Physical Activity Levels in Normal Weight and Overweight Portuguese Children: an Intervention Study during an Elementary School Recess

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Abstract

This study aimed to analyze the effects of an intervention strategy during the school recess on physical activity (PA) levels, by gender, age and body mass index (BMI). The sample comprises 158 Portuguese children aged 6 to 12 years. Weight and height were objectively measured. PA was assessed by accelerometry during the recess in pre-intervention and post-intervention periods. Introduction of extra outdoor play equipment was used as an intervention strategy. Significant interaction effects were found for the following areas: percentage of time spent in PA ($F_{(1,150)}$=70.157;p<0.001), intervention X age group ($F_{(1,150)}$= 24.416;p<0.001) and gender X age group ($F_{(1,150)}$=6.919;p=0.009); the time spent in Moderate PA for intervention X gender ($F_{(1,150)}$=15.290;p<0.001) and BMI X gender ($F_{(1,150)}$=6.411;p=0.012); the time spent in Vigorous and Very Vigorous PA ($F_{(1,150)}$=54.790;p=0.001), intervention X age group ($F_{(1,150)}$=9.490; p=0.002), intervention X gender ($F_{(1,150)}$=14.161;p<0.001) and BMI X gender ($F_{(1,150)}$=5.049;p=0.026). It appears that successful recess interventions to improve PA for children in elementary scholars are possible by providing relatively inexpensive play equipment.

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Key words: *Physical Activity; Accelerometry; School Recess; Children; Intervention.*

Introduction

The health and behavioral benefits of Physical Activity (PA) in childhood and adolescence are well known.[1] Current PA guidelines for children recommend moderate-to-vigorous physical activity (MVPA) for at least 60 min a day.[1-3] Although, some authors suggest 90 min of MVPA a day to prevent clustering of cardiovascular disease risk factors.[4]

The increased prevalence of overweight and obesity among children in developed countries,[5-7] including Portugal,[8, 9] combined with the large proportion of children that do not accomplish PA recommendations are important public health concerns.[4,10,11]

Schools are potential environment to develop and promote healthy behaviors among children, since children spent a considerable amount of their waking hours in school. In the school setting, recess provides important daily opportunity for children to be physically active and has additional educational and developmental benefits,[12] including social (e.g., sharing, cooperation, communication, problem solving, conflict resolution, and self-discipline), emotional (e.g., stress relief, self-esteem, character development), and cognitive (e.g., creativity, problem solving, and vocabulary) aspects.[13]

Recently, some studies have objectively examined PA levels, PA patterns, and the effects of interventions during the school recess. Yet, little is known about how PA levels are affected by an intervention, according to children's weight status.

Literature in school recess shown that boys usually engage in more PA than girls regardless of the age and method used to assess PA.[14-21] However, Mota et al [22] found the opposite; and they also found that PA during school recess may contribute to the achievement of the daily PA recommendations in 6% up to 9% in MVPA.[20, 22] One study also found a significant interaction between BMI category and sex for the percent of recess time spent in moderate PA (MPA) and vigorous PA (VPA).[23]

A limited number of studies have examined intervention programs for the purpose of promoting PA during the school recess. Supervision,[24] encouragement,[25] multicolor playground markings,[26, 27] play equipment,[19, 28] and, increasing time spent in recess[18, 29] are examples of successful low-cost interventions for increasing children's daily PA. Playground redesign, which utilizes both multicolor playground markings and changes in the physical structures, is another example of a successful intervention.[30]

In order to build more activity-friendly playgrounds it is necessary to know more about the factors that influence PA in this young age group[28] and, at the same time, to understand how children respond to different types of interventions.

Purpose of Study

The purpose of this study was to examine the effects of an intervention during the school recess on PA levels, by gender, age and body mass index (BMI), in children. Studies designed to increase PA during recess with Portuguese children are lacking. This study will help to better understand how PA levels (objectively measured) during the school recess are affected by an intervention, according to children's weight status. This new study will be able to add to the literature since most studies have limited their examination to differences between genders and age groups only.

Methods

Subjects

For this study, the sample included all children (n=182) from two elementary schools, with comparable outdoor playground space (about 400 m^2 area without play structures and equipment) and school schedule (from 8.00 to 13.00 am). Twenty-four children were excluded from the analysis due to sickness or absence in one of the two measurements. Therefore, the final sample included 158 children (81 from one school and 87 from the other) aged 6 to 12 years old (92 girls and 66 boys). Data was collected in two consecutive weeks in the spring of 2006, baseline information in the first week and post intervention in the second week.

Children were grouped according to their age in two groups: 6-7 years old; 8 or older than 8 years old.

The protocol and procedure employed in this study followed the Helsinki Declaration for investigation in Human Subjects and was approved by the University Ethic Committee. Data was kept confidential and informed written consent was obtained from the schools principals as well as from the children's parents or guardians.

Instruments

PA was assessed with Actigraph accelerometer (The Actigraph, LLC., Pensacola, FL, USA, formerly the Manufacturing Technology Incorporated (MTI) Actigraph, and the Computer Science Applications accelerometer). The validity of the Actigraph has been established with indirect calorimetry[31] (r = 0.86) and doubly labeled water [32] (r = 0.39 to r = 0.58) as criterion measures. The Actigraph (5.1 x 4.1 x 1.5 cm, 43g) measures uni-axial accelerations within the dynamic range of 0.5 to 2.00 G with a frequency from 0.25 to 2.75 Hz. Measurements are made 10 times per second and summed over a user-defined time period (*epoch period*) for data storage. In this study the epoch period was set to 1 minute. Although shorter sampling interval periods are sometimes used for estimating activity in young children, 1-min intervals are widely used in older children. In order to have a common interval for the entire sample as has been done in previous studies with this type of accelerometer a 1-min time sampling interval was used.[33] The limitation is a possible underestimation of vigorous activity in the younger children. The Actigraph was firmly attached over the child's non-preferred hip with an elastic belt.

Accelerometer count analysis

Accelerometer counts were transferred to a computer and treated with specific software developed for the study by the Department of Computer Science of Polytechnic Institute of Bragança. A key feature of the software was the conversion of MTI actigraph counts into units of relative energy expenditure (METs). The counts were converted to METs using the regression equation developed by Freedson *et al* [34] for children 6-to-18 years of age: METs = 2.757 + (0.0015 x counts/min) – (0.0896 x age[years]) – (0.000038 x counts/min x age), with $r^2 = 0.90$ and SEE = 1.08 METs. The equation was then used to derive cut-offs for the number of counts that corresponded to a specific MET. Based on the cut-offs points, the software calculated for each child the number and average time (in minutes) of the periods in each of the following categories of PA intensity: rest or mild (≤ 2.9 METs), moderate (3.0-5.9 METs, MPA), vigorous (6.0-8.9 METs, VPA), and very vigorous (≥ 9.0 METs, VVPA).

Body Mass Index

Measurements of weight (to the nearest 0.1 Kg) and height (to the nearest 0.1 cm) were taken and the BMI was calculated [(weight (kg)/height^2 (m^2)]. Students were divided into normal weight and overweight, according to Cole's cut off points for BMI.[35]

Procedure

Children' PA was evaluated during the school recesses in two distinct periods: 1) pre-intervention (first week); 2) post-intervention (second week). In both periods, each student was measured for 30 minutes (recess period between 10:30 and 11:00 am). In a normal school day recess did not have play structures and equipment available.

The intervention consisted of the introduction of extra outdoor play equipment, in the playground, such as: balls', skipping ropes, arches, hood horses and the floor was painted for playing traditional games. Equipment was set in the playground during classes' time, so it can be available when the recess period starts. During the intervention children were allowed to play freely with the equipment. No stimuli to its utilization or explanations on how to play with the equipments were given.

Data analysis

To evaluate the effects of the intervention on children's PA levels during recess periods, repeated measures of ANOVA were used, with interactions between gender, age group, and BMI. The statistic level of significance was set at $p < 0.05$. Data were analyzed using SPSS for Windows (15.0).

Results

Participants' characteristics are presented in Table 1. Total sample was divided in Boys and Girls, than were grouped by age, height and weight, and body mass index. Mean values for age ranged between 6.6 ± 0.5 and 8.7 ± 0.8 years and for BMI between 16.4 ± 3.0 and 17.8 ± 3.2 kg/m^2.

Table 2 shows the pre-intervention and pos-intervention results from the percentage of PA and minutes in MPA and VVVPA, in accordance with participant's classification in normal or overweight/obese.

In pre-intervention, mean values for the percentage of PA ranged between 51.3 ± 4.7 (in overweight/obese girls with 6 and 7 years old) and 84.7 ± 2.7 (in normal weight boys ≥ 8 years old), for MPA ranged between 12.7 ± 1.9 min (in overweight/obese boys with 6 and 7 years old) and 16.6 ± 1.5 min (in overweight/obese boys ≥ 8 years old), and for

VVVPA ranged between 2.1 ± 1.9 min (in overweight/obese girls with 6 and 7 years old) and 13.1 ± 1.1 min (in normal weight boys ≥ 8 years old).

In post-intervention, mean values for the percentage of PA ranged between 79.5 ± 1.9 (in normal weight girls ≥ 8 years old) and 94.3 ± 4.3 (in overweight/obese boys with 6 and 7 years old), for MPA ranged between 12.3 ± 0.9 min (in normal weight boys ≥ 8 years old) and 16.6 ± 1.5 min (in overweight/obese boys ≥ 8 years old), and for VVVPA ranged between 5.4 ± 2.1 min (in overweight/obese girls with 6 and 7 years old) and 20.4 ± 2.5 min (in overweight/obese boys with 6 and years old).

Table 3 presents all results from ANOVA analysis of the effects of the intervention.

Percentage of time in Physical Activity

Significant intervention effects were found for the percentages of time spent in total PA ($F_{(1, 150)}$ = 70.157; p<0.001), meaning that, the percentage of time spent for children's on PA increased significantly with intervention. It was found that the younger group (6 to 7 years old) benefited significantly more from the intervention ($F_{(1, 150)}$ = 24.416; p<0.001). Significant interaction between gender and age group were found ($F_{(1, 150)}$ = 6.919; p=0.009), suggesting that the percentages of time spent in PA increased significantly more in the younger group of girls. No significant intervention effects were found for the percentages of time spent PA regarding BMI.

Time in Moderate Physical Activity (MPA)

No significant intervention effects were found for the time spent in MPA. Significant interaction effects for gender and intervention were found for the time spent in MPA ($F_{(1, 150)}$ = 15.290; p<0.001). The time spent in MPA increased in girls and decreased in boys. Significant interaction between BMI and gender were found ($F_{(1, 150)}$ = 6.411; p=0.012), suggesting that the time spent in MPA increased significantly more in the overweight/obese group of girls.

Time in Vigorous and Very Vigorous Physical Activity (VVVPA)

The time spent in VVVPA increased significantly with intervention ($F_{(1, 150)}$ = 54.790; p=0.001). Younger children (6 to 7 years old) benefited significantly more from intervention ($F_{(1, 150)}$ = 9.490; p=0.002) than the older ones (≥ 8 years old). Boys benefited significantly more than girls ($F_{(1, 150)}$ = 14.161; p<0.001) with intervention. Overweight/obese boys increased significantly more the amount of time spent in VVVPA ($F_{(1, 150)}$ = 5.049; p=0.026) than the normal weight boys.

Discussion

The purpose of the present study was to examine the intervention effects of providing play equipment during school recess on children's PA levels.

Results of the study indicated that providing play equipment during school recess was effective in increasing children's PA level. This result was in agreement with others studies.[19, 28] The effects of the intervention showed a significant increase in the percentage of time spent in PA, regardless of gender, age group and BMI status. This result also supported previous findings that 50% time in MVPA during the school recess is a reachable target [19, 21, 28]. However, other studies indicated different results.[14, 15, 27]

Consistent with previous intervention school recess studies [18, 19, 26, 28, 30], on average boys in the current study spent higher percentage of time in PA (pre-intervention 81.97% ± 12.59 and pos-intervention 91.61% ± 7.89) than girls (73.47% ± 17.91 pre and 82.79% ± 13.94 pos-intervention). Although, the younger group of girls was the one who benefited more from the intervention, both genders have benefited from the play equipment. This was indicated by both boys and girls significantly increased the percentages of time spent in total PA. This is a positive and significant finding from a public health perspective, since girls systematically exhibit lower PA levels than boys, and that such trend tends to track into adolescence and adulthood.[36]

No significant effects were found for the time spent in MPA. With intervention MPA decreased in boys and increased in girls. However, the overall percentage of time in PA increased in boys and in girls. This may suggest that boys increased their time spent in VPA and VVPA to help increase the overall time spend in PA. This is further explained by significant gender differences of time spent on MPA and VVVPA. It can be speculated that if this effect became a long time trend, it might translate into cardiovascular and energy expenditure benefits.[37] Nevertheless, previous school recess intervention studies found the opposite results, where boys engaged in more MPA than girls. Future studies are needed to further examine this effect.

Regarding age group differences, the results showed that younger girls and boys benefited more from the

intervention. This result was in consistent with Ridgers et al [18] findings. They found significant intervention effect related to MVPA was stronger for the younger group compared to the older elementary school children.[18] Although Stratton and Mullan [26] found the opposite. These contradictory results may be due to the type of intervention. In the present study the play equipment used was probably more appropriated for the younger students.

The intervention also had a significant improvement in PA levels of obese/overweight children. Overweight/obese girls increased significantly more in MPA and overweight/obese boys significantly in VVVPA than normal weight children. Despite of these results, it seems that BMI had low impact on the results overall. This may suggest that play equipment used in this intervention may attract all children, but that BMI in early ages is not yet a predictor for PA. This interesting finding led us to speculate that early age PA interventions may have similar results for both overweight/obese and normal weight children. Probably, the extra weight in children at these ages does not affect motor skills and fitness levels necessary to play with equipment that was provided, but it may happen later in life.[37-39]

Future studies should consider evaluate large samples and assess other variables including motor skills and fitness levels in order to better understand it´s association with children´s PA. Future intervention may also include a control group.

Conclusions and Recommendations

There are some limitations in this study. We only measured once during pre-intervention and one post-intervention, and we do not know if the increase of PA observed was affected by the novelty effect of the intervention. It was not clear if the effects will remain the same with longer time period. Also, we did not include a control group. Nevertheless, the PA was measured objectively and the play equipment chosen was attractive and relatively inexpensive. Due to small sample size, generalizations cannot be assumed. Further studies with larger Portuguese samples are needed in order to confirm or refute these findings.

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Table 1. Participants Characteristics *

	Girls (n= 92)		**Boys (n= 66)**	
	6 and 7 years old (n=40)	**8 ≥ years old (n=52)**	**6 and 7 years old (n=26)**	**8 ≥ years old (n=40)**
Age (years)	6.7±0.5	8.7±0.8	6.6±0.5	8.5 ± 0.7
Weigh (kg)	24.9±5.7	32.2±8.7	26.1±4.9	32.4±7
Height (cm)	120±70	130±70	120±40	130±10
Body Mass Index (kg/m^2)	16.4±3	17.7±3.6	16.8±2.6	17.8±3.2

*(mean±SD)

Table 2. Pre-intervention and Post-intervention Physical Activity values (mean ± SD).

		Girls (n= 92)				**Boys (n= 66)**			
		(6 and 7 years old) (n= 40)		**(8 ≥ years old) (n= 52)**		**(6 and 7 years old) (n= 26)**		**(8 ≥ years old) (n= 40)**	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Percentage in Physical Activity (%)	Normal	73.8±2.7	89±2.1	76.2±2.4	79.5±1.9	79.5±3.4	93.2±2.6	84.7±2.7	90.6±3.1
	Overweight/obese	51.3±4.7	79.7±3.6	80.9±3.8	80.4±3.0	80±5.6	94.3±4.3	80.3±4.5	90±3.5
Moderate Physical Activity (min)	Normal	13.9±0.9	12.9±1.1	13.6±0.8	12.8±0.9	12.9±1.2	10.1±1.3	12.3±0.9	10±1.1
	Overweight/obese	13.3±1.6	18.5±1.8	13.1±1.3	15±1.5	12.7±1.9	7.9±2.2	16.6±1.5	13.1±1.7
Vigorous to Very Vigorous Physical Activity (min)	Normal	8.2±1.1	13.8±1.2	9.3±0.9	11±1.1	10.9±1.3	17.8±1.5	13.1±1.1	17.1±1.2
	Overweight/obese	2.1±1.9	5.4±2.1	11.1±2.2	9.1±1.7	11.3±2.2	20.4±2.5	7.5±1.7	13.9±1.9

Table 3. Effects of the intervention - ANOVA

	Percentages of time in PA(a)		Time in MPA(b)		Time in VVVPA(c)	
	F (gl)	p	F (gl)	p	F (gl)	p
Intervention	70.157	<0.001**	2.934	0.089	54.790	<0.001**
Intervention x Age group	24.416	<0.001**	0.069	0.792	9.490	0.002*
Intervention x Gender	0.074	0.786	15.290	<0.001**	14.161	<0.001**
Intervention x BMI(d)	1.643	0.202	1.337	0.249	0.089	0.765
Gender x Age group	6.919	0.009*	1.019	0.314	0.582	0.447
Intervention x Age Group x BMI(d)	1.616	0.206	0.334	0.564	0.077	0.782
Intervention x Gender x BMI(d)	0.208	0.649	6.411	0.012*	5.049	0.026*
Intervention x Age Group x Gender x BMI(d)	3.509	0.063*	0.856	0.356	0.112	0.738

Notes: (a) – Physical Activity; (b) – Moderate Physical Activity; (c) - Vigorous to Very Vigorous Physical Activity; (d) – Body Mass Index.

* indicates .05 and ** indicates .01 level of significance.