size=0.07 [95% CI=0.03, 0.12]), and blood lipids (effect size=0.20 [95% CI=0.06, 0.33]).

Of the six studies[28,34,36–39] reporting on physical activity outcomes, three[28,37,39] demonstrated positive effects, with effect sizes ranging from 0.19 to 0.70. Significant physical activity findings were collected using self-report[28,39] and accelerometers.[37] For physical fitness, four[26,31,40,42] of six effect sizes were positive, whereas one[41] found the control group to have greater decreases in diastolic and systolic blood pressure. Ten studies[26,31,34,36,37,39–43] reported outcomes related to body composition. Of these, three[39,41,43] demonstrated reductions in BMI, body weight, or skinfold thickness for the intervention. Blood lipids were reported in three studies,[26,41,42] with with two[41,42] finding significant effects across reported results. Four studies[34–37] reported findings related to psychosocial constructs. Of these, one[35] demonstrated improvements in psychosocial constructs related to physical activity (i.e., self-efficacy toward activity participation). No other improvements were observed. Of the four studies[35–38] investigating sedentary activities, one[36] demonstrated effectiveness in reducing sedentary behaviors.

Table 2. Standardized mean difference effect sizes for study outcomes across six domains

Domain	Study	Effect size[a] (95% CI)	I2
Physical activity	Herman (2006)[28,c]	0.70 (0.05, 1.36)	
	Story (2003)[34,c]	0.22 (−0.08, 0.53)	
	Robinson (2003)[36]	0.19 (−0.10, 0.48)	
	Weintraub (2008)[37]	0.43 (0.04, 0.82)	
	Lubans (2008)[38]	0.63 (−0.04, 1.29)	
	Barbeau (2007)[39]	0.55 (0.37, 0.74)	
	Overall[b]	**0.44 (0.28, 0.60)**	43.40
Physical fitness	Slawta (2006)[26,c]	0.86 (0.50, 1.21)	
	Yin, Moore (2005)[31]	0.24 (0.10, 0.38)	
	Barbeau (2007)[39]	−0.08 (−0.50, 0.34)	
	Gutin (2008)[40]	0.32 (0.09, 0.56)	
	Vizcaino (2008)[41]	−0.23 (−0.34, −0.13)	
	Yin, Gutin (2005)[42]	0.19 (0.10, 0.29)	
	Overall[b]	**0.16 (0.01, 0.30)**	85.73
Body composition	Slawta (2006)[26,c]	0.20 (−0.03, 0.43)	
	Yin, Moore (2005)[31]	0.05 (−0.06, 0.16)	
	Story (2003)[34,c]	−0.34 (−0.72, 0.04)	
	Robinson (2003)[36]	0.04 (−0.32, 0.40)	
	Weintraub (2008)[37]	0.13 (−0.29, 0.54)	
	Barbeau (2007)[39]	0.11 (0.01, 0.22)	
	Gutin (2008)[40]	0.02 (−0.20, 0.25)	
	Vizcaino (2008)[41]	0.10 (0.03, 0.18)	
	Yin, Gutin (2005)[42]	0.03 (−0.05, 0.12)	
	Melnyk (2007)[43]	0.86 (0.05, 1.68)	
	Overall[b]	**0.07 (0.03, 0.12)**	15.20
Lipids	Slawta (2006)[26,c]	0.10 (−0.02, 0.22)	
	Vizcaino (2008)[41]	0.28 (0.05, 0.51)	
	Yin, Gutin (2005)[42]	0.13 (0.01, 0.24)	
	Overall[b]	**0.20 (0.06, 0.33)**	86.52
Psychosocial			
Physical activity	Story (2003)[34,c]	−0.09 (−0.31, 0.12)	
	Kelder (2005)[35,c]	1.19 (0.68, 1.69)	
	Robinson (2003)[36]	0.01 (−0.34, 0.37)	
	Overall[b]	**0.08 (−0.22, 0.37)**	66.24
Body weight concerns	Story (2003)[34,c]	0.12 (−0.30, 0.55)	
	Robinson (2003)[36]	0.10 (−0.26, 0.45)	
	Weintraub (2008)[37]	0.03 (−0.56, 0.61)	
	Overall[b]	**0.10 (−0.16, 0.37)**	53.02
General	Robinson (2003)[36]	−0.01 (−0.51, 0.49)	
	Weintraub (2008)[37]	−0.21 (−0.62, 0.21)	
	Overall[b]	**−0.13 (−0.45, 0.19)**	0.00
Sedentary activity	Kelder (2005)[35,c]	0.19 (−0.68, 1.06)	
	Robinson (2003)[36]	0.38 (0.12, 0.63)	
	Weintraub (2008)[37]	0.05 (−0.54, 0.63)	
	Lubans (2008)[38]	0.10 (−0.12, 0.33)	
	Overall[b]	**0.20 (−0.04, 0.44)**	67.04

[a]Pooled effect size within each study, separately, except for overall effect size estimates
[b]Pooled effect size across studies
[c]Studies with a combined physical activity and dietary intervention
I2, I-squared

Implementation

For each of the studies,[26,28,31,34–43] implementation information was categorized according to the elements of implementation as outlined by Dane and Schneider.[44] Specifically, the following categories were extracted: exposure, (i.e., the number of sessions during which the target audience was exposed to the intervention); adherence (i.e., the extent to which program components were delivered as prescribed in program manuals); quality of delivery (e.g., implementer enthu-

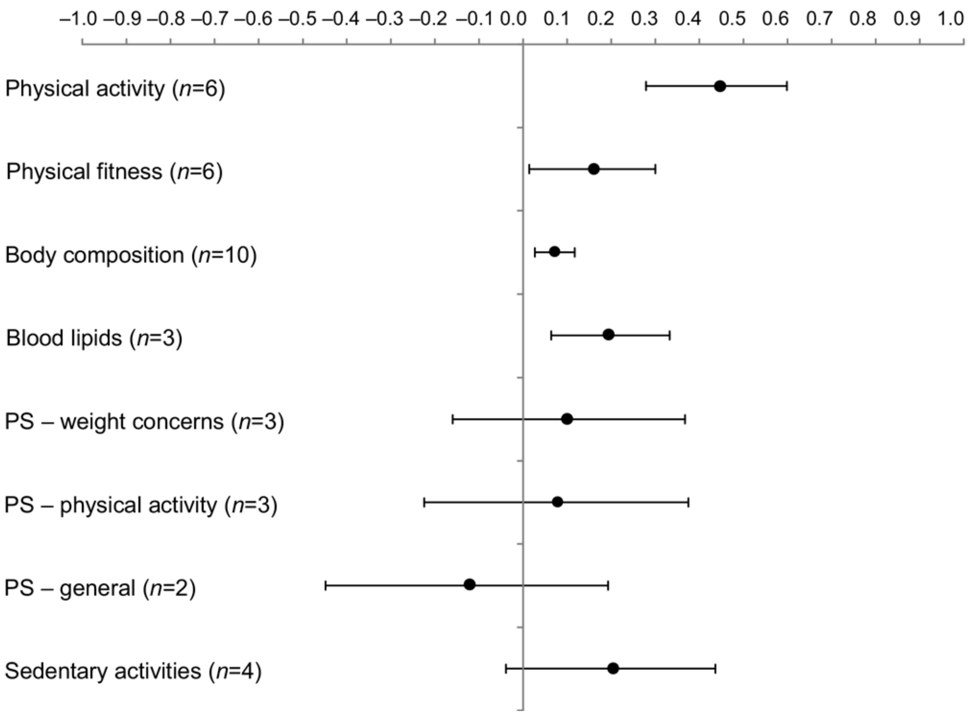

Figure 1. Weighted standardized mean effect sizes and 95% CIs for the effects of after-school programs on each domain. Positive effect sizes are associated with beneficial changes in the intervention group, regardless of the original direction of the scales of measure
PS, psychosocial

siasm, leader preparedness, global estimates of session effectiveness, and attitudes toward the program); participant responsiveness (e.g., level of participation and enthusiasm); and program differentiation (i.e., systematic check of what activities that might mimic the treatment condition were being conducted by the control).

All 13 studies[26,28,31,34–43] included information on the prescribed or delineated exposure of the intervention (e.g., delivered 5 days/week for 60 minutes/session), with eight studies[31,34,36,37,39–42] reporting either the attendance rates of participants at program sessions or the dropout rate of participants over the duration of the study as a measure of actual exposure to the intervention. Dose–response analyses, linking attendance to intervention outcomes, was reported in four studies.[31,39,40,42] Across studies, attendance rates were positively associated with program outcomes related to physical fitness and body composition, suggesting that greater exposure to after-school programs is related to improved outcomes.

Information regarding the adherence to program guidelines for delivery was reported in four studies.[31,39,40,42] In these studies, intensity of heart rate during the physical activity portion of the intervention was used as an indicator of engaging participants in MVPA—the primary focus of the intervention. However, no information was reported regarding use of intervention activities that were provided in manuals or adherence or modification to such activities. An additional two studies[34,41] described program manuals that included written forms of intervention activities or means for tracking whether an intervention activity had been completed.

Reports of program responsiveness were provided in six studies.[34–37,41,42] In these studies, student, parent, and teacher enjoyment ratings of the program were used to describe responsiveness. Across studies, ratings of the program were positive, with no indication of dissatisfaction with program components. One study[42] utilized attendance as an indirect measure of satisfaction, stating that students who liked the program attended the program. Only two studies[35,36] reported on delivery quality, and only three studies included a measure of program differentiation.[34,36,37]

Discussion

Although the number of studies conducted to date is limited, the results of this review suggest that after-school programs that include a physical activity component can be effective in improving physical activity levels, physical fitness, body composition, and blood lipid profiles of children and young adolescents. These findings support the after-school setting as a context in which health-enhancing levels of physical activity can be promoted. However, because of the heterogeneity of the programming and target population, along with limited detail on the types of activity opportunities provided, the specific active components of a successful after-school program remain unclear.

Implementation and Program Content

Although inadequate descriptions of the interventions make it difficult to determine what elements of the programs were effective, several considerations emerged. One element that requires further attention is attendance rate (i.e., exposure to the program). Limited information suggests a dose–response effect of high attendance levels,[31] with those students who attend 40% or more of the sessions showing greater improvement in measures of physical fitness (e.g., cardiovascular fitness) compared to control students.[40,42] Fluctuations in attendance rates are attributed to multiple factors, such as transportation, enjoyment, and tailoring of activities to the target audience. Provision of transportation for students from the school setting to home during after-school hours is linked to attendance at after-school programs[36] and should be a primary consideration for program budgeting. However, improving attendance rates is likely to be more complex than simply providing transportation.

Enjoyment of physical activity can also play a critical role in youth activity levels.[45] Across the studies, little information was provided on the types of activities incorporated into the after-school programs, apart from statements that the selected activities were enjoyable.[35] In several studies,[34,36] activities were culturally tailored to the target audience to address issues of enjoyment. Unfortunately, although these studies reported high levels of enjoyment, no significant improvements in physical activity were found. Hence, enjoyment and culturally specific activities may not be enough to improve activity levels. It could be argued that the lack of an effect in these studies was due to study design, which used an active placebo comparison group. Providing a comparison group with a tailored intervention that includes components that may influence behavior[16,36] is likely to create an effect comparable to the intervention, minimizing the expected and detectable effect of the intervention. Moreover, giving consent to participate in a study may lead to heightened awareness of the targeted behaviors, even when randomized to a control condition.[46] Attending to the specific activities of the control groups, apart from those prescribed by the study, in conjunction with delineating the active components of the intervention is important, as these factors can potentially account for minimal to null effects.[47,48]

Physical Activity Measurement

Future studies need to provide more comprehensive assessments of physical activity, both during and away from the after-school program. Four studies[31,39,40,42] reported measuring activity intensity level during the program. However, this measurement was primarily done to monitor achievement of the prescribed intensity and was collected on only a subsample of attendees. Further, no similar measures were collected for the control conditions. Those studies[28,34,36–39] that used activity levels as an outcome provided measures related to either overall activity or activity during the program. No study separated activity done within and outside of the program. This lack of quantification of activity levels precludes an assessment of the amount of activity attendees receive during the program and how much the program contributes to their overall activity levels. After-school programs can provide up to one third of a child's recommended daily activity.[15] Yet without separate measures of activity within and outside of the programs, it remains unclear whether youth compensate for the activity performed during a program by reducing their activity levels outside it.[49] Current research[40] suggests that youth do reduce activity levels during long periods of nonattendance (e.g., summer) and consequently have lower program-related outcomes (e.g., cardiovascular fitness) upon return. Moreover, it is not possible to determine whether attendees engage in program activities or use program-developed skills when not involved in the program.

Building on recent recommendations for designing school-based interventions to combat obesity,[50] the following design considerations are suggested for developing and evaluating effective after-school programs. Based on current literature, school-level randomization and extensive assessment and follow-up study appear to be necessary in order to better understand the effectiveness of after-school interventions. Program design is also a critical component of any intervention. In this review, very little information is presented about the developmentally appropriate nature of the activities, the variety of activities, the content and frequency of trainings, and staff perceptions of the programs. This information is vital for further advancing the effectiveness of interventions and in order to understand exactly how programs were designed and implemented. Ongoing assessment, specifically process-based qualitative assessment, can provide valuable data. Questions such as: *How often is the program being implemented?* and *Is the program being implemented as intended?* remain unanswered in many of the studies reviewed here. Finally, as this review indicates, during physical activity programs, students that attend the program more often tend to be more active and receive other health benefits. What is not apparent is the influence of programs on physical activity levels outside of the programs. The amount of time children are active during a program is finite. However, the utility of a physical activity program to promote activity outside of the program, as well as during the program, must be examined. A truly effective intervention will result in children wanting to be active outside of the physical activity program and when they are no longer involved in the program.

Conclusion

Consideration of the issues brought forth in this review should allow practitioners to design, implement, and disseminate more-effective after-school programs to promote physical activity among children and young adolescents. Several large-scale trials[16,17] are currently underway, which may address the limitations of those reviewed here. Overall, this study shows that the after-school setting holds considerable promise for increasing activity levels of youth.

No financial disclosures were reported by the authors of this paper.

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