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Promoting physical activity at the pre-school playground: The effects of providing markings and play equipment

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ABSTRACT

Objectives. We aimed to investigate the effects of providing play equipment and markings at the pre-school playground on physical activity engagement levels.

Methods. We performed a cluster randomised control trial. In November and December 2007, a convenience sample of 40 public pre-schools in Flanders, Belgium, was randomly assigned to one of the following conditions: 1) in 10 pre-schools play equipment was provided, 2) in 10 pre-schools markings were painted on the playground, 3) in 10 schools play equipment was provided and markings were painted, 4) 10 schools served as a control condition. Accelerometer-based physical activity levels during recess were evaluated at baseline and 4 to 6 weeks after the implementation of the intervention in 583 children (52% boys; mean age 5.3 years, SD 0.4).

Results. At baseline pre-schoolers spent only 11.2% (average: 4.7 min) of recess time in moderate to vigorous activity, while 61.3% (average: 25.7 min) was spent in sedentary activity. The interventions were not effective in increasing the average activity levels or the percentages of engagement in moderate or vigorous activity, or in decreasing sedentary time.

Conclusion. Providing playground markings or play equipment is not sufficient to increase activity levels and decrease levels of sedentary activity during pre-school recess. More activating supervision and the inclusion of more structured physical activity seem needed.

Introduction

Current knowledge posits that increased physical activity in early childhood is associated with important health benefits, like improved bone health (Janz et al., 2001, 2004) and a reduced risk of being overweight or obese (Moore et al., 2003; Sääkslahti et al., 2004b; Fisher et al., 2005; Janz et al., 2002; Jago et al., 2005; Dietz, 1997). Although the link between physical activity engagement and health outcomes in pre-school children still needs further study, the engagement in moderate to vigorous physical activity, for at least 60 min/day, has also been recommended in this young age group (Department of Health, Physical Activity, Health Improvement and Prevention, 2004; Strong et al., 2005). However, according to the literature review of Oliver et al. (2007) 49 studies measured physical activity in pre-schoolers and it was concluded that pre-schoolers are characterized by low levels of physical activity and high levels of sedentary behavior.

Despite the urgent need for effective interventions aimed at increasing physical activity in pre-schoolers, a recent review by Van Sluijs et al. (2008) found that physical activity intervention studies in pre-schoolers are rare. Sääkslahti et al. (2004a) showed that physical activity in 4 to 7–year-olds could be increased via a family-based intervention. In their study physical activity evaluations were based on diaries from the parents and the intervention focused on motivating the parents to encourage and train their children to be physically active. Since in many countries most children spend extensive time in pre-schools, the pre-school may play an important role in achieving adequate physical activity levels for young children. However, Pate et al. (2004), Finn et al. (2002) and Dowda et al. (2004) reported low levels of physical activity during pre-school attendance. Consequently, physical activity promotion efforts in pre-school settings seem needed.

According to a review of Davison and Lawson (2006), the role of supportive environment is important as a trigger of physical activity, particularly in children. In most pre-school programs, break times with unstructured free play are scheduled for several periods each day, making it an important environmental factor for the promotion of physical activity. While the terminology of break time at pre-school may differ across countries, in the present study the term “recess” is used. Recess is typically held outdoors and allows children to move

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freely. While recesses hold the potential to contribute to daily physical activity, it was shown that 4- to 5-year-old children spent the majority of recess break time in sedentary activities (McKenzie et al., 1997). Also Hannon and Brown (2008) recently found that 3- to 5-year-olds spent almost half of their pre-school outdoor play time engaged in sedentary activity and only 4.5% in vigorous activity.

In the literature, different opportunities, like playground redesign, paintings of court markings, fun trails and hopscotches (Ridgers et al., 2007; Stratton, 2000; Stratton and Mullan, 2005), provision of game equipment (Verstraete et al., 2006), and teacher supervision (Zask et al., 2001), have been evaluated in the scope of activity engagement at recess in elementary school children. However, it is unknown whether these interventions can be used to promote physical activity in pre-schoolers. Hannon and Brown (2008) recently showed in one pre-school that adding portable play equipment (e.g. hurdles, hoops, bean bags and balls) significantly decreased sedentary behavior and increased physical activity during outdoor play in 3- to 5-year-olds on 5 measurement days immediately after adding the play equipment to the playground. However a novelty effect may have caused the positive effects and it is unknown if these effects sustained over longer periods of time. In a previous study, we examined the associations between playground variables and physical activity levels of 783 pre-schoolers on 39 playgrounds (Cardon et al., 2008). In this study it was shown that in pre-school children more play space, shorter recess duration and less supervision during free outdoor play were associated with higher physical activity engagement (Cardon et al., 2008). However, playground markings and access to toys were not significant physical activity predictors, possibly due to the choice of toys and markings in the participating pre-schools. It was observed that mainly field markings and toys for static play were present, which may possibly not be optimal to promote physical activity. Consequently it is still unknown if providing certain toys (e.g. hoops, balls and bean bags) or markings can promote physical activity on pre-school playgrounds. Additionally it is unknown if combining the provision of markings and play equipment results in increased activity engagement.

The aim of the present study was to evaluate if providing play equipment, painting markings or providing play equipment and markings, at the pre-school playground, are effective to increase physical activity levels and to decrease sedentary activities during recess at pre-school. Additionally possible gender and age specific effects were explored.

Methods

Subjects

The study was executed in Flanders, the Dutch speaking part of Belgium, where almost all elementary schools have a public pre-school program (2213 schools with a pre-school program; 95%). The pre-school programs are free and virtually all children attend. A convenience sample of 40 public pre-schools was selected. All schools had comparable playground space. Pre-schools, which already provided play equipment during recess, or had markings other than field markings on their playground were excluded for the present study. In all pre-schools recesses were supervised by one or two pre-school teachers, The 40 pre-schools were randomly assigned by the research team to one of the four conditions: 1) in 10 pre-schools (150 children evaluated) play equipment was provided, 2) in 10 pre-schools (161 children evaluated) markings were painted on the playground, 3) in 10 pre-schools (161 children evaluated) play equipment was provided and markings were painted and 4) 10 pre-schools (162 children evaluated) served as a control condition. In the four conditions the average numbers of children playing on the playground on the day of pre-testing were respectively 91, 71, 99 and 79 children. In each school, depending on accelerometer availability, 12 to 20 children were randomly selected by the research team for physical activity measurement. At baseline the total sample consisted of 332 boys and 304 girls. There was a dropout of 53 children at post-test, due to changing schools or being absent on the day of testing. The dropout was equally distributed over the 4 conditions. The final sample consisted of 583 children (52% boys; mean age 5.3 years, SD 0.4). A priori power analysis showed that a recruitment of 100 children was sufficient to detect an average activity difference of 50 accelerometer counts per registration interval (15 s) between the intervention groups (power = 0.8, $\alpha = 0.05$). In order to account for possible dropout and the loss of efficiency because of clustering, a larger sample was provided. All parents of the 4- and 5-year-old children of the 40 participating pre-schools were informed about the study by an information letter. The evaluations were considered to be part of the psychological, medical and social counselling provided by the pre-school, for which all parents signed a consent form. The study was approved by the Ethical committee of the Institutional Review Board at Ghent University.

Measures and procedure

Pre-testing was performed in November and December 2007. To avoid measuring only the novelty effect of the interventions, post-testing was not performed immediately but 4 to 6 weeks after the implementation of the intervention, in February and March 2008. Physical activity was quantified with the GT1M Actigraph uniaxial accelerometer. Accelerometry has been shown to provide valid assessments of physical activity and sedentary behavior among pre-school-aged children (Fairweather et al., 1999; Reilly et al., 2003, 2008; Sirard et al., 2005). Accelerometers were attached to adjustable elastic belts and worn over the right hip. As the typical 1-min sampling interval may mask the short intermittent bursts of activity characteristics of young children, a 15-s sampling interval was used (Nilsson et al., 2002). Accelerometers were attached a minimum of 1 h before the start of recess and removed after recess. To minimize reactivity the researchers were not present on the playground during recess. In a previous study in 10–year-olds stronger intervention effects were found during recess after lunch break, compared to the morning recess, maybe since the recess after lunch break is longer, which may enable the children to organise and play games with the play equipment resulting in higher proportions of active time (Verstraete et al., 2006). Therefore the recess time after lunch break was selected for physical activity measurements for the present intervention study.

The "raw" accelerometer output (expressed as counts per epoch averaged over the monitor wearing time) was reported to provide a measure of average physical activity. To analyse the amount of time children spent at different levels of intensity, the separate count cut-offs for 4- and 5-year-olds, developed by Sirard et al. (2005) were used (see Table 1). These cut-points are based on empirically derived relationships between accelerometry output and directly observed behavior in 3- to 5-year-old children. The cut-points are specific for the use of 15-s epochs.

Intervention

In the schools of the "markings condition" and the "play equipment plus markings condition" playground markings were painted by the research team. As shown on Fig. 1 the markings

Table 1
Accelerometer count cut-offs corresponding to sedentary, light, moderate and vigorous activity for 4- and 5-year-olds, according to Sirard et al. (2005)

	Sedentary activity	Light activity	Moderate activity	Vigorous activity
4-year-olds	<364	364 to 811	812 to 1234	>1234
5-year-olds	<399	399 to 890	891 to 1254	>1254

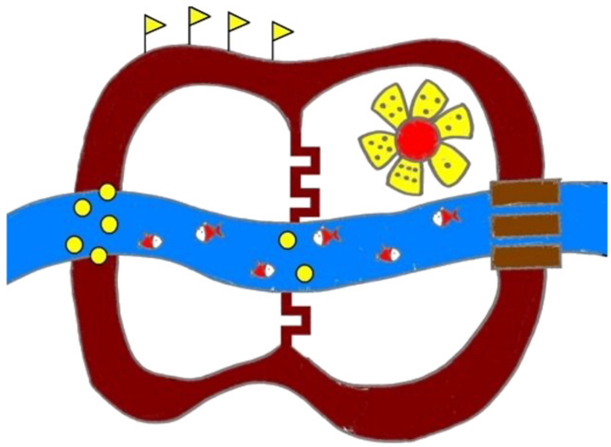

Fig. 1. Shape of the playground marking.

consisted of a "trail", a "river with crossings" and a flower shaped hopscotch. The markings were developed by the research team in cooperation with 3 independent pre-school teachers, taking the provocation of activity into account.

Each school in the "play equipment condition" and the "play equipment plus markings condition" received one set of play equipment. The pre-school teachers were asked to make the play equipment available to the children during all recesses and to spend a minimum of 1 h to introduce the different play equipment to the children, within one week after receiving the play equipment. The play equipment materials were selected by the research team and 3 independent pre-school teachers, maximising the potential of the materials to provoke activity, including for example different kinds of balls, that are safe and easy to catch. The set of play equipment materials for each pre-school included: 2 skippy balls, 2 soft throwing discs, 2 tail balls, 2 spider balls, 8 throwing rings, 2 funny shaped balls, 2 sets of aiming rings, 3 bean bags, 8 hoops, 2 soft grab balls, 2 soft balls, 10 coloured wipes and 2 jumping bags (total cost: € 250/$ 370).

The playground markings and sets of play equipment were provided by the research team within 4 weeks after pre-testing. On all playgrounds also the pre-schoolers, not enrolled in the study, had access to the markings and the play equipment. Within 3 weeks after the provision, a research team member performed a surprise visit during recess for an implementation check in all intervention schools.

Statistical analyses

In the current design pupils are clustered into schools, violating the assumption of independence of observations of the well known regression model. Therefore, multilevel models were used to investigate the impact of both interventions on the post-test activity level. Pupils served as level-one and schools as level-two grouping variables. Level-one predictors were gender, age, pre-test activity level and type of intervention. No group-level predictors were included. For type of intervention, two dummy predictor variables were constructed: "1" yielding the presence of the intervention, and "0" otherwise. The two dummy coded variables, one for markings and one for play equipment, and their interaction uniquely define each condition. Analyses were performed with percentage of recess time spent in sedentary, light, moderate, vigorous and moderate to vigorous physical activity and average activity level, expressed as mean counts per epoch (CPE) as dependent variables. Multilevel models were fitted with SPSS 15 mixed procedure, using a restricted maximum likelihood estimation method. Selective dropout was assessed by logistic regression analyzes with gender, age, the pre-test-values (percentages spent at the different intensities of physical activity and average activity) and the specific condition (dummy coded indicator variables) as predictors, and dropout as the dependent variable. Successful randomization of schools over conditions was investigated with a univariate analysis of variance model with pre-test activity level as dependent variable, and the different conditions as independent variable. The alpha level was set at 0.05 for all analyses.

Results

The average recess time was 42 min (±12 min; range: 26–89 min). At pre-test the total group spend 11.2% (average: 4.7 min) of recess time in moderate to vigorous activity, 25.6% (average: 10.7 min) was spend on light activity and 61.3% (average: 25.7 min) in sedentary activity. Percentages of physical activity engagements at the different intensity levels and average activity levels in the total group and in the four conditions at pre- and post-test can be found in Table 2. Mean values of pre-test percentages moderate to vigorous activity engagement and average activity levels were not different across conditions ($df=3$, $P=.07$ for percentage of moderate to vigorous activity engagement; $P=.13$ for average activity levels). At baseline significant differences between the control condition and the intervention conditions were found for the percentages of time engagement in sedentary, light and moderate activity ($df=3$, $P<.01$), but not for vigorous activity ($P=.42$).

None of the interventions resulted in a significant increase or decrease of the post-test activity engagement percentages and the average activity level. Gender had a significant effect on the post-test activity levels, except on percentage of vigorous activity engagement. Even after controlling for the pre-test, boys obtained lower percentages of engagement in sedentary activity ($P<.001$) than girls and higher engagement in light and moderate activity ($P<.001$) at post-test. Also the average activity level was higher in boys ($P=.01$). Gender only had an additive effect, and did not act as a moderator variable for both interventions (also with alpha = .10). Age

Table 2
Percentages and standard deviations (SD) of recess time spent in each of 4 physical activity intensity levels and average activity in counts per epoch (CPE); registered in the total group and in the four conditions

	Sedentary activity % (SD)		Light activity % (SD)		Moderate activity % (SD)		Vigorous activity % (SD)		Average activity in CPE (SD)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Total ($n=583$)	61.3 (11.4)	58.5 (11.4)	27.6 (7.9)	29.5 (1.7)	6.9 (3.1)	6.6 (2.7)	4.2 (4.8)	5.3 (5.7)	531.1 (290.0)	610.3 (334.9)
Control ($n=146$)	64.2 (12.0)	59.3 (11.6)	25.3 (8.4)	29.3 (7.7)	6.1 (2.8)	6.6 (2.4)	4.0 (4.6)	4.8 (5.3)	494.1 (282.7)	585.3 (325.7)
Play equipment ($n=145$)	60.1 (12.2)	57.1 (10.6)	28.5 (8.5)	30.3 (7.4)	7.2 (3.1)	6.5 (2.4)	4.3 (6.1)	6.0 (6.3)	536.6 (357.3)	654.6 (351.3)
Markings ($n=147$)	59.5 (9.9)	59.8 (11.2)	28.7 (6.7)	28.9 (7.5)	7.1 (3.2)	6.4 (2.6)	4.8 (4.2)	4.8 (4.5)	569.8 (244.5)	571.3 (284.1)
Play equipment plus markings ($n=145$)	60.8 (11.0)	57.8 (12.0)	28.0 (7.6)	29.5 (8.0)	7.3 (3.2)	7.0 (3.3)	3.9 (4.3)	5.7 (6.4)	531.1 (265.7)	631.6 (368.7)

Flanders 2007–2008, 583 children from 40 pre-schools.

Table 3
Multilevel models: estimated effect of covariates and intervention factors “play equipment” and “markings” on percentage of time spent at sedentary, light, moderate, vigorous and moderate to vigorous physical activity (MVPA) and average activity

	% Sedentary activity		% Light activity		% Moderate activity		% Vigorous activity		% MVPA		Average activity	
	β(SD)	95% C.I.	β(SD)	95% C.I.	β(SD)	95% C.I.	β(SD)	95% C.I.	β(SD)	95% C.I.	β(SD)	95% C.I.
Gender	−4.1 (.8)	**−5.8: −2.5**	2.9 (.6)	**1.7: 4.0**	1.0 (.2)	**.6: 1.4**	.7 (.4)	−.2: 1.6	1.5 (.5)	**.5: 2.5**	66.4 (26.2)	**14.9: 117.9**
Age	−.2 (1.2)	−2.57: 2.13	.1 (.8)	−1.6: 1.7	.0 (.3)	−.59: .66	−.1 (.6)	−1.4: 1.1	.4 (.7)	−1.1: 1.8	−14.2 (37.2)	−87.2: 58.8
Pre-test	.3 (.04)	**.2: .4**	.2 (.0)	**.1: .2**	.10 (.0)	**.0: .2**	.4 (.0)	**.3: .4**	.3 (.0)	**.2: .4**	.4 (.0)	**.3: .4**
Play equipment[a]	2.1 (2.6)	−3.1: 7.3	.4 (1.7)	−2.9: 3.8	−.2 (.5)	−1.3: .9	1.3 (.8)	−0.3: 2.8	.9 (1.1)	−1.3: 3.1	62.5 (50.0)	−39.0: 163.9
Markings[a]	−1.1 (2.6)	−6.3: 4.1	−1.0 (1.7)	−4.4: 2.3	−.3 (.5)	−1.5: .8	−.12 (.8)	−1.6: 1.4	−.7 (1.1)	−2.9: 1.5	−38.9 (49.9)	−140.1: 62.3
Play equipment plus markings[a]	−1.7 (3.6)	−9.1: 5.6	.5 (2.4)	−4.3: 5.3	.8 (.8)	−.7: 2.4	−.2 (1.1)	−2.4: 2.0	.8 (1.5)	−2.3: 3.9	11.3 (70.9)	−132.4: 155.0
	β(SD)	*P*	β(SD)	*P*	β(SD)	*P*	β(SD)	*P*	β(SD)	*P*	β(SD)	*P*
Variance residual	91.0 (5.6)	<**.001**	44.9 (2.74)	<**.001**	6.03 (.4)	<**.001**	28.1 (1.7)	<**.001**	35.1 (2.1)	<**.001**	93192.2 (5691.9)	<**.001**
Variance random effect school	26.0 (7.7)	**.001**	10.8 (3.3)	**.001**	1.1 (.4)	**.003**	.9 (.7)	.175	3.4 (1.4)	**.01**	5856.0 (2924.2)	**.05**

Flanders 2007–2008, 583 children from 40 pre-schools.
Significant effects ($P<.05$) are bold faced.
[a] The estimated β coefficients for type of intervention represent the estimated difference in post-test activity level for the presence versus absence of the intervention.

had no significant effect on the activity engagement percentages and average activity level (see Table 3). Differences in average recess time did not influence the results, not as main effect, nor as moderator variable. Furthermore, removing the non significant interaction term from the multilevel models, had no influence on our conclusions.

Clustering of pupils in schools explained a small to average and significant amount of variance except for the vigorous activity level (5.9%, $P=.05$ for average activity levels; 22.2%, $P<.01$ for sedentary activity; 19.4%, $P<.01$ for light activity, 15.1%, $P<.01$ for moderate activity, 3.1%, $P=.18$ for vigorous activity; 8.8%, $P=.01$ for moderate to vigorous activity).

Discussion

It was found that the evaluated pre-schoolers spent only 11%, or on average less than 5 min, of recess time in moderate to vigorous activity, whereas 61% was spent in sedentary activity. In the study of Hannon and Brown (2008) 3- to 5-year-olds spent 18% of pre-school outdoor play in moderate to vigorous activity and 49% in sedentary activity. In the present study the average physical activity at baseline was 531 counts per 15-s epoch, which is considered light activity. In the evaluated pre-schoolers the contribution of their longest recess to daily physical activity engagement of 60 min daily was only limited to about 8%. The review of Ridgers et al. (2006) indicated that school playtime contributed between 5 and 40% of recommended daily physical activity levels when no interventions have been utilised.

The low activity levels during pre-school recess at baseline emphasise the potential of recess times to increase activity engagement. However, the interventions, evaluated in the present study, namely providing play equipment, providing markings or providing both, were not effective in increasing the engagement in physical activity or in decreasing sedentary activity in the pre-school children 4 to 6 weeks after the provision of the play equipment and the markings. This is in contrast with the positive effects of adding portable play equipment to a pre-school ground, reported by Hannon and Brown (2008). However the latter study included only one pre-school and physical activity levels were only measured at baseline and on 5 post-intervention days. Consequently a novelty effect may have caused the increase in physical activity intensities. Possibly the interventions of the present study were also effective in increasing physical activity behaviors and in decreasing sedentary behaviors immediately after the implementations and effects diminished over time. However measurements were not performed immediately after the intervention implementation. The present study findings are also in contrast with studies in elementary school children, showing increased activity levels 3 months after the provision of play equipment (Verstraete et al., 2006) Apparently pre-schoolers respond differently than primary schoolchildren to provided play equipment and they may need more new infusions of different equipment and more guidance or encouragement to play in an active way. Possibly results may have been different when the children did not have access to the play equipment and the markings during all recesses.

In a previous study (Cardon et al., 2008) in pre-schoolers, it was observed that differences in activity levels could not be explained by the presence of markings or play equipment. However it was argued that the selection of markings and play equipment by the schools was possibly not optimal. In the present study special attention was given to the selection of the markings and play equipment, with a focus on play equipment and markings considered to promote active play. However, the children still had the free choice to use the play equipment and markings or not and to be active or not. According to our implementation checks, the play equipment was used by the children and the children played on the markings during recess. Nevertheless, the objectively measured activity levels did not increase in the intervention pre-schools. Consequently, it can be concluded that creating an activity friendly environment may not be sufficient to promote physical activity engagement in pre-schoolers.

Although the use of play equipment and markings, without necessarily resulting in higher physical activity engagement, may still be useful to promote the development of some fundamental motor skills, additional efforts seem needed to increase activity levels in pre-schoolers. In a prior study (Cardon et al., 2008) it was observed that girls were less active when more supervising teachers were present, possibly due to staying close to the teachers. It was argued that teachers should be more encouraging towards active play during recess. The disappointing results of the present intervention study also advocate a more activating approach of pre-school teachers during recess. In the present study teachers were not instructed to prompt the pre-schoolers to be active and during our implementation checks it was informally noted that the teachers supervised in a passive way, without prompting for physical activity.

Furthermore more time allocation to structured physical activity seems already needed in pre-schools. In Europe most pre-schools organise structured physical activity. However time allocation is limited in most countries: for example less than 60 min/week in Portugal and Hungary, 60 to 90 min/week in the United Kingdom, 90 to 120 min/week in France and 120 min/week in Belgium (De Martelaer et al., 2007). Sigmund et al. (2007) reported in a sample of Czech pre-school children appropriate levels of activity energy expenditure in relation to health enhancement, probably due to the program in the Czech pre-schools, including daily organized physical activity. On the other hand, in the study of Reilly et al. (2006) a nursery based physical activity intervention, consisting of three 30 min sessions of physical activity per week delivered by the nursery staff, seemed an inadequate "dose" of physical activity to have a net impact on overall physical activity.

Hence, daily structured physical activity, including sufficient activity at moderate to high intensity, like running games, seems needed, even in pre-school. Similarly, the National Association for Sport and Physical Education (2002) suggested that pre-school-aged children accumulate at least 120 min of physical activity per day, one-half of that time in structured physical activity and the remaining in unstructured free-play settings. Specialized physical education teachers may be preferable to provide structured physical activity in pre-schools. However, incorporating physical activity promotion in the training of future pre-school teachers may enable them to implement the principles in their daily work and to enter into a professional career with a positive attitude towards physical activity promotion. Besides the pre-school environment, the home environment is also important. Therefore family-based interventions also need further evaluation.

In the present study activity levels were higher at post-test compared to pre-test. A possible explanation may be the fact that post-tests were executed in February and March. Consequently, compared to November and December, when pre-tests were performed, most schools had more dry grass land and consequently more play space was accessible during recess. In a prior study (Cardon et al., 2008) it was shown that more play space is associated with higher activity levels in pre-schoolers. Furthermore activity levels in boys increased significantly more than activity levels in girls, independent from condition. A possible explanation may be the fact that boys used the extra play space more than girls, since grass land is more promoting to sports-like activities, which may be more common in boys. On the other hand, activity levels did not increase differently between ages, which can be explained by the small age range of the evaluated sample.

Although for this intervention study, schools with comparable playgrounds were selected, in terms of space and playground features, a significant percentage of physical activity differences could be explained by the pre-schools, which the children attended. Possibly, the behavior or encouragement of the pre-school teachers differed significantly between the participating schools.

Study limitations and strengths

A limitation of the present study is that the access to the play equipment and the markings was not controlled, since in all schools, also the other pre-schoolers, not participating in the measurements, were allowed to use the play equipment and the markings. Especially for the conditions with the provision of play equipment, results may have been different when more play equipments were provided. However, it is not feasible to provide a piece of play equipment for each child. A second limitation is the use of cut-points to convert accelerometer outputs into percentages of recess times spent at different intensity levels. According to Cliff and Okeley (2007), more research is needed to reach greater consensus on the most appropriate cut-points to use. According to the recent review of Reilly et al. (2008) current evidence from high quality calibration studies in children is fairly consistent in suggesting that the most appropriate cut-point for moderate to vigorous physical activity, when using the Actigraph – with 1 min epochs – lies in the range 3000–3600 counts/min. In the present study the age specific cut-points of Sirard et al. (2005) were used, which are specific for 15 s measurement intervals. However, when multiplying these cut-points by 4, they are in the suggested range (3248 counts/min for 4-year-olds and 3564 for 5-year-olds counts/min). Furthermore the present study also included the "raw" accelerometer outputs in the analyses. Some other limitations are the lack of data on pre-schoolers' after school activity and the fact that physical activity levels were measured during only one recess period at pre- and post-test.

Strengths of the present study include the use of 4 conditions in relatively large samples, the use of an objective physical activity measure and the use of multilevel analyses taking into account the clustering of children within pre-schools.

Conclusions

The present study contributes to the dearth of literature focusing on the effects of physical activity interventions in pre-school children. It can be concluded that providing playground markings or play equipment during recess are not sufficient to increase time spent in physical activity or decrease time spent in sedentary activity during pre-school recess. Consequently, the inclusion of more activating supervision during free play and more time allocation to structured physical activity, including play at moderate to high intensity, seem needed. Further study is also recommended in order to evaluate if the present findings can be generalized towards other pre-school settings.

Conflict of interest
The authors declare that there are no conflicts of interest.

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