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Playground Designs to Increase Physical Activity Levels During School Recess: A Systematic Review

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Abstract

School recess provides a major opportunity to increase children's physical activity levels. Various studies have described strategies to increase levels of physical activity. The purpose of this systematic review is therefore to examine the interventions proposed as forms of increasing children's physical activity levels during recess. A systematic search of seven databases was made from the July 1 to July 5, 2012, leading to a final set of eight studies (a total of 2,383 subjects—599 "preschoolers" and 1,784 "schoolchildren") meeting the inclusion criteria. These studies were classified according to the intervention used: playground markings, game equipment, playground markings plus physical structures, and playground markings plus game equipment. The results of these studies indicate that the strategies analyzed do have the potential to increase physical activity levels during recess. The cumulative evidence was (*a*) that interventions based on playground markings, game equipment, or a combination of the two, do not seem to increase the physical activity of preschoolers and schoolchildren during recess and (ii) that interventions based on playground markings plus physical structures do increase the physical activity of schoolchildren during recess in the short to medium term.

Keywords

accelerometer, break time, physical activity, school

The health benefits of an active lifestyle are well established (Slentz, Houmard, & Kraus, 2007). Despite this, the levels of physical activity (PA) of children and young people are very low. For this reason, organizations and expert panels consider it a priority to develop interventions to increase PA levels (U.S. Department of Health and Human Services, 2012). In this regard, it is recommended that children accumulate at least 60 minutes of daily moderate or vigorous PA, mainly aerobic. In addition, activities that strengthen the musculoskeletal system should be engaged in on a minimum of three occasions per week (World Health Organization, 2010). This recommendation includes that at least 30 minutes of PA takes place in school (Janssen & Leblanc, 2010). School is the environment in which children spend most of their time and is a commonly used setting for the promotion of PA for youth (van Sluijs, McMinn, & Griffin, 2007). Physical education and recess provide the two main opportunities for school-based PA (Ridgers, Stratton, Fairclough, & Twisk, 2007b). A physical education session, however, provides only 8% to 11% of the child's daily PA and does so in a directed fashion (Tudor-Locke, Lee, Morgan, Beighle, & Pangrazi, 2006), whereas recess allows undirected PA that is freely chosen by the children (Ramstetter, Murray, & Garner, 2010). Previous studies have suggested that recess may contribute between 5% and 40% toward daily recommended PA (Ridgers, Stratton, Clark, Fairclough, & Richardson, 2006), and between 6% and 13% toward total moderate-to-vigorous PA (Mota et al., 2005). PA during recess is influenced by the size of the playground (Escalante, Backx, Saavedra, García-Hermoso, Domínguez, 2012), age and sex of the children (Escalante, Backx, Saavedra, García-Hermoso, Domínguez, 2011), and differences in ethnicity (Blatchford, Baines, & Pellegrini, 2003). In particular, an environment that fosters play has a great potential to contribute to attaining the recommended amounts of PA in children (Huberty, Beets, Beighle, & Welk, 2011).

Various strategies have been reported aimed at increasing children's PA during recess: structured recess (Howe, Freedson, Alhassan, Feldman, & Osganian, 2012), the use of active video games (Duncan & Staples, 2010), providing equipment that allows the practice of PA (Ridgers, Fairclough, & Stratton, 2010), or including breaks during classes on

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schedules determined by the teachers (Whitt-Glover, Ham, & Yancey, 2011). The effectiveness of these different strategies remains unclear. The purpose of this systematic review was therefore to examine and compare the interventions proposed as forms of increasing children's PA during recess.

Materials and Methods

Literature Search

A systematic review of the literature using the bibliographic databases CINAHL (1937 to May 31, 2012), Cochrane Central Register of Controlled Trials (2002 to May 31, 2012), EMBASE (1980 to May 31, 2012), ERIC (1966 to May 31, 2012), MEDLINE (1965 to May 2011), PsycINFO (1987 to May 31, 2012), and Science Citation Index (1900 to May 31, 2012) was performed from the July 1 to July 5, 2012. Randomized controlled trials (RCTs) and controlled clinical trials (CCTs) that had an appropriate control group of preschoolers and/or preadolescents with no intervention were located. For each of the databases, the search was limited to "preschool child" (2-5 years) and "child" (5-12 years; for the purposes of the present communication, the terms "preschooler" and "schoolchild," respectively, will be used to indicate this distinction in ages). Three "*or*"-type keyword categorical searches were conducted: (a) "school recess" *or* "school break time" *or* "school playgrounds"; (b) "intervention"; and (c) "school playtime." The search was limited to articles written in English.

Study Selection

The criteria for inclusion were as follows: (a) subjects—preschooler (2-5 years old) and schoolchild (5-12 years old); (b) type of study—RCT or CCT, in which the control group received no intervention; (c) type of intervention—no structured activities in recess, playground markings, game equipment, and/or physical structures; (d) type of assessment method—objective measurements through heart rate monitoring, pedometer, and/or accelerometer; and (e) type of PA assessed—vigorous physical activity (VPA) and/or moderate-to-vigorous physical activity (MVPA).

Data Collection

One of the authors independently extracted the following data from each candidate selectable article: (a) characteristics of trial participants (number, age, sex, and ethnicity); (b) environmental intervention features (type and duration); (c) type of physical activity during recess (MVPA and VPA in percentages); and (d) results (comparing before and after the environmental intervention). When there were doubts about a study's eligibility as could be determined from the abstract, this was resolved by consensus among the authors. The studies were then grouped according to the content of the environmental intervention: playground markings, game equipment, playground markings plus physical structures, and playground markings plus game equipment.

Results

Study Selection

The flowchart in Figure 1 describes the selection of candidate eligible articles. Using the search protocol, 477 potentially relevant articles were identified. Manual search of references within these retrieved articles led to a further 7 journal articles being included. At the next step, 414 were discarded because they did not meet the inclusion criteria. The full texts of the remaining 63 articles were then examined. This led to 55 being rejected—27 for not being about recess intervention, 5 not about environmental intervention, 10 for having no control group, 12 for failing the objective measurements criterion, and 1 was a study protocol. This left 8 studies that met the inclusion criteria and were used for the present systematic review.

Study Characteristics and Interventions

The characteristics of the eight studies are listed in Table 1. Seven were of schoolchildren and one of preschoolers. Three were RCTs (n = 926; Ridgers et al., 2007b; Stratton, 2000; Stratton & Mullan, 2005) and five were CCTs (n =1457; Cardon, Labarque, Smits, & De Bourdeaudhuij, 2009; Huberty et al., 2011; Ridgers et al., 2010; Ridgers, Stratton, Fairclough, & Twisk, 2007a; Verstraete, Cardon, De Clercq, & De Bourdeaudhuij, 2006). The studies were then grouped into four categories according to the redesign characteristics involved in their intervention: playground markings (n = 2), game equipment (n = 2), playground markings plus physical structures (n = 3), and playground markings plus game equipment (n = 1).

In the first of these categories—playground markings—the different teams of researchers designed a series of markings on the floor with bright fluorescent colors, using different themes according to the school preferences (Stratton, 2000; Stratton & Mullan, 2005), markings with a specific shape (Cardon et al., 2009), or markings dividing the playground area into three color zones—a sports area (red zone), a fitness and skills area (blue zone), and a "chill out" area (yellow zone; Ridgers et al., 2007a, 2007b; Ridgers et al., 2010). In the game equipment category of interventions, each school received a suitable set of equipment for games (skipping ropes, scoop sets, flying discs, catch balls, plastic hoops, super grips, racquets, playground balls; Huberty et al., 2011; Verstraete et al., 2006), and the teachers were requested to encourage the children every day to play with the equipment during recess (Verstraete et al., 2006). In the category that included physical structures in the design, the schools received various structures, including soccer goal

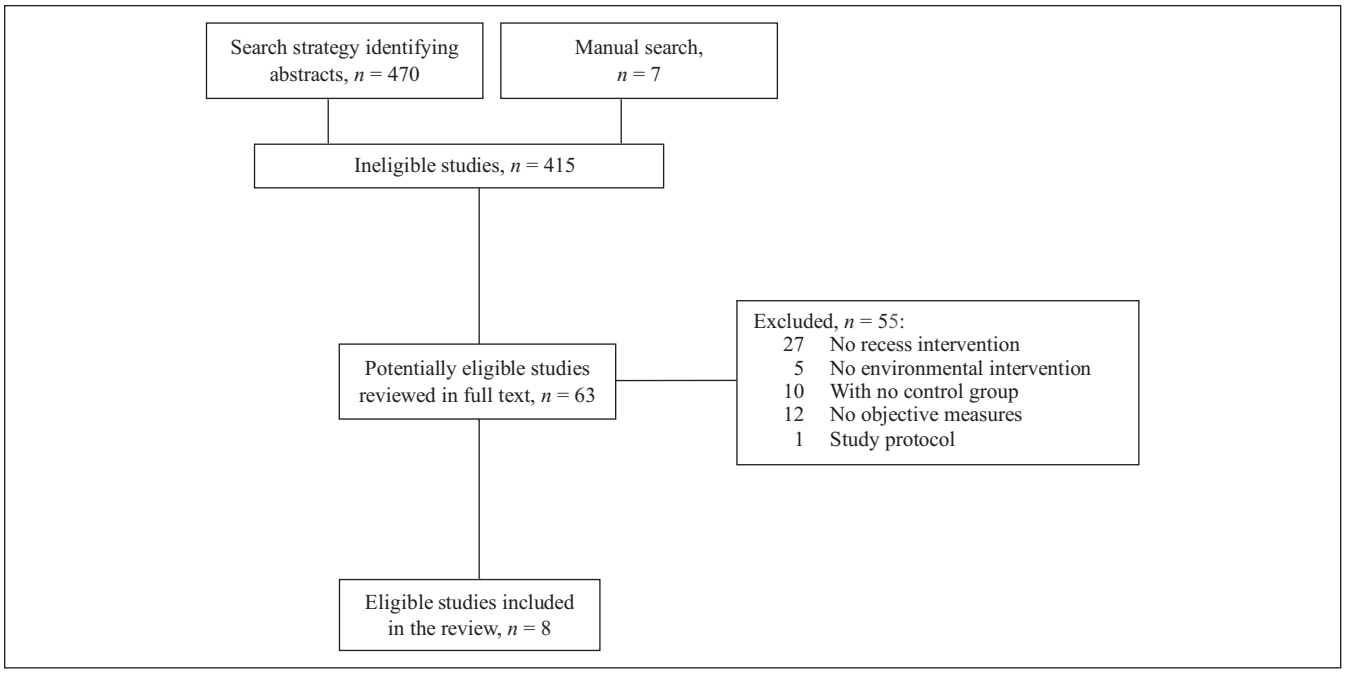

Figure 1. Flowchart of the selection of the studies.

posts, basketball hoops, and fences (Ridgers et al., 2007a, 2007b; Ridgers et al., 2010).

Participants

In total, there were 2,383 subjects in the identified studies—599 "preschoolers" and 1,784 "schoolchildren" (see above). In all the studies, the two groups (experimental group [EG] and control [CG]) had similar proportions of boys and girls. Only one study reported ethnicity (Huberty et al., 2011).

Recess Characteristics

The schools had no playground markings at the beginning of the study (only field marks) and had only a limited quantity of game equipment. Only one study reported the space available for the participants to play and the number of children who occupied the space available at any given time (Stratton, 2000), even though this is a determining factor in preschoolers' (Hannon & Brown, 2008) and schoolchildren's PA (Harten, Olds, & Dollman, 2008). The recess duration varied from 16 minutes (Verstraete et al., 2006) to 42 minutes (Cardon et al., 2009), with two studies not reporting the recess duration (Stratton, 2000; Stratton & Mullan, 2005).

Assessment Method

Two studies used heart rate monitoring to estimate the MVPA and VPA (Table 1). They took 200 beats per minute as maximum heart rate, and heart rate reserve thresholds at 50%, 60%, and 75% were calculated for each individual, representing moderate PA, MVPA, and VPA, respectively (Stratton, 1996). Six studies used accelerometers to estimate MVPA and VPA (Table 1). The epoch lengths were set at 5 seconds (moderate; Huberty et al., 2011; Ridgers et al., 2007a, 2007b; Ridgers et al., 2010), 15 seconds (high; Cardon et al., 2009), and 60 seconds (very high intensity; Verstraete et al., 2006). MVPA was defined as the summed total time spent in each activity intensity category during recess (moderate, high, plus very high intensities), and VPA as the summed total time spent in the high and very high intensity categories.

Physical Activity Changes

In preschoolers, none of the interventions (playground markings, game equipment, or both) seemed to foster greater physical activity during playtime (Cardon et al., 2009). In schoolchildren, however, playground markings did seem to encourage greater MVPA (2.4% and 6.9% in early and late primary school, respectively) and VPA (1.6% and 4.1% in early and late primary school, respectively; Stratton & Mullan, 2005). Game equipment increased girls' MVPA in an EG (3.9%; Verstraete et al., 2006) but reduced the MVPA of healthy weight boys (Huberty et al., 2011). Finally, playground markings plus physical structures seemed to be effective in increasing MVPA (5.9%) and VPA (1.7%) in the short term (Ridgers et al., 2007a), and these improvements carried over to the medium term in both MVPA (4.5%) and VPA (2.3%; Ridgers et al., 2007b).

Table 1. Characteristics of the Studies Included in the Review.

Author/s (Year)	Participants (*n*) EG	CG	Age Range (Years)	Assessment Method	Recess Time (Minutes)	Study Design	Statistical Analysis	Interventions	Duration (Weeks)	Evaluations	Major Findings
Preschool child study (2-5 years old)											
Cardon et al. (2009)	437	146	4-5	Accelerometer	42.0	CCT	Multilevel modeling	(a) Playground markings (b) Game equipment (c) Playground markings plus game equipment	4	EG vs. CG	Providing playground markings or play equipment is not sufficient to increase PA levels and decrease levels of sedentary activity during preschool recess
School child studies (5-12 years old)											
Stratton (2000)	36	24	5-7	Heart rate	NR	RCT	2 × 2 ANOVA (group × intervention) ANCOVA (covariable: play duration)	Playground markings	4	EG vs. CG	Playground markings had a significant and positive influence on children's PA, factors other than playground markings may also influence children's physically active play
Stratton and Mullan (2005)	67	32	4-11	Heart rate	NR	RCT	2 × 2 ANCOVA (sex × time; group × time; age × time) (covariables: play duration and BMI)	Playground markings	4	EG vs CG	School playgrounds with multicolor markings would make a valuable contribution to PA recommendations for young people
Verstraete et al. (2006)	122	113	10-11	Accelerometer	16.0	CCT	Repeated-measures ANOVA	Game equipment	12	EG vs. CG EG boys vs. CG boys EG girls vs. CG girls	Providing game equipment during recess periods was found to be effective in increasing children's PA levels
Ridgers et al. (2007a)	149	148	5-10	Accelerometer	19.5	CCT	Multilevel modeling	Playground markings plus physical structures	6	EG vs. CG EG boys vs. CG boys EG girls vs. CG girls	The playground redesign intervention resulted in small but nonsignificant increases in children's recess PA. Changing the playground environment produced a stronger intervention effect for younger children
Ridgers et al. (2007b)	256	214	7-8	Accelerometer	19.5	RCT	Multilevel modeling	Playground markings plus physical structures	24	EG vs. CG EG boys vs. CG boys EG girls vs. CG girls	Playground redesign, which uses multicolor playground markings and physical structures, is a suitable stimulus for increasing children's school recess PA levels
Ridgers et al. (2010)	256	214	7-8	Accelerometer	19.5	CCT	Multilevel modeling	Playground markings plus physical structures	52	EG vs. CG	A playground markings and physical structures intervention had a positive effect on intervention children's, but this effect is strongest 6 months postintervention and decreased between 6 and 12 months
Huberty et al. (2011)	86	67	9-11	Accelerometer	19.8	CCT	Linear regression models	Game equipment	52	NW boys vs. OW boys NW girls vs. OW girls	Game equipment represents a possible means to increase MVPA in OW/obese girls/boys

Note. RCT = randomized controlled trial; CCT = controlled clinical trials; EG = experimental group; CG = control group; PA = physical activity; NR = not reported; ANOVA = analysis of variance; ANCOVA = analysis of covariance; BMI = body mass index; MVPA = moderate-to-vigorous physical activity; NW = normal weight; OW = overweight/obese.

Discussion

Of the total number of 470 articles retrieved in the database search, only 8 met the preset inclusion criteria for the evaluation of the influence of different physical exercise programs. Findings of the studies will be discussed according to each of the different types of intervention: playground markings, game equipment, playground markings plus physical structures, and playground markings plus game equipment.

Playground Markings

Multicolor playground markings constitute a low-cost approach to increasing children's daily PA levels. But the results reported in the studies reviewed, whether in preschoolers (Cardon et al., 2009) or in schoolchildren (Stratton, 2000; Stratton & Mullan, 2005), are inconclusive. In preschoolers, simply providing playground markings is insufficient to increase levels of activity and decrease levels of sedentary behavior during playtime. Specifically, two of the studies found no increase in preschoolers' MVPA and VPA. In contrast, the other study on schoolchildren observed increases in both, although the improvements could have been because initially only 10% of the sample met the recommended MVPA criterion for recess (Ridgers et al., 2006), so that the scope for improvement in the EG was large. Differences by sex were analyzed only in one preschoolers study (Cardon et al., 2009), with both boys and girls increasing their MVPA and VPA. These improvements could, however, have been due to a "novelty effect" and may or may not have been sustainable. Indeed, repainting playgrounds may reignite enthusiasm for engagement with PA (Stratton & Mullan, 2005), and this possible "novelty effect" could also have been enhanced by the duration of the intervention (4 weeks; Cardon et al., 2009; Stratton, 2000; Stratton & Mullan, 2005). There is a need for research that addresses the effect of these interventions in the medium and long terms. One may conclude that creating an activity-friendly environment may not in itself be sufficient to promote engagement with PA in preschoolers and schoolchildren.

Game Equipment

The World Health Organization (2010) guidelines recommend that appropriate facilities and equipment can promote PA in schools. The three RCTs that were analyzed conducted a game equipment based intervention for 4 weeks (Cardon et al., 2009), 12 weeks (Verstraete et al., 2006), and 52 weeks (Huberty et al., 2011).

Considering the preschoolers first, the short-term (4 weeks) study found the intervention led to no changes in recess PA in its preschoolers. It is possible that these preschoolers may have needed more different equipment, more guidance and encouragement to play actively, or greater playground area per child. The teachers' ongoing support may be an especially important factor in early attempts at promoting preschoolers' PA. Neither does it seem that creating a more open space in the playground is sufficient to foster PA. However, a recent systematic review indicated that portable play equipment such as balls and other objects seems to be likely to stimulate more PA as it can be used in many different ways, and typically involves games of at least MVPA (Kreichauf et al., 2012). Its acquisition therefore is more cost effective than buying additional fixed equipment. Also, preschoolers seem be more active the more portable equipment (e.g., balls and tricycles) the preschool makes available to them.

Considering now the schoolchildren, the second RCT concluded that the game equipment provided for recess periods was effective in increasing their moderate PA and MVPA levels but not their VPA. An observational study (using the System for Observing Fitness Instruction Time instrument) concluded that, except for balls, equipment availability in itself was not a significant PA predictor in elementary school children (Zask, van Beurden, Barnett, Brooks, & Dietrich, 2001). With respect to the analysis by sex, an increase in MVPA was observed in the EG in girls only (Verstraete et al., 2006). A possible explanation could be that the game equipment in this study might primarily have been of interest to girls (i.e., flying discs, angle-stick, juggling material, etc.). The third study in this category found a reduction in the MVPA of healthy weight boys (<85th percentile). This may have been because boys usually tend to participate in activities geared to competition and achievement (Rees et al., 2006), making this material appear not to be new or exciting for them. In summary, the results of these studies therefore suggest that providing game equipment during recess is in itself insufficient to increase the amount of MVPA and VPA during recess for preschoolers or schoolchildren.

Playground Markings Plus Physical Structures

There has only been one intervention study based on playground markings plus physical structures, and it was in schoolchildren (Haug, Torsheim, Sallis, & Samdal, 2010). Secondary school facilities are associated with the child's daily PA participation during recess. In this sense, Ridgers and coworkers investigated the effect of playground markings plus physical structures on recess PA in the short term (6 weeks; Ridgers et al., 2007a), medium term (24 weeks; Ridgers et al., 2007b), and long term (52 weeks; Ridgers et al., 2010). In the short term, this intervention was effective in increasing MVPA and VPA, and these improvements continued to be present in the medium term (Ridgers et al., 2007b). However, in the long term (Ridgers et al., 2010) this intervention seemed to lose effectiveness, since there was no increase in PA compared with the controls, confirming previous studies suggesting that increases in children's PA are not maintained over time (Dishman & Buckworth, 1996). The physical structures included in these studies may have been

more closely associated with activities typical of boys (Bauer, Yang, & Austin, 2004). Thus, even though areas and facilities may be physically available for all pupils, fewer girls may perceive them as accessible or enjoyable than boys.

Playground Markings Plus Game Equipment

There has only been one study of an intervention based on playground markings plus game equipment, and it was in preschoolers (Cardon et al., 2009). This combined intervention did not increase their PA. A remarkable finding of the study was that neither the availability of toys nor the presence of play equipment or of markings was associated with more PA. This seems to run counter to the findings of recent studies that interventions of this type could be especially important for preschoolers (Van Cauwenberghe, De Bourdeaudhuij, Maes, & Cardon, 2012) and schoolchildren (Escalante et al., 2012) with high playground densities (measured inversely in terms of square meters per child). Further research is needed to evaluate whether specific toys, equipment, markings, and densities may be more successful in triggering PA, and whether such triggering occurs when they are available to all children.

Limitations and Future Research Suggestion

In general, the studies reviewed present certain limitations. First, only three are RCTs (Ridgers et al., 2007b; Stratton, 2000; Stratton & Mullan, 2005). Second, the interventions are disparate, even within the same group. For example, in "playground markings," the interventions range from drawing different shapes and colors on the ground (Cardon et al., 2009) to dividing the space into zones (Ridgers et al., 2007a, 2007b; Ridgers et al., 2010). Third, there are certain factors that are not discussed in the works but which could have had some influence on them—for example, the ethnicity of the subjects (only analyzed in Huberty et al., 2011), the cost-effectiveness of the interventions (no study analyses this), and the density or available space in the playground in square meters per child (only analyzed in Stratton, 2000). Fourth, four studies (Stratton, 2000; Stratton & Mullan 2005, Cardon et al., 2009; Ridgers et al., 2010) consider boys and girls conjointly, which could affect the results, especially since, from age 9 onward, differences between the sexes can become important (Escalante et al., 2011). And fifth, the studies did not analyze the possible influence of the teacher in stimulating the child's use of the equipment, given that children normally respond to the stimulus of adults to perform PA.

With respect to suggestions for future research lines, the EPICOT+ structure for formulating research recommendations could be followed (Brown et al., 2006). The "core elements" are as follows: (E) evidence (current)—playground markings plus physical structures are effective at increasing physical activity during playtime; (P) population—conduct studies with girls because they are less active than boys; (I) intervention—study other interventions based on teacher involvement; (C) comparison—make comparisons according to the type of school in which the evaluation is made; (O) outcomes—take measurements also of daily PA; (T) time stamp—December 2014. The optional elements are as follows: (d) disease burden—the findings from this type of study may help devise strategies to reduce childhood obesity; (t) timeliness—conduct medium- and long-term studies; and (s) study type—conduct RCTs.

Conclusions and Implications

The results of these studies indicate that the strategies analyzed do have the potential to increase PA levels during recess. Clearly, however, a greater number of studies are needed to identify which strategic route to take for playground PA to contribute significantly to the minimum recommended levels of daily MVPA. The cumulative evidence is (a) that interventions based on playground markings, game equipment, or the combination of the two do not seem to increase the PA of preschoolers and schoolchildren during recess; (b) that interventions based on playground markings plus physical structures do increase the PA of schoolchildren during recess in the short to medium term; and (c) that such interventions are most effective in young children and in those who were less active at baseline.

The present systematic review allows one to put forward the following recommendations for action: (a) identification and analysis of the modifiable aspects of playground recess that will ensure greater PA of preschoolers and children and (b) identification of the activities, games, and sports that are actually participated in by each sex and at each age, so as to design an appropriate action plan involving playground markings, game equipment, and physical structures.

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