Jornal de Pediatria (2021);97(6):585–594

Jornal de Pediatria
www.jped.com.br

REVIEW ARTICLE

Effects of interventions for promoting physical activity during recess in elementary schools: a systematic review☆

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Received 30 October 2020; accepted 8 February 2021
Available online 25 March 2021

KEYWORDS
Physical activity;
School;
Interventions;
Children;
Recess

Abstract

Objective: Summarize the effects of interventions designed to promote physical activity during elementary school recess in children between 5 and 10 years old. Effective school interventions for children can promote physical activity and healthy behaviors.

Methods: PubMed, Scopus, Bireme, SciELO, Web of Science, PsychINFO, Proquest, Physical Education Index, Sports Discus, and Eric databases were included in the data search. Original intervention articles on physical activity that used regression methods, published between 2000 and 2019 in English, Portuguese and Spanish were analyzed. Analyses were performed in 2019. Outcomes were organized according to the direction of the association by independent variables. Ten articles were considered eligible for data extraction and evaluation.

Results: Several strategies were used including playground markings, demarcation of physical activities zones, group activities, availability of sports equipment and facilities. Most of the studies were conducted in the United States. Recess periods ranged from 20–94 min per day and intervention time ranged from 6 weeks to 2 years. Recess duration and intervention effects were positively associated with physical activity. Gender (girls) and age (oldest) were negatively associated with physical activity during recess.

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https://doi.org/10.1016/j.jped.2021.02.005

Conclusions: Interventions based on modifications of school environment such as playground markings demarcation of physical activities zones, group activities, availability of sports equipment and facilities are cheap and cost-effective for increasing physical activity in school recess.

Background

Physical activity (PA) is recommended for human development, especially during childhood and adolescence.[1,2] Nonetheless, with wide dissemination of knowledge on the benefits of PA for health and quality of life a considerable portion of children and adolescents do not attend daily PA recommendations.[3] The guidelines suggest 60 minutes or more of moderate to vigorous physical activities.[4]

Especially in children, PA promotion is a very complex task and the current understanding is that active behavior is determined not only by individual factors but must consider the impacts of social, economic and environmental factors as well.[2,4,5] In middle-income countries there is a lack of evidence in the school context as a source of PA promotion and only the most developed countries present a better situation.[6] Thus, the need arises in the literature to study PA promotion in the different contexts in which children participate, recognizing its possibilities and specificities.

It is widely recognized in the literature that the school is a potential environment for the implementation of strategies to promote PA[7,8] and, in addition to structured actions usually implemented in classes or occasions that resemble the more formal classes, some efforts advocate for the promotion of PA in moments of school recess, where children can choose unstructured free activities (e.g. free play and games).[9–11] In this sense, besides the possibility of promoting PA, previous research suggests that recess is also important for the development and exploration of different motor skills,[12,13] as well as closer social relations.[14,15] Therefore, PA during school recess could be influenced by different factors such as teachers, staff and the perceived and built school environments.[16–18]

The promotion of physical activity in children can represent great benefits that are carried throughout childhood, as it is a time when children are highly receptive to healthy behaviors. The adoption of healthy behaviors in this period has been shown to be associated with benefits for physiological and behavioral development over time.[19] Proper monitoring of physical activity during childhood and adolescence, associated with intervention planning, may be related to maintaining an active lifestyle as adults with favorable health consequences.[20–22] In previous studies, intervention effects were positively related to children's PA during school recess.[23,24]

Previous reviews indicate that interventions developed in school recess have shown promising effects on the promotion of PA in children and adolescents, highlighting structural strategies, such as equipment availability and markings for play and games.[13,25–28] While all of these systematic reviews are very important for the academic and scientific debate, presenting an up-to-date review primarily with children in the early grades may allow a better understanding of the effects of these interventions on PA during school recess. The focus on five- to ten-year-old children allows a better understanding of the relationship between the predictors of PA during recess, as other published reviews synthesized studies involving both children and adolescents.[13,25–28] The adoption of healthy behaviors during early childhood has been shown to be associated with benefits for health over time. Effective environmental school interventions to promote physical activity and health in children are not well known. Therefore, the aim of this systematic review was to identify and summarize the effects of interventions designed to promote PA during recess in children between five and ten years old.

Methods

Study design

This study is a systematic review of literature, designed, conducted, and reported according to the items in the Preferred Report Items for Systematic Reviews and Meta-Analyses (http://www.prisma-statement.org).[29]

Inclusion criteria

Intervention studies (trials) aiming to promote physical activity during recess period(s) in school were searched in the scientific literature. For our purposes, the recess period in the school environment was defined as the free time between classes, in which children could perform activities of their interests.[10] These periods could be one or more times throughout the school day (morning and afternoon recess and/or lunchtime).

Therefore, the established inclusion criteria for the intervention studies were: (1) No restriction on design (e.g. randomization and/or presence of control group); (2) Must report physical activity in different school periods such as physical education classes, distinct periods of recess, before and after school. Also, total school day and stratified data of any recess period, considering the specific age of children in the study; (3) Target children between five and ten years old or in classes that included the selected age; (4) Present association analyses (regression models); (5) Original studies; and (6) Articles in English, Portuguese and Spanish languages and published from January 2000 to July 2019. Non-inclusion criteria were only studies that investigated the level of physical activity in special populations (e.g. autism spectrum

disorder, attention deficit disorder, or physical and cognitive limitations).

Recovery of potential evidence

Potential articles were searched in two phases. Firstly, they were searched through systematic searches in ten electronic databases: Bireme, Eric, Physical Education Index, ProQuest, PsycINFO, PubMed, SciELO, Scopus, SportDiscus, and Web of Science. Systematic searches were developed based on the protocol designed by PubMed by using keywords and Boolean operators: (physical activity OR exercise * OR motor activity) AND (schools * OR school-based OR elementary school OR school environment OR environment design *) AND (student OR preschool OR child, preschool * OR child * OR children) AND (recess OR playground OR active play OR playtime OR interval class). The second phase included manual searches in the reference lists of studies in which full texts were assessed. Since 2000, a growing number of publications were identified. Earlier periods already have been synthesized in other systematic reviews.[25–28]

Operational process

The searches were performed independently by two researchers (ACMS and AAPS). In case of disagreement, a senior researcher was consulted (CRRA). The evidence search was performed in July 2019, and data analyses between August to December de 2019.

Data extraction and synthesis

To summarize the evidence from selected articles, the following information was extracted: author/year of publication, country/year of data collection, sampling method, sample size, age, intervention time, the instrument used to assess physical activity and valid days of its use, number and duration of recess, and statistical analysis method. The variables tested in the studies were organized and described according to the direction of association (positive, null or negative). All measures of effect were considered for the synthesis (e.g. beta-coefficient, odds ratio, the difference in means). At the end of the data extraction process, the descriptive synthesis was prepared by all researchers involved in the review, considering the domains mentioned (e.g. descriptive characteristics, information about methods and results). Due to the high heterogeneity in data from the studies (e.g. age, intervention protocols, intervention time, type of regression model used, and adjusted variables), we opted to not perform subgroup analysis and metanalysis.

Risk of bias

The risk of bias of the original articles was assessed by a senior researcher (PHG) through a 12-item adapted version of the Effective Public Health Practice Project (EPHPP) instrument[30] which covers important methodological domains of a scientific study, such as ''selection bias'', ''study design'' (with the evaluation of the randomization process, when possible), ''confounders'', ''blinding of data analysis advisor'', ''data collection methods'', ''withdrawals and dropouts'', ''analyzes'' and ''analysis based on intention-to-treat principles''. This adapted version can be requested from the corresponding author by electronic message.

Results

Fig. 1 shows the flowchart of the search of 2459 studies screened by titles and abstracts, where 217 went through full-text assessment. After the exclusion of 207 studies, ten articles composed the descriptive synthesis.[23,24,31–38]

Of the ten articles included in this analysis, three of them used the same sample,[35–37] resulting in a total of eight independent studies analyzed. Most studies were developed in the United States (n = 4; 40%). Convenience sampling was the most used sampling method (n = 6). Sample sizes ranged from 93 to 1537 individuals, with high heterogeneity in the mean age ranges addressed. Intervention time ranged from six weeks to two years. These results are shown in Table 1.

In regards to PA assessment, four distinct instruments were identified (SOPLAY, accelerometers Actigraph 7164, GT1M and GT3X, CAST-3, and heart rate Polar). The accelerometer was the most frequently used (n = 9), however, in four of the studies the number of valid days of use was not available.[32,34,36,37] Four of them reported three distinct recess periods.[32,35–37] Among the included studies, recess time ranged from 20—94 min per day. The most common statistical analysis to evaluate the effect was linear regression (n = 4),[23,32,33,38] followed by multilevel linear regression (n = 3).[35–37] Results are presented in Table 1.

Risk of bias

Eight studies were evaluated for risk of bias (Fig. 2). For ''selection bias'', the highest representation of studies was moderate (62.5%); for ''study type'', it was low (50.0%); for ''study design'', reported only by three studies, the frequency was low (100.0%); for ''blinding of data analysis assessors'' the information was not available in most of the studies (87.5%); for ''data collection methods'' bias was low for all evaluated studies (100.0%); for ''withdrawals and drop-outs'', bias was low (50.0%); for ''analysis'' it was low in all the studies (100.0%), and for ''intention-to-treat-analysis'' the highest representative category was moderate (87.5%). The results are presented in Fig. 2.

Nine individual variables were identified in the studies. Girls[23,35,36] and age[23,35] presented negative effects. Higher levels of physical activity at baseline were associated with a positive effect, where most active children on baseline became even more active after the intervention.[35,36] No effects were identified regarding race/ethnicity[23,38] and body mass index (BMI).[23,35,36]

Only one interpersonal variable was identified. Teacher's social support was a negative predictor of children's physical activity.[24] Nine organizational variables were reported in the studies. Only one study reported the positive effect on the school type and, despite presenting itself as a positive predictor, the categories of this variable were not detailed in the study.[23] Recess duration had a positive effect on physical activity.[23,35] Only one study tested the perception of

Table 1 Descriptive characteristics of included studies in systematic review (n = 10).

Author	Country (year of data collection)	Sampling method	Sample size (n) (%G)	Age	Intervention time	PA measurement (valid day use)	Number of daily recess periods and average time (min/day)	Regression Methods
Ridgers et al.[36]	ENG (2003–4)	R	297[a] (49)	5–10	6 months	Acc 7164 (na)	3 (81)	Multilevel Linear
Ridgers et al.[37]	ENG (2003–4)	C	470[a] (51)	8.1	6 months	Acc 7164; HR Polar (na)	3 (na)	Multilevel Linear
Huberty et al.[23]	USA (2008–9)	C	93 (46)	9.6	6 months	Acc GT1M (5)	na (20)	Linear
Ridgers et al.[35]	ENG (2003–4)	R	470[a] (51)	8.3	12 months	Acc 7164; HR Polar (1–2)	3[c] (94)	Multilevel Linear
Elder et al.[32]	USA (na)	C	667 (na)	5–7	12 months	SO SOPLAY (na)	3 (82)	Linear/Logistic
Kelly et al. [34]	AUS (2010)	C	126 (55)	6.5	6 weeks	Acc GT1M; SO, CAST-3 (na)	2 (60)	Binomial
Siahpush et al. [38]	USA (2008–9)	C	93 (46)	8–10[b]	6 months	Acc GT1M (5)	na (23)	Linear
Beyler et al. [31]	USA (2010–12)	na	1537 (53)	9–10[b]	1 school year	Acc GT3X (1–2)	na (33)	Logistic
Yildirim et al. [24]	AUS (2010)	C	260 (57)	8.2	18 months	Acc GT3X (3)	2 (83)	Logistic
Farmer et al. [33]	NZL (2010–13)	Cl	840 (54)	6-9	24 months	Acc GT3X (7)	na	Linear

R, random; na, not available; Cl, cluster; C, convenience; %G, percentage of girls in the sample; Acc, accelerometer; SO, systematic observation; HR, heart rate; na, not available.

[a] Studies using the same sample.

[b] Age estimates according to grade.

[c] 11 schools with 3 recess.

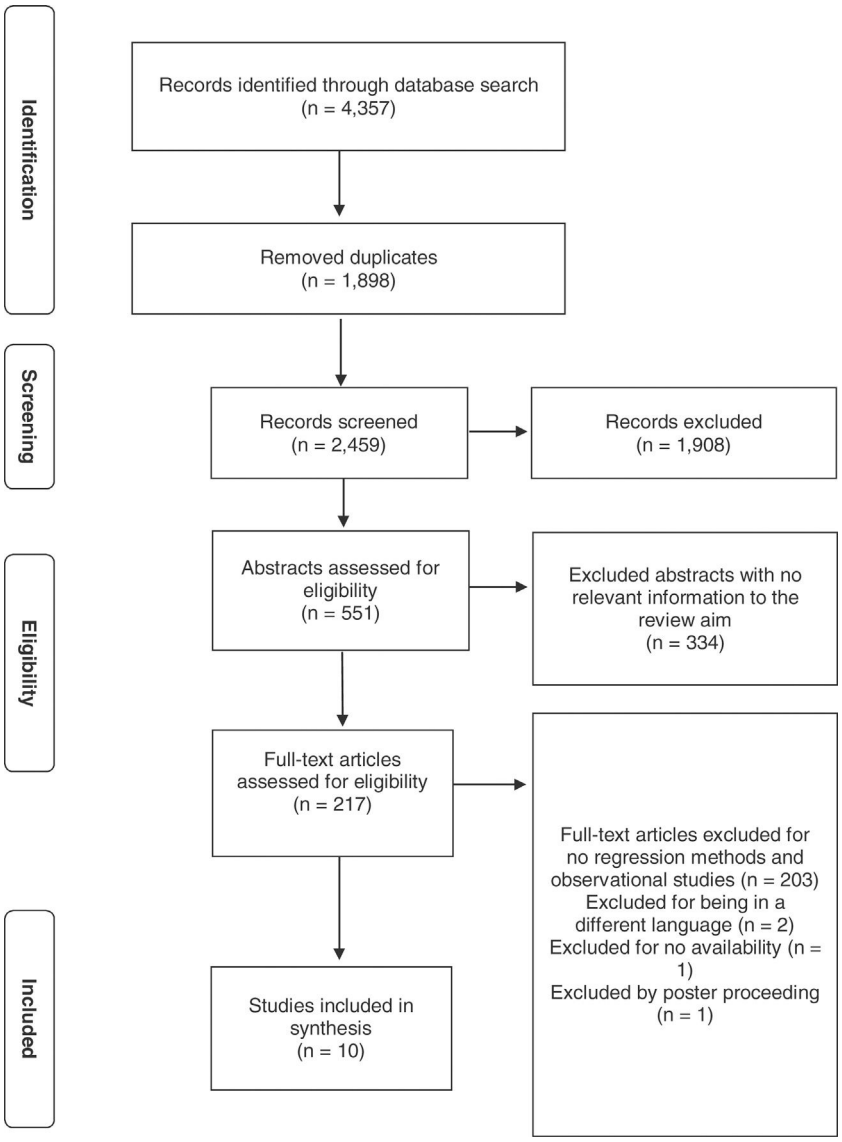

Figure 1 Flowchart of systematic review.

the school environment, and this variable was positive with physical activity in the playground.[24]

Five studies analyzed the strategies used to promote physical activity in children.[23,24,35,37,38] The interventions consisted of playground markings, physical structures, playground zones, sports equipment, games resources, and activity groups. Organized recess[32] and the perception of line marking[24] had a negative effect on physical activity during recess. The effect of program duration was inconclusive.[35] Intervention interactions with variables such as gender, age, BMI, recess duration, intervention duration, presence of equipment, and MVPA were also inconclusive.[32,35,36] The perception of accessibility of sports equipment by children showed no effect.[24] Results are presented in Table 2. The summary of the variables' effects according to physical activity outcome can be found in the Supplementary material (Appendix 1).

Discussion

The aim of this review was to synthesize the evidence of interventions used to promote physical activity in children aged five to ten years old during school recess periods. The synthesis indicated that boys and younger children seem to have more benefits from interventions during recess. Although most studies focus mainly on moderate, vigorous, and moderate to vigorous intensities, the present review sought to report all variables available as outcomes of interventions according to the direction of the association (positive, null, negative, or inconsistent). The findings of the studies will be discussed according to the direction of the associations found.

Female gender was inversely associated with physical activity during recess, especially with the vigorous and moderate to vigorous intensity categories. What could explain

Table 2 Summary of reported outcomes in intervention studies (n = 10).

		Positive	Null	Negative	Total	%	Summary code (-/+)
Individuals							
Gender	Boys		24[a, d, r, lt]	23[b]	1/2	50	–
	Girls	24[d,r,]	24[a, r,lt,] 24[d,lt]	36[c] 36[d, r] 23[c] 35[c,r,acc] 35[c,lt,hr,acc] 35[d,r,acc] 35[d,lt,hr,acc]	3/4	75	–
	All		35[c, d] 38[d]		0/2	0	0
Race/Ethnicity			23[b, c] 38[d]		0/2	0	0
Age			36[c,d] 23[c,] 35[c,r,lt,acc]	36[b] 35[c,r,hr] 35[d,r,lt,hr]	3/3	100	–
BMI			36[c] 23[c] 35[c,r,hr,acc] 35[c,lt,hr] 35[d,r,lt,hr, acc]		0/3	0	0
Counts per minute			31[r] 33[r,lt,acc]		0/2	0	0
Steps per minute			33[r]		0/1	0	0
Baseline PA		35[c] 35[d,r,lthr,acc]			1/1	100	+
Baseline VPA		36[c,d]			1/1	100	+
Baseline MVPA		36[d]			1/1	100	+
Interpersonal							
Teachers social support	All		24[d,r,lt]	24[a,r]	1/1	100	–
Organizational							
Type of school		23[b]	23[c]		1/1	100	+
Recess duration		23[b] 35[c,r,hr]	36[c] 36[d], 23[c] 35[c,lt,acc,hr] 35[d]	35[c,r,acc]	2/3	66	+
Organized recess	All, Boys, Girls			32[c,d]	1/1	100	–
Perceived accessibility of sports equipment	All		24[a,r,lt] 24[d,r,lt]		0/1	0	0
Perceived school environment	All	24[d,r,lt]	24[a,r,lt,] 24[d,lt]		1/1	100	+
Perceived marked lines	All		24[d,r]	24[a,r,lt]	1/1	100	–
Program duration	All	35[c,r,hr,acc]	35[d,r,acc,hr] 35[c,lt]	35[c,lt,hr] 35[d,lt,hr]	1/1	100	?
Interventions*		37[c, hr] 37[d] 23[b] 35[c, lt, acc] 38[c] 24[a, d, r]	36[c,d] 35[c,r,hr,acc] 35[c,lt,hr] 35[d] 34[a,d] 31[c, d] 24[d] 33[d]	34[al]	5/9	55	+
Interventions Interactions**		36[d]	36[d] 35[d] 32[d] 32[w] 36[c] 32[c]	36[d]	2/3	66	?

BMI, recess duration, time, equipment, MVPA; +, positive association; -, negative association; 0, no association;? , inconclusive association; [a], low activity level; [b], moderate activity level; [c], vigorous activity level; [d], moderate to vigorous activity level; [r], recess; [lt], lunchtime; [acc], accelerometer; [hr], heart rate; [co], counts; [w], walking; [al], activity level.

* Type of interventions: playground markings, physical structures, playground zones, sports equipment, activity groups.

** With baseline, gender, age.

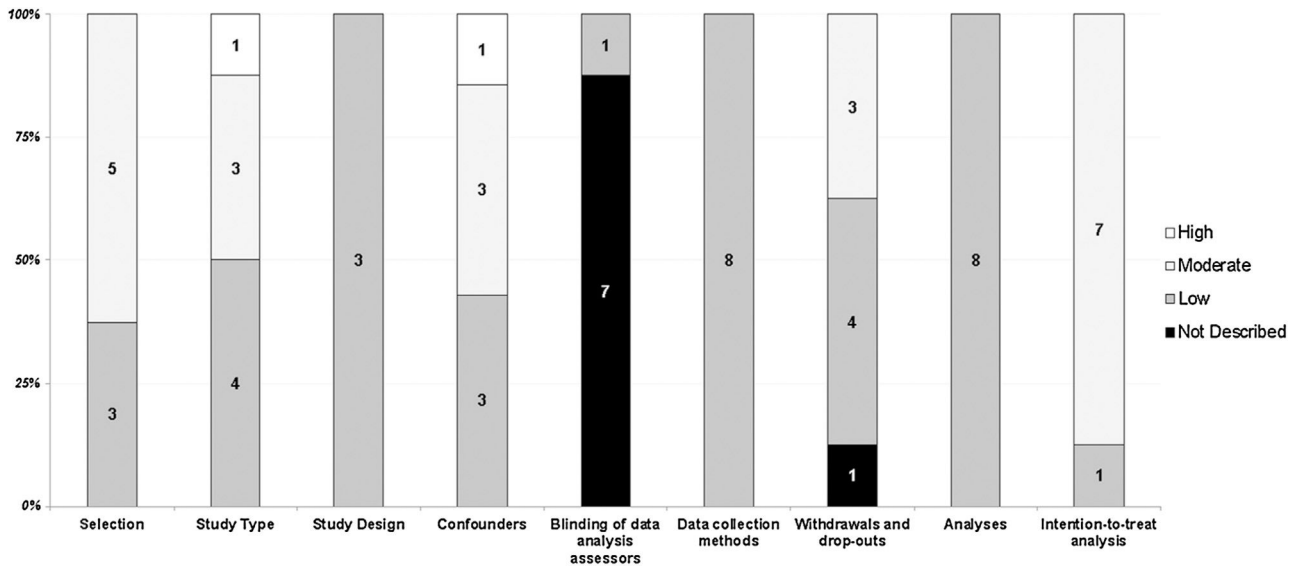

Figure 2 Assessment of risk of bias in the selected studies (n = 8).

these results is the fact that interventions may not have been so attractive to girls since their preferences were not considered during its design. Most of these interventions sought to increase physical activity levels, providing opportunities for play, equipment and changes in the school environment.[26,33,36,37] A study by Yildirim and collaborators[24] showed a positive effect of the intervention and used teachers' social support and the perception of equipment and the characteristics of the school environment as moderator variables. Girls were less engaged in active behaviors compared to boys, which resulted in less participation in physical activity, and when this happens participation occurs in low-intensity activities.[39] Future interventions should take into account social interactions during recess, as they appear to be important characteristics for the adoption of active and more intense active behavior in girls.[24,39,40]

The negative effect of age was observed in two of the analyzed studies.[23,35] This negative effect of age on PA levels was significantly associated in a meta-analysis that analyzed this relationship.[13] It may be that children acquire other interests instead of physical activity over the years which is reflected in the decrease of this practice.[36,41] Therefore, different physical activity promotion strategies should be considered for each age group.[13] Also, activities that are appropriate for children during recess should be attractive and age-appropriate.[35] Children's baseline physical activity level was shown to be a predictor of post-intervention physical activity levels, which corroborates the information that children or adolescents with active behaviors tend to maintain this behavior as they age, provided that they have the right incentives and opportunities.[35,36]

Teachers' social support was assessed in a single study.[24] Social support was to participate, watch, reward, or praise children during active games.[24] Results found the presence/praise of such support to have a negative effect on children's physical activity levels. It may be that children have interpreted teachers' social support as a form of control and thus inhibited children to act more spontaneously during recess.[24] Although this finding was inconclusive, it goes against the results of a systematic review performed by Ridgers et al.[28] which indicates that the perception of encouragement for physical activity by parents, friends, the school, and teachers was positively associated with children's active behavior during recess. Similar results were observed in another review that pointed out that the involvement of teachers and school staff as proponents of physical activity was effective for students of all ages to engage in active behaviors.[26]

Regarding the type of school, only one study reported a positive effect for the intervention on children's physical activity.[23] A limitation of this study was the lack of details by the authors about the differences between public and private schools.[23] Studies have shown that physical activity levels in private schools are greater than in public schools because they offer better opportunities in different periods.[42,43]

Recess duration was tested in three studies[23,35,36] and two[23,35] of them were positively associated with children's physical activity. Longer recess periods provide a greater opportunity for children to be active and when this duration is associated with stimuli (such as interventions) the results seem to be better.[23,35] Results from a systematic review found no consistent effect of the length of recess on children's PA levels.[28] In this review, there was a large amplitude in the duration of recess (20—94 min) and as mentioned above, it was considered as a predictor variable in only one study. As is the case in Brazilian schools, one of the alternatives for making better use of recess time could be to provide school lunches at a time before or different from recess to allow children more free time to play.[43]

The organized play had a negative effect on children's physical activity during playtime.[32] This result is different from the findings reported by Coolkens et al.,[44] which show that children who have organized activities during recess spend less time in sedentary behavior and more time in moderate to vigorous physical activity than children who do not have it. Mckenzie et al.[45] showed that boys accumulated similar physical activity levels in recess with and without

organized activities, whereas girls accumulated less physical activity in organized areas. Due to the small number of studies that controlled this variable the results should be viewed with caution. Organized playgrounds are expected to provide opportunities for children who normally do not participate in games and activities putting them on an equal footing with other children who are already active.[9] Thus, organized activities should prioritize the participation of girls who may benefit from the possibility of performing activities that could not be performed at other times.[27]

Children's perceived school environment is positively associated with PA during recess while the perception of line marking had the opposite effect.[24] It is possible that playground markings are not stimulating for children to use. This could explain why children who perceive equipment and school structures as good are more physically active.[17] Multicolored playground markings are easy to implement, inexpensive, and have been shown as promising strategies for promoting physical activity during recess.[25] However, due to the small number of studies using this strategy, the results are inconclusive.[25,28] The interventions included in this review focused on transforming the school environment by redesigning playgrounds (marking for games including the organization of spaces) and making different fixed and mobile structures available.[23,24,35,37,38] However, there is a lack of assessment of children's perception of the environment. Changes in the school environment are a low-cost alternative that can affect practically all school children. However, for these modifications to be effective, the spaces must be attractive and appropriate to the age range of the children. Therefore, solely making space markings available is not enough, these should be perceived as inviting for children.

The duration of the intervention program and PA was inconclusive and only one study included in this review tested this variable.[35] Erwin and collaborators[13] reported in a meta-analysis that total minutes per day in recess interventions had a positive effect on children's PA. However, the effect of duration of interventions was not a significant predictor.[13] The studies included in this review ranged from six weeks to 24 months of intervention. Over time the ñovelty effectöf the intervention may or may not be sustained given that children get used to the environment.[13,25] Comparisons between studies are difficult to conduct because of the large difference in the duration of interventions included in this review even though most of the changes are similar involving mainly environmental changes.

Most of the interventions reviewed showed positive effects on increasing PA during recess. The main features addressed in the interventions involved playground markings, physical structure, demarcation of activity zones, availability of sports equipment, and activity groups. The positive effect of interventions performed during school recess supports the results found in other reviews[13,25–28] showing that regardless of age group the strategies used were effective in increasing physical activity.

One fact that should be noted is that four in five studies in which positive results are observed for this variable showed effects mainly for moderate and vigorous intensities.[23,35,37,38] A likely explanation for this outcome is that moderate, vigorous, and moderate to vigorous intensities are the most studied because they offer the greatest benefits for children's health and development.[2] However, promoting any activity regardless of intensity becomes beneficial when there is a need to decrease children's sedentary behaviors.[24,46] Finally, in three studies, interactions with the interventions (baseline physical activity, gender, age, BMI, duration of play, time, equipment, and moderate to vigorous-intensity physical activity) were tested.[32,35,36] Positive results for recess duration and negative for age vs vigorous and moderate to vigorous physical activity were observed in only one study.[36] Thus, for interventions that take into account the age of children, the availability of playgrounds and play space is proved to be more effective for younger children, as playing on the playground is more attractive for them.[13,36] The duration of the recess is proved to be a positive interaction with the intervention as this period made available to children is increased.[13,36] However, in a review that also considered observational studies, this interaction was inconclusive.[28]

Implications for school health

In children aged five to ten years old, interventions based on modifications of the school environment as playground markings, demarcation of physical activity zones, group activities, availability of sports equipment and facilities are more effective among boys and younger children. Longer duration of recess showed positive effects on increased physical activity in the playground. Changes in the school environment to promote physical activity seems promising for this age group. Interventions based on modifications of the school environment as playground markings demarcation of physical activities zones, group activities, availability of sports equipment and facilities are cheap and cost-effective for increasing physical activity in school recess.

Limitations

The heterogeneity of studies did not allow for meta-analysis.

Future studies

Intervention studies need to be carried out in several parts of the world and especially in low- and middle-income countries. It is important to understand how different characteristics affect individual, interpersonal, environmental, and political levels of schools and can help promote physical activity. In addition, interventions should be prioritized for girls, given the low percentage of active girls during school recess, and to identify different correlates at multiple levels of influence. Also, feedback from the children's perception of recess time could add valuable information.

Few studies have investigated the health benefits of light intensity interventions although they seem as important as moderate and vigorous activities. Light activity should be promoted, evaluated, and studied since it can contribute to children's increased active behavior.[4] Possibly the non-inclusion of this category in most studies is due to the fact that physical activities of at least moderate intensity receive predominant attention from the academic community. Con-

sidering that the greater proportion of time in the school period is filled with activities categorized as sedentary, short periods of activity, even of light intensity, may shorten these long sedentary bouts.

Conflicts of interest

The authors declare no conflicts of interest.

Acknowledgments

We thank Hermes Koller de Paiva for the assistance in the systematic review; Javier Brazo-Sayavera and Cassiano Ricardo Rech for being volunteers on the review process.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jped.2021.02.005.

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