Interventions to promote physical activity among young and adolescent girls: a systematic review

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Abstract

A narrative systematic review was conducted to describe the available evidence from physical activity (PA) interventions that targeted girls aged 5–18 years and to determine their effectiveness and key characteristics of success. Systematic literature searches were conducted using four databases: PubMed, Web of Science, PsychInfo and SPORTDiscus and by examining the reference lists of included articles and published relevant reviews, to identify studies published in English from 2000 to July 2010. Randomized controlled trials or quasi-experimental designs with pre-test and post-test behavioral outcome data (objective or self-report measure) were included. Methodological quality was assessed using a checklist and conclusions were made concerning effectiveness. A total of 29 articles were reviewed, describing the evaluation of 21 interventions. Ten studies reported a favorable intervention effect upon PA outcomes, seven of which were rated as having a high methodological quality. Multi-component school-based interventions that also offer a physical education that address the unique needs of girls seemed to be the most effective. Although family support is revealed as ineffective, peer strategies showed promising evidence. The review finishes highlighting possible intervention strategies and reporting areas where further investigation is required.

Introduction

Regular participation in physical activity (PA) provides significant health benefits for young people such as obesity prevention, improved psychological well-being, cardiovascular (CV) fitness and bone health [1–3]. Furthermore, PA behaviors adopted during adolescence are likely to be maintained into adulthood underscoring the relevance of adequate participation during this stage of life [4–6]. To attain these benefits, recommended guidelines state that children and adolescents need to accumulate at least 60 min of moderate-to-vigorous physical activity (MVPA) most days of the week [7, 8]. However, the Youth Risk Behavior Surveillance System estimates that 45.6% of the boys and only 27.7% of the girls were meeting these guidelines [9]. Not only are youth not meeting recommended PA levels, but gender differences are present. Globally, girls are less active than boys [10–13] and there is a more pronounced decline in PA during adolescence in girls than in boys [14–16], with age as a significant correlate of PA prevalence in adolescent girls [10, 17].

Due to the pronounced gender differences in PA during adolescent years and the great disparity for girls between the reality and the targets of the recommended PA level, it is appropriate that adolescent girls were recently identified as a high priority group for PA promotion. A call for action from researchers [18–20] and institutions [1, 21]...
underscores the problem of physical inactivity of girls. In response to this need, a new body of literature on girls’ PA promotion was recently established, including studies that have developed and evaluated targeted intervention strategies designed specifically for addressing the unique needs of girls. Despite these many efforts, it is unclear how successful were these projects.

Recently published reviews have summarized the evidence of promotion of PA in young people [22–28], drawing conclusions applicable for PA interventions targeting both girls and boys. Only three reviews addressed girls’ PA interventions, but with a different purpose, focus and inclusion criteria than the current review. The first systematic review of PA interventions conducted with girls, included only studies targeting samples of both girls and boys aged 12–19 years [29]. Another review focused on Hispanic American girls and women and evaluated the success of interventions targeting this racial/ethnic female population [30]. However, conclusions about girl’s PA were based on three projects: a pilot study without control group [31] and two interventions that targeted girls and also boys [32, 33]. Finally, the review conducted by van Sluijs et al. [27] found little evidence on the effectiveness of girl-only programs for children and adolescents. Although this review did not exclusively focus on girls, the evaluation of the programs was completed within a more comprehensive framework and did not focus specifically on how to address the issue of girls’ PA.

A focus on ‘girls only’ interventions is critical as researchers in multiple disciplines have claimed single-sex programs specially tailored to meet the unique needs of girls are imperative [34]. Scholars have argued that most PA contexts reinforce gender stereotypes in ways that disadvantage girls and celebrate characteristics typically associated with masculinity such as power, strength, speed and aggressiveness [35, 36]. In addition, girls prefer single-sex PA for many reasons, including freedom from constant comparison to boys and boys’ scrutiny and critical comments, greater opportunity to develop skills and relationships, more enjoyment, increased attention from instructors and less concern about body image [37–42]. Furthermore, in coed-gender setting is imperative to meet girls’ needs and provide an inclusive environment in which they feel comfortable, supported and encouraged to be physically active [43, 44].

Therefore, the question about effective strategies to address and increase girls’ PA is an important global public health topic that has yet to be adequately explored. With this state of affair, how to best address the problem of female inactivity during developmental periods of childhood and adolescence remains an open question.

The aim of this study was to conduct a systematic review to describe the available evidence of PA interventions that targeted both young and adolescent girls. It must be pointed out, to avoid confusion, that in this review, the term ‘young girls’ refers to elementary school-aged girls (5–11 years old), while ‘adolescent girls’ encompasses those secondary school (aged 12–18). Specific objectives were to analyze intervention characteristics of these kinds of programs and to determine their effectiveness and key characteristics of success. Based on the review findings, a range of recommendations for practice and future research are suggested.

### Materials and methods

#### Identification of studies

Relevant articles were identified by means of a computerized search in the bibliographic databases PubMed, Web of Science, PsychInfo and SPORTDiscus. Individualized search strategies for the different databases included combinations of the following key words: ‘girls, adolescent girls, exercise, fitness, PA, sport, intervention and program’.

The review was conducted in three phases: (i) articles were included or excluded based on their titles or abstracts; (ii) full-text articles were checked for relevance and (iii) additional articles were sought by reviewing the reference lists of included articles and published relevant reviews [22–28].
Study selection

In order to be included, articles had to fulfill the following criteria:

- The target group was comprised of elementary and secondary school-aged girls (aged 5-18 years).
- A component of the intervention targeted on increasing PA of girls.
- Published from 2000 to July 2010 (inclusive) in English language.
- Experimental or quasi-experimental study design.
- A quantitative, objective or self-reported assessment of PA as primary or secondary outcome.

Although the primary outcome of interest was PA, we also included articles that used CV fitness (aerobic capacity), as an outcome, since the only way to increase aerobic capacity is to increase PA, as pointed out by Kahn et al. [45] in their review.

Articles identified through the literature search were excluded if the following criteria occurred:

- The target group of the intervention included a sample of girls, but girls were not specifically the focus of the intervention (i.e. studies directed to the general adolescent population and studies of girls and women as a group or child-parent interventions).
- Efficacy studies of PA on girls’ health parameters.
- The target group of the intervention was girls with a manifested chronic disease state and/or recruitment strategies included using chronic disease registries.
- Unpublished reports, conference papers, dissertations, qualitative studies and description of the development of an intervention.

The initial cross-database literature search yielded 1366 publications. After removing duplicates and reviewing the title and abstract of these publications, 43 were identified as potentially relevant and full texts were obtained. Of these, 15 were excluded for meeting one of the exclusion criteria. The search of reference lists of relevant papers, including previous reviews, yielded the inclusion of one more article. Finally, 29 publications were included, yielding a total of 21 interventions [46–74].

Data synthesis

Each selected study was analyzed using a standardized consensual form by the team members to obtain the following data: characteristics of the sample, study design, study setting, intervention description, behavioral theories, PA measures used and results.

Methodological quality

The methodological quality of the studies included in the review was assessed by means of a checklist (Table I). Checklist criteria were derived from previously used quality criteria [27, 28, 75, 76] and consisted of 11 criteria symbolizing the quality of the intervention based on the study’s internal validity and analysis. A formal quality score for each study was completed on an 11-point scale by assigning the value of ‘1’ (yes) or ‘0’ (no, unclear, insufficiently described or non-applicable) to each of the items listed. Each criteria had the same value or weight, the sum of which was used as a methodological quality score and was calculated as a percentage of the maximum obtainable score [76]. The purpose of these scores was to offer an overview of the research in this area that provide formulate evidence-based conclusions about the effectiveness of the studies and not to rank them. Studies, which had an above average score based on the mean of all included studies, were considered to be of high quality, whereas studies below this score were of low quality.

First author extracted all the information, and when any doubt existed, the extraction was carried out by co-authors and agreement was achieved.

Results

Summaries of the 21 intervention studies included in this review are shown in Table II; information
Intervention and study characteristics

Country

A first scope of the interventions revealed that all the selected studies were from the United States, except for one in the United Kingdom [54], two in Australia [52, 67] and one in Iran [72].

Aim

Nine studies focused exclusively on improving the girls’ PA level [52, 54, 61, 62, 67, 68, 72–74], while others targeted obesity prevention [46, 47, 59, 63, 64, 69], increased bone mineral density [49, 56–58, 66] and prevention of CV disease [48]. Eleven programs exclusively targeted PA behavior [52, 54, 57, 61, 62, 66–68, 72–74], while the remaining were more comprehensive and also included strategies related to food consumption [46–49, 56, 58, 59, 63, 64, 69].

Behavioral theory

Fourteen of the interventions defined a behavioral theory as the framework for the intervention [46, 52, 56, 58, 59, 61–64, 68, 69, 72–74]. However, there is a large variability in the explanations about how the theory constructs were used in the intervention. Ten interventions were grounded only on one theory [46, 52, 56, 59, 61, 63, 64, 69, 73, 74],

Table I. Criteria checklist for the methodological quality assessment of the studies

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
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<tr>
<td>Were baseline groups comparable at baseline on key characteristics?</td>
<td>If no, was analysis conducted to estimate/adjust for effect of demographic measure on the outcomes?</td>
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<td>Was the study a Randomized Controlled Trial (RCT)?</td>
<td>If yes, was the method of randomization procedure clearly described and adequately carried out?</td>
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<td>Was the unit of analysis individual?</td>
<td>(Score no, if unit of analysis was cluster or cluster randomization not accounted for individual level analysis).</td>
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<td>Were those responsible for assessing PA at outcome blinded to group location of individual participants?</td>
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<td>Was the timing of outcome assessment comparable between intervention and control groups, for all important outcome assessments?</td>
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<tr>
<td>Were outcome measurement instruments valid?</td>
<td>Was there a description of instrument reliability/validity (reference or coefficients) or did they use a well-established known valid measure?</td>
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<td>Were the outcomes an objective measure?</td>
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<td>Were the participant followed up (after post-test) for a minimum of 6 months?</td>
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<tr>
<td>Was retention rate adequately described?</td>
<td>If yes, was ≥ 80% at post-test/post-intervention follow-up for studies with follow-up of 6 months or shorter and 70% for studies with follow-up of more than 6 months?</td>
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<tr>
<td>Were analysis controlled for potential confounders?</td>
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<td>Was intention to treat analysis used?</td>
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</table>

Presented is about the first author, year, study name, participants, study design, primary setting, length of the intervention, behavioral theories used and a description of the intervention.

Target population

Six studies targeted elementary school-aged girls [46, 47, 56, 63, 64, 69], while five studies recruited middle school-aged girls [54, 58, 62, 68, 73] and ten involved high school-aged girls [48, 49, 52, 57, 59, 61, 66, 67, 72, 74]. Five of the studies conducted in the United States evaluated interventions specifically aimed at ethnic minority groups, such as African American [46, 47, 63, 69] or Hispanic [68]; another Australian study targeted girls from low-income backgrounds [52]. Girls at risk of obesity [46, 59, 63, 69], with low levels of PA [59, 62, 66, 67, 72] or low PA enjoyment [52], were also targeted.
<table>
<thead>
<tr>
<th>Author (date) ref., country, study name</th>
<th>Sample</th>
<th>Study design</th>
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<th>Behavioral theories</th>
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</thead>
<tbody>
<tr>
<td>Dudley et al. (2010) [52], Australia</td>
<td>38 high school girls Low level of PA enjoyment Low income girls Mean age ≈ 16.5 years</td>
<td>RCT (individual)</td>
<td>School</td>
<td>12 weeks (six sessions)</td>
<td>Social Cognitive Theory (SCT)</td>
<td>Six 90-min sessions delivered during school sport time. Enjoyable, challenging and new activities such as yoga/pilates/dance sessions run in a classroom using commercially purchased instructional videos, an introductory tennis-coaching course and aquatic games in a swimming pool. Activities based on formative data and participant feedback.</td>
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<td>Rosenkranz et al. (2010) [64], USA, SNAP (Scouting Nutrition &amp; Activity Program)</td>
<td>76 elementary school girls Mean age ≈ 10.5</td>
<td>RCT (girls Scout troop)</td>
<td>Community</td>
<td>4 months</td>
<td>SCT</td>
<td>Interactive educational curriculum focus on nutrition and PA and delivered by trained troop leaders as part of the regular troop meetings (meeting at least twice per month). The curriculum included physically active recreation sessions, discussion of the target behaviors and worksheets for goal setting and</td>
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<td>Jones et al. (2009) [58], USA, IMPACT (Incorporating More Physical Activity and Calcium in Teens)</td>
<td>718 middle school girlsMean age 11.6 years (SD = 0.4)</td>
<td>RCT (school)</td>
<td>School</td>
<td>18 months</td>
<td>SCT Transtheoretical Model</td>
<td>self-monitoring. Troop meeting policies (e.g. troop leaders providing 15 min per meeting for PA, participating in physically active recreation with girls and verbally promoting PA). Badge assignments completed at home by girls with parental assistance. 10-min-warm-up of high-impact activities during the regular PE classes. Classroom lessons in PE and science classes designed to promote increased consumption of CA (Calcium) rich foods calcium-rich foods and increasing WBPA (Weight-Bearing Physical Activity) weight-bearing PAs. A peer-based behavioral journalism with role model stories.</td>
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<tr>
<td>Spruijt-Metz et al. (2008) [68], USA, Get Moving!</td>
<td>459 middle school girls (73% Latina) Mean age 12.5</td>
<td>RCT (school)</td>
<td>School</td>
<td>1 week approximately (5–7 sessions in consecutive days).</td>
<td>Self-Determination Theory</td>
<td>Classroom media intervention in which teams of 7–10 girls</td>
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<td>Taymoori et al. (2008) [71, 72], Iran</td>
<td>161 high school girls in the preparation stage of behavior change</td>
<td>RCT (school)</td>
<td>School</td>
<td>6 months</td>
<td>Health Promotion Model (HPM)</td>
<td>Intervention Group 1(I1), based on HPM: Four group educational sessions focused on benefits and barriers to IPA, goal setting and social support. Four individual counseling sessions tailored to different stages of changes. Follow-up phone calls to encourage the girls PA and to discuss her PA goals. Educational sessions with mothers and teachers for social support and modeling. Girls, parents and teachers participated in 1-day</td>
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Meanings of Behavior.

were asked to develop and to present animated Public Service Announcement that supported engagement in PA and reduction of sedentary time. Information about PA and sedentary behavior was provided to girls.
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<tr>
<td>Webber et al. (2008) [70, 73], USA, TAAG (Trial of Activity for Adolescent Girls)</td>
<td>Three cross-sectional samples of middle school girls. Sixth graders in 2003 ( n = 1721 ) Eighth graders in 2005 ( n = 3504 ) Eighth graders in 2006 ( n = 3502 )</td>
<td>RCT (school)</td>
<td>School comprehensive</td>
<td>2-year staff-directed intervention + 1-year sustainability</td>
<td>Sociocological model</td>
<td>mountaineering activity intervention Group 2, based on Transtheoretical model: Idem as I1, plus two educational sessions focus on counter conditioning and stimulus control. PE teachers trained to provide MVPA for at least 50% of class time and to promote PA outside of class. Health Education program designed to enhance behavioral skills related to PA participation and reinforced with activity challenges. PA programs for girls linking schools with community organizations. Promotional efforts (media, events) to promote awareness and participation in activities and to increase the acceptance and support for PA for all girls. 1-year sustainability of the</td>
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<td>Barbeau et al. (2007) [47], USA</td>
<td>201 elementary school girls, African American, Mean age ≈ 9.5 years.</td>
<td>RCT (school)</td>
<td>School</td>
<td>10 months</td>
<td>None</td>
<td>Program using school and community personal to direct intervention activities. After-school program offered daily that included 80 min for PA, with three class parts: skill development, sustained MVPA and toning and stretching. Subjects wore HR monitors and were taught how to maintain their HR above 150 bpm during the MVPA part of the class. After the PA class, girls attended 30 min of homework time and were provided with a healthy snack.</td>
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<td>Schneider et al. (2007) [66], USA Project FAB II (Fitness and Bone)</td>
<td>146 high school girls, Low active girls, Mean age 15.04 years (SD = 0.79) Three successive school cohorts</td>
<td>RT (school)</td>
<td>School</td>
<td>9 months</td>
<td>None</td>
<td>Special girls-only PE class 5 days week⁻¹. Supervised PA 4 days week⁻¹ included a range of variety and innovative aerobic and strength-building activities. Educative component 1 days week⁻¹ on health.</td>
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<td>Robbins et al. (2006) [62], USA, Girls on the move</td>
<td>77 middle school girls In the contemplation or preparation stage of behavior change. 11–14 years of age.</td>
<td>RCT (grade)</td>
<td>School</td>
<td>12 weeks</td>
<td>HPM Transtheoretical model</td>
<td>benefits from PA and strategies to increase PA. Three computerized, individually tailored feedback sessions for increasing PA. Individual counseling from the school’s pediatric nurse practitioner focus on goal setting in which they signed a contract to indicate mutual agreement regarding the goals. Telephone calls focusing on agreed goals. Parents were posted two tip sheets to support girls.</td>
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<tr>
<td>Young et al. (2006) [74], USA, Life Skills Intervention</td>
<td>221 high school girls 83% African American. Mean age 13.8 (SD = 0.5) years.</td>
<td>RCT (individual). PE class 5 days week$^{-1}$</td>
<td>School comprehensive</td>
<td>8 months. Social Action Theory</td>
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<td>with lifestyle-oriented PAs and designed to maximize PA during the class. Classes included an educative component about the personal benefits of a physically active lifestyle, problem-solving skills, obtaining support from others and self-monitoring. Family support included a 2-hour family workshop,</td>
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Table II. Continued

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<td>Fairclough &amp; Stratton (2005) [54, 55], UK</td>
<td>33 middle school girls. Mean age 12.4 (SD = 0.4) years.</td>
<td>RCT (class)</td>
<td>School</td>
<td>5 weeks (5 sessions)</td>
<td>None</td>
<td>monthly newsletters and adult-child homework assignments. Teaching intervention in girls-only PE class (2-hour period week⁻¹) that incorporated enhance PA levels as an additional lesson objective, alongside existing objectives in a unit of basic gymnastic skills. The teaching intervention included ten 90-min activity-based sessions each year, focus on the development of behavioral skills to choose CA-rich foods and to engage in WBPA. An interactive web-based program was continuously available for girls. 1-week summer camp. Home activities to do with parents were provided.</td>
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<tr>
<td>French et al. (2005) [56], USA, Cal-girls</td>
<td>322 elementary school girls. Mean age ≈ 10.5 years.</td>
<td>RCT (girl scout troop)</td>
<td>Community</td>
<td>2 year</td>
<td>SCT</td>
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<td>Schofield et al. (2005) [67], Australia, GSOP (Girls Stepping Out Program)</td>
<td>85 high school girls. Low active. Mean age 15.8 (SD = 0.8) years.</td>
<td>CT (school)</td>
<td>School</td>
<td>12 weeks</td>
<td>None</td>
<td>through the web-based program. I Group 1, based on pedometer self-monitoring: 6 weekly group sessions with pedometer based on self-monitoring and goal setting focus on increasing PA until 10 000 steps day$^{-1}$. Educative program focus on healthy eating, benefits, barriers, etc. Three postcards were sent home during the following 6 weeks. I Group 2, based on minutes for self-monitoring: Same as I1, using time-based prescription until 30–60 min day$^{-1}$.</td>
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<tr>
<td>Pate et al. (2005) [50, 51, 60, 61, 65], USA, LEAP (Lifestyle Education for Activity Program)</td>
<td>2744 high school girls. Mean age 13.6 (SD = 0.6) years. Two successive class cohorts.</td>
<td>RCT (school)</td>
<td>School comprehensive</td>
<td>1 year</td>
<td>Socioecological model</td>
<td>Girls only PE provided by school teachers and focus on providing girls with the physical and behavioral skills needed to adopt a physically active lifestyle. Health education focused on PA behavioral</td>
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<td>De Barr et al. (2004) [49], USA</td>
<td>228 adolescent girls, BMI (Body Mass Index) below the national media, 14–16 years of age.</td>
<td>RCT (individual)</td>
<td>Primary care clinic</td>
<td>2 years</td>
<td>None</td>
<td>skills. Other components are: creating supportive school environment, school health services, staff health promotion and both family and community-based activities. Bimonthly team meetings for information and group support and annually individual visits to provide individualized feedback and motivation for increasing high-impact and WBPA as well as consumption of CA, fruits/vegetables. Coaching calls to address individual adherence issues. A web-based study site was provided to participants to keep them informed of project activities, offer communication with staff and other participants and provide</td>
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<td>Jamner et al. (2004) [57], USA, <em>Project FAB</em></td>
<td>58 high school girls. Sedentary and unfit girls, 14–16 years of age.</td>
<td>CT (school)</td>
<td>School</td>
<td>4 months</td>
<td>None</td>
<td>Feedback. Parent and youth newsletters. Special girls-only PE class 5 days week&lt;sup&gt;−1&lt;/sup&gt; with 40’ of PA (range of different and alternative activities) Educative component 1 days week&lt;sup&gt;−1&lt;/sup&gt; on health benefits from PA and strategies to increase PA.</td>
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<td>Bayne-Smith et al. (2004) [48], USA, <em>PATH (Physical Activity and Teenage Health) Program</em></td>
<td>442 high school girls. Mean age ≈ 16 years.</td>
<td>RCT (individual and class)</td>
<td>School</td>
<td>12 weeks</td>
<td>None</td>
<td>Daily PE classes (5 days week&lt;sup&gt;−1&lt;/sup&gt;) that consisted of 5–10-min lecture on a topic of CV health and fitness and 20–25 min of VPA, with additional homework assignments.</td>
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<tr>
<td>Baranowski et al. (2003) [46], USA, <em>GEMS-FFFP (Girls health Enrichment Multi-site Studies-The Fun, Food, and Fitness Project)</em></td>
<td>35 elementary girls school. African American Mean age ≈ 8.4 years.</td>
<td>RCT (individual)</td>
<td>Community</td>
<td>12 weeks</td>
<td>SCT</td>
<td>4-week summer day camp in which girls were encouraged to improved their dietary intake and to increase their PA levels through social support, goal setting and pedometer for self-monitoring. Girls asked to log on to an internet program at home once a week.</td>
</tr>
</tbody>
</table>
Table II. Continued

<table>
<thead>
<tr>
<th>Author (date) ref., country, study name</th>
<th>Sample</th>
<th>Study design</th>
<th>Primary setting</th>
<th>Duration of intervention</th>
<th>Behavioral theories</th>
<th>Description of the intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neumark-Sztainer et al. (2003) [59], USA, New Moves</td>
<td>201 high school girls. Low active girls and/or with high BMI. Mean age 15.4 (SD = 1.1) years.</td>
<td>RCT (school)</td>
<td>School</td>
<td>16 weeks</td>
<td>SCT</td>
<td>after summer camp. An internet program for parents with the same weekly behavioral/environmental foci that as for the girls. Special girls-only PE class with PA 4 days week$^{-1}$ focus on promoting life-long activities suitable for all girls. One educational session per week focus on discussion social support or nutrition. Community links were developed (p.e. community guest instructor in PE). 14 postcards containing information related to PA, social support or nutrition were mailed home. Maintenance component: weekly meetings with healthy food for lunch at school during 8 weeks following the intervention.</td>
</tr>
<tr>
<td>Robinson et al. (2003) [63], USA Standford GEMS</td>
<td>61 elementary school girls. African American and low</td>
<td>RCT (individual)</td>
<td>School</td>
<td>12 weeks</td>
<td>SCT</td>
<td>After-school dance program offered 5 days week$^{-1}$ for 2.5</td>
</tr>
<tr>
<td>Author (date)</td>
<td>Sample</td>
<td>Study design</td>
<td>Primary setting</td>
<td>Duration of intervention</td>
<td>Behavioral theories</td>
<td>Description of the intervention</td>
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<tr>
<td>Story et al. (2003) [69], USA, GEMS-Girlfriends for KEEPS (Keys to Eating, Exercising, Playing and Sharing)</td>
<td>54 elementary school girls, 83% African American and low income, Mean age ≈ 9.4 years.</td>
<td>RCT (individual)</td>
<td>School</td>
<td>12 weeks</td>
<td>SCT</td>
<td>hours and included: an hour of homework with a healthy snack, 45–60 min of moderate-to-vigorous dance and 30’ talking about dance. Family-based TV reduction program consisted of five lessons to be delivered during home visits with participating families. Two after-school session club meetings per week focus on increasing PA levels with a variety and choice of activities, decreasing time spent in sedentary activities and experiencing feelings of enjoyment, physical competence and self-confidence. The family component included weekly packets sent home to the parents; family night events, phone calls and organized neighborhood walks.</td>
</tr>
</tbody>
</table>
while four studies reported using more than one theory for the intervention framework [58, 62, 68, 72]. The Social Cognitive Theory, which was the most commonly theory reported, was utilized in eight studies [46, 52, 56, 58, 59, 63, 64, 69]. Other theories used were Transtheoretical Model of Behavior [58, 62, 72], Self-determination Theory [68], Theory of Meaning of Behavior [68], Health Promotion Model (HPM) [62, 72], Social Action Theory [74] and Socioecological model [61, 73].

**Setting**

The school setting was the most frequent location for intervention implementation. From the 17 studies located at schools, five studies were non-curricular interventions [47, 52, 62, 63, 69] usually offered as after-school programs and eight studies primarily involved a physical education (PE) specific intervention [48, 54, 57–59, 66, 72, 74]. Two studies included PE as one of the main intervention components but within a more comprehensive approach related to school environmental and policy changes [61, 73]. Only three studies were developed in community settings; two of them involved Girl Scout troops [56, 64] and the other offered a summer camp program [46]. One intervention was carried out at a primary care clinic [49]. Within these interventions, 11 studies included some kind of family involvement [46, 47, 59, 61–64, 69, 72–74] and two added the school-community links [61, 73].

**Intervention duration**

The duration of the programs varied greatly from 1 week [68] to 3 years [73] with one-third lasting 12 weeks [37, 39, 43, 53, 54, 58, 60] and another third lasting 4 months to 1 year [47, 57, 59, 64, 66, 72, 74].

**Methodological quality of the studies**

The average methodological quality score of all included studies is 58%, which means that studies that accomplished seven or more of the 11 established criteria were considered to have a high methodological quality within this research area. Of the included studies, 12 were identified as high quality [46, 47, 56, 58, 59, 61, 63, 64, 66, 67–74], while the remaining 9 studies were rated as low quality [48, 49, 52, 54, 57, 62, 67–69] (Table III).

Two studies used a quasi-experimental design [57, 66] and the remaining studies were randomized controlled trials (RCTs) that randomly assigned individuals [46, 48, 49, 52, 63, 67, 69, 74], clusters of classes [48, 54], grades [62], schools [47, 58, 59, 61, 67, 68, 72, 73] or Scout troops [56, 64] to an intervention or control group (see Table II).

In general, methodological limitations were absent of randomization inherent to quasi-experimental studies [57, 66] or no randomization procedure was described in the RCT [47, 48, 54, 56, 59, 61, 63, 67–74]; no blinded outcome measures [52, 59, 67, 72] or absence of information to value this criteria [46–48, 52, 54, 56–58, 61, 62, 66, 68, 69, 73, 74] and the lack of follow-up assessment to test the long-term sustainability of PA behavior [46–49, 52, 54, 56–58, 62–64, 66–69, 74].

However, most studies have an adequate retention rate of participants [46, 47, 49, 54, 56–59, 62–64, 66, 68, 69, 72, 74]; (range = 74–98%) and used a valid outcome measurement instrument [46, 47, 52, 54, 56, 58, 61–64, 66–69, 72–74]. Fourteen studies used objective tools: accelerometers [46, 52, 63, 64, 70, 73], pedometers [67], heart rate monitors [54] and CV fitness tests [47–49, 57, 66, 67, 74].

**Effective interventions**

Ten of the 21 studies reported a favorable intervention effect upon PA outcomes [47, 54, 57, 58, 61, 64, 66, 72, 73], seven of which were rated as having a high methodological quality [47, 58, 61, 64, 66, 72, 73] (Table III). These seven high-quality studies offered the strongest evidence for a positive relationship between the intervention and any change in outcome measures, so they provided key characteristics of successful efforts to promote PA among girls. Five of these interventions targeted specifically
adolescent girls [58, 61, 66, 72, 73] and two targeted young girls [47, 64]; a brief summary of these interventions is provided below.

The project FAB II [53, 66] (Fitness and Bone) was a two semester intervention for insufficiently active adolescent girls, consisting of a special PE class that included a range of innovative PAs and a health education component once per week. PA was assessed with the 3-Day Physical Activity Recall (3DPAR) and CV fitness (VO2peak) through a ramp-type progressive exercise test on a cycle ergometer. The study was successful in increasing the percentage of girls participating in Vigorous Physical Activity (VPA) and the average minutes spent in moderate activity. The intervention group subjects also increased CV fitness by 8%, whereas the control group decreased by 4%.

The IMPACT (Incorporating More Physical Activity and Calcium in Teens) study [58] was a 18-month multi-component intervention to promote bone health among girls. The PA component was developed through a PE program, which included high-impact activities and a health curriculum with peer-based activities. PA was assessed with the Self-Administered Physical activity Checklist. The study was effective in increasing the daily minutes of VPA, which was significantly higher at follow-up for girls enrolled in intervention schools compared with girls in control schools with a difference of 6 min.
The study of Taymory et al. [71, 72] evaluated two 6-month individually tailored interventions designed for sedentary adolescent girls in Iranian schools. One study was based on Pender’s HPM and another study integrated constructs from the Transtheoretical model (THP) with HPM. The two intervention groups received educational sessions tailored to their stage of change and individual counseling through face-to-face sessions and follow-up phone calls. Social support from mothers and teachers was promoted through educational sessions and a 1-day mountaineering activity. Additionally, the THP intervention received two educational sessions focused on counter conditioning and stimulus control. PA was assessed with the Child/Adolescent Activity Log. At the end of the intervention, both intervention groups reported spending about one more hour in PA per day compared with participants in the control group. This effect was maintained at the 6-month follow-up only by the THP intervention group compared with the control group.

Two large-scale and school-based randomized trials, both based on comprehensive approaches drawing from ecological models, have shown some type of effective results: the Lifestyle Education for Activity Program (LEAP) for high school girls [50, 51, 60, 61, 65] and the Trial for Adolescent Activity Girls (TAAG) for middle school girls [73]. The LEAP intervention involved (i) changes in the instructional programs (PE and health education) through teacher training to provide adolescents with a positive experience related to PA and (ii) the environmental strategy that integrated changes to school health services, faculty-staff health promotion, school environmental and school-community linkages [60, 61].

The TAAG study [70, 73] also included the same curriculum-based intervention components with the main focus on training teachers. In addition, TAAG included some innovative components. First, collaborations were formed among schools, community agencies and the TAAG universities to provide PA programs for girls. Second, promotional activities were developed to support PA and promote TAAG-specific programs. Third, a TAAG Program Champion component was developed to encourage sustainability after the 2-year staff-directed intervention [73]. Both in TAAG as well in LEAP, there were program teams led by a program champion (usually the PE teacher) that served as a coordinated body, establishing a linkage system between researchers and programs users that adapt the program to each school context facilitating the implementation as well the sustainability of the intervention.

In the LEAP program, PA was measured by self-report with the 3DPAR. After the 1-year intervention, the prevalence of VPA was 8% significantly higher in the intervention schools than in the control schools [61], with a greater percentage of girls in high-implementing schools reported engaging in VPA [65]. This effect was also associated with greater school level program implementation after a 3-year follow-up [60]. In contrast, the 3DPAR and an objective PA measure, accelerometry, was used in TAAG, with the primary outcome being the daily MET-weighted minutes of MVPA. The study showed no positive results after the 2-year staff-directed intervention. However, 1-year later and after the implementation of the TAAG Program Champion, girls in the intervention schools were more physically active than girls in control schools, with a modest effect of a difference about 1.6 min of MVPA [73].

Only two high-quality studies were successful in increasing PA in young girls [47, 64]. The Barbeau et al. study [47] was a 10-month after-school program for African American girls, which included 80 min of PA. PA was assessed with the 7DPAR, and CV fitness was measured using a multistage treadmill test. The intervention group had significant increases in MPA, MVPA and CV fitness compared with the control group. The SNAP (Scouting Nutrition & Activity Program) [64] was a 5-month intervention developed by trained troop leaders at regular Scout troop meetings. The program included an educational curriculum policy to promote PA opportunities such as PA recreation sessions in which troop leaders participate with girls and a homework assignment to do with parent...
assistance. Habitual PA was evaluated by a self-report questionnaire and PA during troop meetings using accelerometers. The intervention groups showed an increase of MPA and MVPA during troop meetings compared with control groups, although no changes were found in habitual PA.

Three studies also reported positive results between-group effects on PA and/or CV fitness outcomes but were of low methodological quality [54, 57, 67]. One study of low-active female adolescents (project FAB) [57] found that a one-semester PE-based intervention increased self-report VPA and maintained CV fitness. The second study [54, 55] was a PE intervention that integrated into the lesson planning increased PA with existing objectives. This study showed that the intervention was effective in getting adolescent girls to be more moderately to vigorously active during PE class. Finally, in the Girls Stepping out Program (GSOP) [67], a pedometer based self-monitoring and goal setting after-school program, girls in the step-based intervention group significantly increased their step counts compared with the control group.

Non-effective interventions

Five studies rated as having a high methodological quality reported a non-effective result upon PA outcomes [46, 56, 59, 63, 74] (Table III). Two were aimed at adolescents and were based on a girls-only PE class [59, 74] and three targeted elementary school-aged girls: one study was an after-school dance program [63] another was developed by trained troop leaders as part of the regular troop meetings and included 1-week summer camp [56] and the last was a 4-week summer day camp [46].

The remaining six ineffective PA interventions were studies rated as low quality [48, 49, 52, 62, 68, 69]. Three of them targeted adolescent girls and were developed without the practice of PA, that is only through an educative component such as a 1-week classroom media intervention [68], team meetings and a web site [49] and computerized individual tailored feedback and individual counseling [62]. The other three low-quality ineffective interventions consisted of a daily PE class [48]; after-school session club meetings [69] and six school sport sessions [52].

Of all these ineffective interventions, the five high-quality studies [46, 56, 59, 63, 74] and three of the low-quality studies included some type of family support (i.e. workshops or educational material sent home).

Discussion

This is the first review, to our knowledge, that has systematically identified the research on PA interventions to promote PA among girls, describing common characteristics of these studies and the quality of evidence-based data on successful interventions.

Findings from the PA intervention studies were mixed with regard to their effectiveness. Of the 12 studies with an acceptable methodological quality, 5 failed to increase girls’ PA and although 7 were successful, in some cases, their results were modest. This was true even in large RCTs [61, 73], which reinforces that promoting PA among young girls is a complex task and is in need of further research.

It is notable that most of the reviewed studies concerning the PA of girls have been conducted in the United States; with the problem of girl physical inactivity all over the world, more interventions are needed in other developed countries. The information learned from successful interventions and even ineffective interventions could have a positive impact on other sociocultural contexts of Western countries where interests, values and social norms for girls’ PA are different. A dissemination of the successful programs and collaboration between scholars and funding institutions are needed.

Most of the girls’ PA interventions and nearly all effective studies were school-based. The school has been identified as an ideal setting for the promotion of positive health behavior such as PA among youth [45], and also it is argued that schools should assume a leadership role in ensuring that young people engage in enough PA each day [77]. However, interventions carried out in the school setting...
should be gender-sensitive and address the specific problem of girls’ physical inactivity. PE is a common component in 10 of the included studies, 4 rated as high-quality effective programs [58, 61, 66, 73] and 2 of which integrated PE within multi-component interventions [61, 73]. Making PE enjoyable for more girls is a high priority in these interventions, by increasing choice and offering a wide range of non-competitive and innovative activities used as main strategies. Facilitating adequate MVPA during a PE lesson is also seen as crucial in the reviewed studies, in order to meet the recommended levels of PA, although in some intervention PA is limited or cut short by the inclusion of a health education content [48, 57, 58, 66, 74]. In any case, the reduction in curriculum time and the traditionally conferred low status of the subject may limit PE’s potential to influence youth PA in general [43, 78, 79] and girls’ PA in particular [80]. Adequate training periods that address gender disparities is crucial to meet the challenges that face physical educators in relation to girls’ PA.

One might have expected family support in a girls program to be a promising component, considering the positive correlation that exists with youth PA, especially in younger children [81]. However, and despite the difficulty to isolate its effects on the interventions, only four of the reviewed studies that included some kind of family support strategies were effective. Our results are supported by the little evidence for effectiveness of family involvement strategies in youth intervention programs found by a recent review [82]. The primary influence of peers, as youth move from childhood to adolescence, makes it necessary to focus on this social influence in activity promotion efforts targeted at girls, either through specific intervention strategies, such as peer tutoring or peer modeling, or with specific peer-based interventions. Only two included studies [56, 64], one of them effective [64] and both aimed at young girls, were peer-based, so future research is needed which carefully addresses and evaluates this type of programs, especially when implemented at older-ages. The strong influence of the friendship group among adolescent girls found in a large-qualitative study [19] also suggests a need to encourage interventions, which are inclusive of all friends, regardless of their physical fitness or motor ability.

Two high-quality comprehensive interventions developed in the school setting, including environmental and policy strategies and community linkages in keeping with the ecological approach to behavior change [83, 84] have shown some promising evidence [61, 73]. However, our review has shown a scarcity of community interventions [46, 56, 64], so the potential of the community to increase PA opportunities for girls should be investigated. Overall, our results pointed out that theoretical models, which focus on the personal level, should be mixed with more ‘choice-persuasive’ environmental perspectives ranging from micro- to meso- to macro- scales [83]. Ecological models of behavior change provide a valuable approach to organize theory constructs from multiple theories into individual, interpersonal, organizational and community/environmental levels of influence [85].

Of the six studies aimed at young girls [46, 47, 56, 63, 64, 69], only two of them were effective [47, 64], so a research gap is identified for this age group compared with adolescent age. Targeting girls in pre-pubertal age (i.e. before they leave elementary school) may be one way to detain the age-related decline in PA already present as well as combating the further drop-off in PA as they develop into adolescence. Additionally, culturally appropriate PA interventions should be addressed because of six included studies targeting female ethnic minorities, only one was effective [47]. Culturally tailored interventions should acknowledge and be built on cultural beliefs and practices of these girls, integrate culturally appropriate activities and use formative research techniques to incorporate cultural relevant facilitators and minimize barriers to PA [86].

Our review has identified several limitations in the methodological quality of studies. Specifically, information was lacking on the randomization procedure, blinding at outcome assessment and lack
of follow-up. This last limitation does not allow us to demonstrate the long-term effectiveness of these interventions, mainly when the most important component of them is precisely PA. Furthermore, although valid and reliable self-reported measurement instruments were used, there was a lack of objective PA outcome measures that counteracted the potential bias of self-reporting in favor of behavior change [87]. To improve the quality of studies reporting the effects of intervention, we suggest that future studies follow specific guidelines for designing and reporting interventions (the CONSORT Statement) [88].

The limitations of this review must also be acknowledged. First, there is a large heterogeneity of studies in terms of their duration, program components and strategies, participants and outcome measures. Such factors make comparisons difficult [76], and hence a narrative systematic review was conducted. Second, our review included only RCT or RT because they provide the stronger evidence about effectiveness. However, studies with other methodological designs and a more qualitative approach would provide a more holistic knowledge in this research area. Third, it is possible that the search did not identify all trials published, especially when we included only studies published over the last 10 years. This was minimized by checking the references of previously published reviews of interventions to promote PA among children and adolescents and of the articles retrieved in the search. No additional study was found before the time frame established for study inclusion, which confirms that our review could be generalized over time.

Conclusions

This review provides a detailed picture of the girls’ PA intervention research that has been conducted and published. Although it is difficult to draw general conclusions based on the mixed results of studies included in this review, the most effective interventions to increase PA among girls (5–18 years) appeared to be those that were school-based, with an enjoyable PE being one of their main components, and that addressed multiple levels of influence on behavior using a socioecological framework. Although our review points out that family support strategies are ineffective, it seems promising to promote positive peer relationships and social support of friendship groups in PA setting.

Research should focus on filling the gaps identified in this review, such as the lack of studies tailoring different subgroups of girls (i.e. young girls and ethnic minority population); implementation of peer-leaders and friendship groups strategies; community-based interventions; replication of successful programs in other sociocultural contexts and the need to improve methodological quality as well as report on the studies.

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References


Promoting girls’ physical activity