
Promising school-based strategies and intervention guidelines to increase physical activity of adolescents

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Abstract

This narrative review describes the available scientific evidence regarding promising school-based strategies to increase physical activity of adolescents. We conducted a literature search for studies published up to 2011, regarding adolescent physical activity intervention studies that resulted in increased physical activity (regardless of measurement) and reviewed 52 intervention articles and 21 review articles. We identified several promising strategies and grouped into five broad intervention guidelines. These guidelines are as follows: (i) design multi-component interventions that foster the empowerment of members of the school community; (ii) develop improvements to Physical Education curricula as a strategy to promote physical activity to adolescents; (iii) design and implement non-curricular programmes and activities to promote physical activity; (iv) include computer-tailored interventions during the implementation and monitoring of physical activity promotion programmes and (v) design and implement specific strategies that respond to the interests and needs of girls. On the basis of our review of the adolescent physical activity promotion literature, we suggest that these five guidelines should be taken into account in school-based interventions geared towards achieving an increase in adolescent physical activity.

Introduction

Regular participation in physical activity (PA) and an active lifestyle provide a series of benefits for young people's health [1, 2]. Moreover, PA behaviours adopted during adolescence are likely to be maintained in adulthood, thus underscoring the importance of adequate participation and the promotion of PA during this stage of life [3–6]. Schools, in particular, have been identified as ideal settings for the promotion of youth PA [7]. Despite the acknowledged health benefits of PA, the PA levels of young people fall below international recommendations [8–10].

In response to this issue, in recent years many studies have addressed adolescent PA and health promotion, including studies focussing on the development and evaluation of specific school-based intervention strategies. Although school-based interventions are considered the most feasible and effective way to counter low PA levels, there is no consensus regarding optimal intervention strategies [11]. In addition, many reviews have analysed the effect of different interventions aimed at promoting PA, focussing on promoting PA to girls [12], active transportation to school [13], non-curricular activities or programmes [14] or on components of physical education (PE) that aim to directly or indirectly increase the PA of children and adolescents [15, 16]. Other reviews have assessed the effectiveness of different methods or policies, and effective

strategies to increase PA in different intervention settings. The majority of the reviews include US-based interventions [1, 2, 6, 17–23]. With respect to European evidence, we found only one study [10]. Only two of the reviews found focussed exclusively on school-based interventions. These reviews assessed the effects that the interventions had on the PA levels of students and the influence of specific intervention factors. However, we still know little about the factors that explain the effects of interventions [2, 6]. Furthermore, none of these reviews explicitly includes intervention guidelines or key strategies that should be taken into account when designing a PA promotion intervention. Finally, the interventions in these reviews were mainly researcher driven and therefore not fully responsive to local needs and circumstances. Therefore, identifying promising school-based strategies to develop intervention guidelines to increase the regular PA of adolescents is an important topic that has yet to be explored properly. Hence, the objective of this narrative review is to identify strategies found in scientific literature, which have been effective (i.e. successful) in increasing adolescents' school-based PA, and to outline general intervention guidelines that may help translate the research knowledge into the development of future programmes and interventions. Finally, we adopted an inclusive approach that gathered evidence from studies that have used a variety of research designs—while acknowledging that the strength of the evidence may vary across studies—and that left room to a more qualitative discussion of the identified strategies.

Method

The literature search was conducted up to 2011, using the Medline, Pubmed and Web of Knowledge databases. The following search terms were used and combined with the logic operator AND: 'physical activity', 'adolescents', 'intervention' and 'school'. In addition to these electronic databases, reference lists in the review papers, together with our own archives of published

documents, were reviewed. Inclusion criteria were as follows: (i) the intervention carried out was school based; (ii) the intervention generated an increase in PA, regardless of how this was measured; (iii) the study population was between 12 and 18 years; (iv) the characteristics of the intervention were described and (v) the original studies or reviews were written in English or Spanish.

A total of 98 articles were identified, of which 73 studies satisfied the inclusion criteria and were therefore included in the review. Of these, 52 documents were original studies and 21 were reviews. Any disagreements in the inclusion process were resolved through discussion among authors. Data were then extracted from the articles, mainly including intervention and study characteristics (study design, participants, intervention context and strategies) and effectiveness considerations (outcomes and measures) [24]. All the data extracted were independently reviewed by two researchers, to classify the contributions of each study. If no agreement was reached, a third researcher helped to solve discrepancies and adopt a consensus. Given the heterogeneity in terms of intervention and study characteristics, measures and outcomes, we undertook a narrative review to make sense of the findings.

Results and discussion

On the basis of studies, we reviewed and identified several effective intervention strategies that were further grouped into five general intervention guidelines to increase adolescent PA. These guidelines arose as a result of an inductive process assisted by constant comparison procedures. This process was carried out until further levels of generalization were not possible or sensible taking into account the extant literature. The first intervention guideline situates PA promotion within a broader health promotion framework in which the school is a privileged setting to promote health and PA in an integrated manner through multiple levels of influence. The remaining four intervention guidelines include more specific school-based strategies;

these should be used to complement the strategies proposed in the first intervention guideline.

Propose or develop multi-component interventions that foster the empowerment of members of the school community

Ecological models have proven to be appropriate conceptual models to design interventions aimed at increasing levels of PA [17, 25–28], due to their ability to generate behavioural changes based on comprehensive approaches [29–31]. The participation of different members of the school community will promote empowerment and improve effectiveness of interventions aimed at increasing participation in PA [32, 33]. Multi-component interventions are in line with the ecological approach, as they consider that health-related behaviours are influenced by many different factors. In a recent review of reviews [11], school-based multi-component interventions emerged as the most consistent, promising strategy to increase PA in children and adolescents. Furthermore, these interventions show potential to increase PA both in-school and out-of-school [11]. Hence, in recent years, the intervention studies and reviews on the issue suggest the need for school-based promotional efforts that include developing students' knowledge and skills, providing social support and creating favourable environmental conditions and opportunities for healthy living [33–37]. Overall, these three components form the reference framework of Health Promoting Schools [38], which purport to intervene through multiple levels of influence in the students' lives in a coherent and integrated manner. A health promoting school places the priority on the health of students and staff and involves the whole school community in addressing such priority. A particular emphasis is placed on helping students to develop life skills that can be used in a variety of contexts and circumstances to make sound decisions and gain access to important resources [37]. Consequently, there have been calls in the literature for schools to play a leadership role in promoting PA [6, 25, 36–44].

The school-based interventions included various studies [9, 32, 33, 36, 37, 45–57, 58] under the

umbrella of the ecological model, with multi-component interventions that favour the empowerment of members of the school community, and are mainly developed through two intervention channels: curricular and non-curricular. The curricular channel involves changes in the content and teaching of the different content areas (mathematics, language, science, physical education, etc.). The non-curricular channel refers to changes in aspects of the school life that are not part of the formal curriculum. In this case, the role of the PE teacher is essential as a facilitator and promoter of a healthy lifestyle, together with the involvement of families and the community.

Among the curricular strategies used are interventions whose aim is to teach the necessary skills and abilities to adopt and maintain a physically active lifestyle [48–50, 55] and to foster students' responsibility through a personalized action plan in the context of group work [37] or through seeking to develop increasing levels of self-control, participation, self-responsibility and care [56]. To this end, teaching strategies such as the teacher's intervention, modelling, tutoring and time for reflection [56] are used. Students participate in the creation of their own strategies, and the focus of work is on motivation, life skills development and promoting students' confidence, autonomy and involvement [49, 53, 54, 58]. The preferences expressed by students about informal and non-competitive activities that they enjoy have been also incorporated in intervention studies in which an increase in adolescent PA was found [47, 49, 51, 53]. Another curricular strategy that has been used to increase adolescent PA levels, in combination with other curricular strategies, is fostering peer support to create positive social interactions and model PA behaviours [57].

Regarding the non-curricular channel, some intervention strategies include a collaboration between the school and the family in an attempt to obtain the support and participation of parents, in particular [36, 37, 47–50]. To determine the effectiveness of including a family component in school-based interventions, studies that provide information about ways in which schools can engage parents in PA promotion efforts are needed [24, 59]. In other

cases, the objectives include increasing the number of facilities available and access to PA spaces, fostering social support and providing supervision for PA [36, 45, 47]. An increase in the number of accessible programmes and opportunities is necessary, especially those geared towards girls and families, so that students can take advantage of opportunities to be active in school and in the community [36]. Other proposals include promoting PA through the school health services [48–50] and creating and training a school-based action team or committee that assumes responsibility for establishing priorities and putting them into practice via a school action plan [33]. Of these types of interventions, the multi-component Intervention Centred on Adolescents' Physical Activity and Sedentary Behaviour (ICAPS) was one of the few that were effective in increasing the proportion of adolescent boys (69–81%) and girls (59–83%) who participate in PA organized during leisure time in eastern France [45]. ICAPS adopted a socioecological perspective that acknowledges the dynamic interactions between personal factors and environmental factors of social and physical nature. The aim was to improve adolescents' attitudes towards and aptitude for PA by emphasizing recreational and daily-life activities within a lifelong perspective and reducing common barriers to PA through strategies such as adapting times and places, fostering open participation, emphasizing fun and social interaction and eliminating competitive aspects.

Furthermore, the use of social marketing strategies has generated important changes in recent years in terms of promoting and increasing PA levels in adolescents [47, 49, 60–63]. One example of this is the VERB programme or campaign that successfully encouraged young people between the ages of 9 and 13 years in the United States to be physically active every day by positively influencing attitudes towards PA and PA behaviours [62]. It sought to transmit a positive message about PA through the media, schools, the Internet and partnerships with national and local organizations, as well as to improve access to PA resources, taking advantage of the influence that fathers, mothers and teachers, as well as other people involved in the lives of

pre-adolescents and adolescents, have on adolescents. Another example is the Trial of Activity for Adolescent Girls (TAAG) intervention that promoted awareness and participation in activities through the media and events as well as the provision of messages to increase the acceptance and support of PA through access to appealing activities in the playgrounds and after school hours [36, 47, 61]. TAAG achieved modest increases in the amount of PA among girls in participating middle schools in the United States.

An example of multi-component intervention that incorporates both curricular and non-curricular strategies to promote PA in high school students is the Saude na Boa project [64]. The intervention sought to implement simple environmental changes (e.g. increase availability of safe bike racks), educate students about PA and train and engage school personnel (e.g. curriculum modification training for PE teachers). The intervention included culturally relevant activities and low cost resources, emphasized enjoyable, easy-to-implement activities, incorporated health promotion components in the PE curriculum and used activities that were easy to maintain after the intervention and to disseminate to other schools. The intervention was effective in increasing the number of days per week on which students accumulated 60 minutes or more of moderate-to-vigorous physical activity (MVPA) and reducing the proportion of students who did not accumulate 60 minutes of MVPA at least once a week.

An important aim pursued through curricular and non-curricular intervention channels is to empower students so that they are able to manage their own behaviour, thus achieving more opportunities to promote current and future PA [47–50, 52, 65]. Similarly, in recent years, some authors have defended the leadership that adolescents must assume (as leading players, social actors and facilitators of environmental changes) in the intervention setting [9, 32, 37, 57]. As indicated in Table I, a majority of interventions that have focused on empowering students to manage their own behaviour have been successful in achieving post-intervention increases in adolescent PA. Hence, one criterion that

Table 1. Synthesis of strategies grouped by intervention guideline and of the results of the studies reviewed

Intervention guidelines	Strategies	Study (main reference)	Outcomes	
			Self-reported physical activity	Objective physical activity
Curricular channel	Teach the necessary skills and abilities to adopt and maintain a physically active lifestyle.	Lifestyle Education of Activity Program (LEAP) [49]	1 ^a	
		Lifestyle Education of Activity Program (LEAP) A case study [50]	4 ^a	
	Teaching strategies such as the teacher's intervention, modelling, tutoring and time for reflection	Planning to be Active [55]	2 ^a	
		Bromikowski <i>et al.</i> [56]	6 ^a	
	Promoting students' confidence, autonomy and involvement with their own strategies (empowerment).	Wilson <i>et al.</i> [53]		4 ^a
		The Active by Choice Today [54]		6 ^a
	Taking into account the preferences expressed by students regarding PA in intervention studies.	Trial of Activity for Adolescent Girls (TAAG) [61]		6 ^a
		Lifetime Activity Program [58]		5 ^a
		Trial of Activity for Adolescent Girls (TAAG) [47]		6 ^a
		Lifestyle Education of Activity Program (LEAP) [49]		1 ^a
Multi-component interventions that foster empowerment	Incorporating an action planning (fostering student's responsibility). Creating and training a school-based action team or small groups or committees.	Cass <i>et al.</i> [51]	6 ^a	4 ^a
		Wilson <i>et al.</i> [53]		5 ^{a,6}
	Fostering peer support to create positive social interactions and model PA behaviours.	It's your body—use it well! [57]		5 ^b
		Pérez <i>et al.</i> [37]		6 ^a
	Non-curricular channel	Trial of Activity for Adolescent Girls (TAAG) [61]		6 ^a
		Pérez <i>et al.</i> [37]		5 ^b
	Intervention strategies include collaboration between the school and the family.	Trial of Activity for Adolescent Girls (TAAG) [47]		6 ^a
		Lifestyle Education of Activity Program (LEAP) [49]		1 ^a
	Increasing the number of facilities available and access to PA spaces, programmes and opportunities, fostering social support, and providing supervision of the PA.	Lifestyle Education of Activity Program (LEAP).		4 ^a
		A case study [50]		5 ^a
Intervention Centred on Adolescents' Physical Activity and Sedentary behaviour (ICAPS) [45]			6 ^a	
Trial of Activity for Adolescent Girls (TAAG) [47]			6 ^a	
	Trial of Activity for Adolescent Girls (TAAG) [61]		6 ^a	

(continued)

Table I. *Continued*

Intervention guidelines	Strategies	Study (main reference)	Outcomes	
			Self-reported physical activity	Objective physical activity
	Promoting PA through the school health services.	Saude na Boa project [64] Lifestyle Education of Activity Program (LEAP) [49] Lifestyle Education of Activity Program (LEAP). A case study [50]	6 ^a 1 ^a 4 ^a	
	Promoted awareness and participation in activities through the media and events, activities in the recess and after school hours and the provision of messages to increase access, acceptance and support of PA.	Trial of Activity for Adolescent Girls (TAAG) [47] Lifestyle Education of Activity Program (LEAP) [49] Trial of Activity for Adolescent Girls (TAAG) [61] VERB [62]	1 ^a	6 ^a 6 ^a 6 ^a
	Increasing the students' knowledge, raising awareness to make them interested in healthy lifestyles and providing them with the skills to enable them to change through changes in the programme/curriculum.	Pérez <i>et al.</i> [37] Killen <i>et al.</i> [74] Lifetime Activity Program [58]	5 ^b 5 ^a 5 ^a	
	Teachers must also promote enjoyment and participation in moderate-to-vigorous PA in and out of class, by varying the contents and structure of PE to place emphasis on the promotion of PA.	Planning to Be Active [55] The Child and Adolescent Trial for Cardiovascular Health (CATCH) [75]	2 ^a 4 ^a	
	Designed curricular materials involving the teaching staff in the monitoring of the intervention.	Project Active Teens [76] Middle School Physical Activity and Nutrition (M-SPAN) [77]	5 ^a 3 ^a	
	Identifying students' needs and interests implementing innovative and sustainable strategies in response to these needs and interests.	Project FAB [78]	5 ^a	
	Integration of moderate-to-vigorous PA with other programmed learning objectives.	Fairclough <i>et al.</i> [79]		4 ^b
	Different types of supervision and feedback about the moderate-to-vigorous PA.	Schuldheisz <i>et al.</i> [80]	3 ^a	

(continued)

Table 1. Continued

Intervention guidelines	Strategies	Study (main reference)	Outcomes	
			Self-reported physical activity	Objective physical activity
Non-curricular interventions	Include providing choices for PA and implementing changes in the environment during leisure time periods at school.	Middle School Physical Activity and Nutrition (M-SPAN) [77] Middle School Physical Activity and Nutrition (M-SPAN) [94] Planning to Be Active [55]	3 ^a 5 ^a 2 ^a	
	Combine non-curricular approaches with a curriculum-based approach to foster the use of self-regulation skills to promote and increase regular PA of students outside school.	Wilson <i>et al.</i> [53]		4 ^a
	Encourage adolescents to take charge of the programme development and encourage them to participate in the development of their own strategies.	The Incorporating More Physical Activity and Calcium in Teens (IMPACT) [95]	1 ^a , 5 ^a	
	Peers work together, using the media, through a school-based newsletter including stories that present positive models to decrease the adoption of sedentary behaviours.	Intervention Centred on Adolescents' Physical Activity and Sedentary behaviour (ICAPS) [45] The Active by Choice Today [54]	5 ^a	6 ^a
	Modify knowledge, attitudes and motivation towards PA through information, debates, PA sessions, fostering the social support of parents, students and teachers and providing an atmosphere that encourages students to engage in PA.	Haerens <i>et al.</i> [34] The Active-O-Meter [35] Haerens <i>et al.</i> [39] Lee <i>et al.</i> [100]	1 ^a , 2 ^a , 6 ^a	3 ^a , 5 ^a 5 ^a 6 ^a
	Give students normative information comparing their PA with the recommended levels of PA. Define the content and focus of the information. Give students personalized information at the end of the intervention.	Haerens <i>et al.</i> [39] Haerens <i>et al.</i> [34] Haerens <i>et al.</i> [34] Frenn <i>et al.</i> [97] PACE+ for adolescents [98]	3 ^a 6 ^a	5 ^a 3 ^a , 5 ^a 3 ^a , 5 ^a 6 ^a
	The schools were guided and supported by the research team to initiate the intervention.			
	Parents participation an interactive meeting about PA and wrok at home.			
	Interventions with computer-tailored components during the implementation and monitoring			

(continued)

Table I. Continued

Intervention guidelines	Strategies	Study (main reference)	Outcomes	
			Self-reported physical activity	Objective physical activity
	<p>Developed with multi-component programmes</p> <p>Creating greater awareness among those responsible for promoting PA and adapting the programmes to their needs.</p> <p>Developing a feeling of empowerment; proposing comprehensive opportunities for girls so that they can contribute to and have an influence on decisions about their PA and participation.</p> <p>Increasing their participation in PA at school and in the community.</p> <p>Promoting participation in non-competitive activities.</p> <p>Achieving incentives and support to increase PA.</p> <p>Seeking a change in behaviour through the promotion of active learning in the classroom, as well as by modifying the environment to support an increase PA and reduce sedentary activity.</p>	<p>Lifestyle Education of Activity Program (LEAP) [46]</p> <p>Trial of Activity for Adolescent Girls (TAAG) [47]</p> <p>Lifestyle Education of Activity Program (LEAP) [49]</p> <p>Lifestyle Education of Activity Program (LEAP).</p> <p>A case study [50]</p> <p>Cass <i>et al.</i> [51]</p> <p>The Incorporating More Physical Activity and Calcium in Teens (IMPACT) [95]</p>	<p>5^a</p> <p>6^a</p> <p>1^a</p> <p>4^a</p> <p>6^a 1^a, 5^a</p>	<p>6^a</p>
<p>Interventions that respond to the needs or interests of girls</p>	<p>Not developed with multi-component programmes</p> <p>Offering special PE classes aimed at discovering and discussing the benefits of PA-based health and strategies to increase PA.</p> <p>PA is promoted as a way of improving self-concept and increasing PA outside school.</p> <p>Both curricular and non-curricular interventions play a role in facilitating PA in adolescents.</p>	<p>Project FAB [78]</p> <p>Schneider <i>et al.</i> [106]</p> <p>Trial of Activity for Adolescent Girls (TAAG) [112]</p>	<p>5^a</p> <p>1^a</p> <p>4^b</p>	

1. Increase in vigorous physical activity; 2. Increase in moderate physical activity; 3. Increase in MVPA; 4. Increase in MVPA and vigorous physical activity; 5. Increase in PA levels during and right after the intervention; 6. Increase PA levels (MVPA) after the intervention (from 2 months up to 2 years after the intervention).
^aThere is significant differences between groups in a study that include intervention and control group. ^bThe study included only an intervention group.

might help schools is to use the same guiding principles, and work towards the same goal, but to do so using different strategies, depending on their differing needs and resources [37]. An example of this is Action Schools! BC (AS!BC) [66, 67], a comprehensive school-based model that promotes PA and healthy eating in elementary schools in British Columbia. The PA component of the model operates through a school-specific planning process where relevant stakeholders (e.g. teachers, administrators, parents) create action plans for different target areas based on an assessment of existing resources opportunities for PA. With appropriate adaptations, this model could be implemented in secondary schools as well.

Interventions focused on the improvement of physical education programmes as a strategy to promote physical activity

PE has great potential to help increase PA in adolescents in two ways: direct and indirect [15]. Directly, PE itself can contribute to the daily accumulation of minutes of PA [16] recommended in the different PA guidelines regarding adolescents' minutes and intensity of daily PA [68–70]. Indirectly, PE can be a tool to promote PA outside the school and achieve a physically active lifestyle [71, 72]. PE is an essential part of comprehensive school programmes, and it has been said that combining PE with programmes in other settings (family and community) may make a more significant contribution to the PA levels of adolescents [15]. In the same vein, Carreiro da Costa [73] proposes a model of PE that must give children and adolescents opportunities to acquire knowledge and to develop the necessary attitudes and competencies becoming then a way to promote PA as a means towards autonomous, satisfactory and prolonged participation throughout the course of life.

The most effective PE-based interventions to increase PA propose changes in the programme that lead to improvements, mainly by increasing the students' knowledge, raising awareness to make them interested in healthy lifestyles and providing them with the skills to enable them to change

[37, 52, 58, 74]. They must also promote enjoyment and participation in moderate-to-vigorous PA in and out of class [55, 75], by varying the contents and structure of PE to place emphasis on the promotion of PA [76]. Curricular materials must also be designed, involving the teaching staff in the monitoring of the intervention, to review and adapt the current teaching strategies [77]. Students' needs and interests must be identified, implementing innovative and sustainable strategies in response to these needs and interests, and even proposing the creation of special PE classes during the week [16, 78]. Other pedagogical interventions have focused on the planning processes and teaching via the integration of moderate-to-vigorous PA with other programmed learning objectives [79]. Conversely, an alternative intervention focused on pedagogy is based on the effect of different types of supervision and feedback about the moderate-to-vigorous PA [80].

Recently, various studies have proposed high-quality PE based on interventions aimed at increasing PA outside school and, in the long term, within an active lifestyle [68]. The intervention strategies designed in these programmes have the potential to provide all young people with experiences that promote PA during their adolescence and adult life [18, 41, 68, 81–83]. The aim of high-quality PE is to make students more competent and to empower them, especially girls, to manage their own behaviour [52, 65, 68, 84]. Likewise, high-quality PE can contribute to develop physically literate individuals who not only move efficiently but also move creatively, competently and with enthusiasm; that is individuals who have the knowledge, skills, and attitudes to lead healthy lifestyles and help others do the same [85]. Indeed, a positive association between physical literacy and leisure PA has been observed as early as in grade 3 and 4 children [86]. Based on this aim, a different role of physical educators is proposed: that of facilitators and promoters of a healthy, active lifestyle. In this regard, it should be noted that PA is considered as the vehicle through which students become physically educated; however, by itself, and without a meaningful educational process, PA is not sufficient to create a physically educated person [87].

Design and use of non-curricular programmes and activities to promote physical activity

Non-curricular PA is very important as a complement to curricular PA [42, 88, 89]. For the purposes of this review, non-curricular PA refers to programmes and activities delivered in school that do not focus on modifications of the formal curriculum in PE, health education or other topics. In previous years, there has been an increase in the use of non-curricular programmes and activities that might be effective to promote PA [14, 19, 90–92].

Based on the studies reviewed, the most effective non-curricular strategies to increase PA during the school day include providing choices for PA and implementing changes in the environment during leisure time periods at school [14, 77]. Therefore, improving the outdoor environment must be considered when designing PA promotion programmes in secondary schools [93, 94]. Notably, these programmes need to pay particular attention to the needs of girls, because in some of the studies reviewed, the intervention was not effective among girls [94]. Some studies combined non-curricular approaches with a curriculum-based approach; the aim was to foster the use of self-regulation skills to promote and increase regular PA of students outside school [55]. During after-school hours, the most effective strategies to increase PA involve the use of cognitive mediators (self-efficacy and perceived competence) and motivational counselling (intrinsic motivation, commitment and positive self-concept) to increase the PA adolescents practice with friends and family members [54]. These programmes encourage adolescents to take charge of the programme development, selecting the activities that generate fun, enjoyment and interest, and encourage them to participate in the development of their own strategies to achieve effective PA lifestyle changes [52, 53].

Another way of addressing the promotion and increase of PA in less active adolescents is by examining the prevalence of sedentary behaviour, and using intervention strategies to reduce it. For example, the Incorporating More Physical Activity

and Calcium in Teens intervention focuses on the impact on behavioural changes through the promotion of active learning in classrooms and through the importance of the environment. Peers work together, using the media, through a school-based newsletter including stories that present positive models to decrease the adoption of sedentary behaviours [95]. Another example is the previously mentioned ICAPS intervention that purports to modify knowledge, attitudes and motivation towards PA through information, debates, PA sessions, fostering the social support of parents, students and teachers, and providing an atmosphere that encourages students to engage in PA [45].

The strategies presented here are low cost for the most part and have shown some success in terms of increasing the PA levels of adolescents. Moreover, there seems to be ample room for future development in terms of use of these strategies. Two particularly promising venues for future work in this area are PA during school recess time [14] and active transportation to school [53].

Interventions that include a computer-tailored component during implementation and monitoring

Over the last decade, a new education strategy for health has emerged: computerized tailored interactive feedback systems that can be used in the classroom and combined with changes in the curriculum and in the school environment. Previous studies on adults have shown that personalized computer messages are more effective on personal and motivational factors. This, in turn, has had an influence on PA behaviours, which are more likely to be perceived as interesting and personally relevant [96, 97]. More recently, different studies on adolescents have shown that interventions based on this strategy can be effective to increase adolescents' PA levels [34, 35, 39, 97–99].

This type of intervention starts by giving students normative information comparing their PA with the recommended levels of PA. Then, the student's stage of change is used to define the content and focus of the information they receive in

counselling sessions. At the end of the intervention, students receive personalized information about their attitudes, self-efficacy, social support, knowledge and perceived benefits barriers related to their PA [34, 35, 39, 97]. In one such study [39], during the first months of the intervention, the schools were guided and supported by the research team to initiate the intervention, but later continued with the implementation more independently, as it was considered the intervention would be more successful when carried out by the school itself. Parents are also deemed important and taken into consideration in this type of intervention. In one study, parents were invited to an interactive meeting about PA and its relationship with health, and the information was also sent to their homes, including a compact disc with the PA intervention adapted to the adult, to complete at home [34]. The results of another intervention, that included eight lessons given to low-income adolescents from different cultures, show an increase in PA of an average of 7 minutes a day in intervention group students and a reduction of an average of 15 minutes a day in control group students [97]. A second intervention with personalized feedback messages was not effective in increasing the moderate-to-vigorous PA, as measured with questionnaires and accelerometers. However, the number of days of activity per week increased by 7.3% among the intervention group boys, whereas no changes were found in the control group [98].

Given the few available studies in this area, and the promising findings, more research is needed to help researchers and practitioners design better interventions and programs to take advantage of the potential of computer-tailored strategies to promote PA among all adolescents. Moreover, the available findings suggest that some of the tested strategies were more effective with boys, a finding consistent with other work concluding that, generally, boys benefit more from PA interventions than girls [34]. Therefore, future work should attempt to find ways to engage girls with similar success in interventions using computer-tailored strategies. One example of this is an intervention that combined self-efficacy as a theoretical foundation and

pedometers to enhance motivation towards PA by setting individual goals, using graphs to represent the distance of walking or running as monitored by pedometers, engaging girls in discussions about the difficulties they faced to achieve the target number of steps and using rewards for achieving set targets [100].

Interventions or programmes that respond to the needs or interests of girls

Our review indicates that girls are a high priority group for PA promotion due to lower levels of PA compared with boys, and particularly low compliance with current PA recommendations [12, 101–104]. In response to this need, some interventions have focussed on girls [33, 36, 46–51, 78, 91, 95, 105–107]. The majority of these interventions have been developed with multi-component programmes based on an ecological approach that have mainly consisted of (i) creating greater awareness among those responsible for promoting PA and adapting the programmes to their needs, (ii) developing a feeling of empowerment; proposing comprehensive opportunities for girls so that they can contribute to and have an influence on decisions about their PA and participation; (iii) modifying the school and community environment to foster participation in PA; (iv) promoting participation in non-competitive activities; (v) offering incentives and support to increase PA and (vi) seeking a change in behaviour through the promotion of active learning in the classroom, as well as by modifying the environment to support an increase in PA and reduce sedentary activity [36, 46–51, 95]. Other strategies that have been used in some of these programmes include the implementation of a supportive learning environment aiming at creating a feeling of personal mastery and self-efficacy alongside opportunities to develop social relationships and networks [9, 47, 50, 108, 109].

Other interventions, not developed in multi-component programmes, have also used effective strategies to increase girls' PA levels. For example, offering special PE classes aimed at discovering and discussing the benefits of PA-based health and

strategies to increase PA [78]. For this strategy, girls keep a journal and attend weekly meetings where information about how to be active on a daily basis, and advice to help girls establish realistic goals based on individual reference data, are provided [78]. PA is promoted as a way of improving self-concept and increasing PA outside school [106], including the combination of educational sessions in the entire school area, individual counselling sessions and PA sessions with the participants' mothers [107]. Ideally, interventions designed specifically for girls should be guided by relevant theory [110]. Although there is no single theory to explain adequately girls' PA behaviour, self-efficacy is one of the most consistent correlates of PA in adolescent girls and has been identified as an important mediator of PA behaviour in interventions with adolescent girls [103, 110, 111].

The results of one study suggest that both curricular and non-curricular interventions play a role in facilitating PA in adolescents [112]. However, it seems clear that school-based multi-component interventions where PE addresses the specific needs of girls so that they feel competent and supported, for example through peer based-strategies, are more effective [12]. Yet, intervention research must not only find ways to encourage girls to participate in curricular and non-curricular activities but also identify strategies to maximize movement and fun regardless of the participants' skill level [113].

As a complement to the Results and Discussion section, the data in Table I present the evidence for a positive relationship between the different strategies, grouped by intervention guideline, and an increase in PA. Thus, this table provides the key characteristics of the successful efforts to promote PA among adolescents. It also provides the reference of the studies from which the strategies were extracted, and information on how PA was measured, the types of PA outcomes achieved, and whether these outcomes were short or long term. The table also identifies the studies that included an intervention and control group and where significant differences in terms of PA were found between the groups.

Conclusion

This narrative review article provides information about and discusses promising school-based strategies and more general intervention guidelines to increase PA in adolescents. Together, these promising strategies consist of addressing multiple levels of behaviour influence within an ecological framework, developing a sense of empowerment, and quality PE as an important opportunity to provide all young people with experiences that promote PA. They are combined with extracurricular PA and computerized advice offered during the intervention as well as strategies that bear in mind the needs and interests of girls, as a high priority group given the gender differences observed between actual and recommended PA levels.

Future research could focus on designing, implementing and evaluating interventions based on the principles identified in this review. These include empowering students to manage their own behaviour; fostering the role of PE teachers as facilitators and promoters of PA in the context of a healthy lifestyle; using a variety of school-based strategies within a comprehensive approach to health approach; fostering the social support of parents, peers and teachers; and creating an environment that encourages the practice of PA.

One important challenge in this regard is to achieve a link between research and practice [37, 114]. In other words, to ensure new knowledge is translated into practice. Recent work suggests that one way of achieving this objective is through Integrated Knowledge Translation (IKT), which entails the participation and integration of the people who will have to act upon the findings or results in the research process [114]. IKT also ensures that research is grounded in and responsive to the needs of practitioners, including student teachers as part of their pre-service education field experiences or stages, and local school communities, rather than being driven only by the researchers' agenda.

This review points to the need to continue intervention research to improve intervention strategies to promote PA in adolescents, contributing to a better understanding of the options available.

This will help adolescents initiate and sustain important active lifestyle behavioural changes. To this end, we believe that the promotion of PA must be based on innovation and research, but that it is also necessary to reconsider the relationship between knowledge and action, so both dimensions inform each other. We hope that this review is beneficial to researchers, and that the intervention guidelines and strategies identified help to successfully develop interventions that contribute to increasing levels of PA among adolescents and open new ways for the promotion of PA to this population.

Our review has several limitations: (i) most intervention studies have been conducted in the United States, hence the need for more interventions in different geographical and cultural contexts to have a wider evidence base; (ii) to have a better knowledge of effective approaches to promote PA, developing an understanding of approaches that were not effective and of the reasons why may be also necessary; (iii) the review was limited only to studies reporting an increase in PA and did not include interventions reporting results that may be conducive to an increase in PA, such as reductions in sedentary behaviour and/or improvements in physical fitness; (iv) the review is inclusive in terms of incorporating studies that used different approaches to measure PA and research designs to evaluate the impact and outcomes of the interventions; therefore, the strength of the evidence presented may vary across studies. Future studies should attempt as much as possible to incorporate objective measures of PA such as accelerometers although, as some authors point out [43, 115, 116], this may be challenging or even not feasible in large scale intervention studies. Overall, these limitations may have biased some of the findings and conclusions presented. Nevertheless, despite these limitations, the review offers a wealth of information about strategies that were found successful in particular contexts and circumstances and that could be eventually applied in different contexts and circumstances with appropriate modifications. As Okely *et al.* [33] argue, giving schools the ownership of interventions and the opportunity to develop strategies that respond to

their needs, interests and knowledge is a way to build sustainability into their initiatives.

Conflict of interest statement

None declared.

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