Physical Activity Patterns During School Recess: A Study in Children 6 to 10 Years Old

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Abstract

The aims of this study were to characterize the spontaneous physical activity of children during school recess, and to estimate variation in physical activity associated with gender and age. A MTI actigraph (Model 7164) was used with a sample of 140 boys and 131 girls, 6 to 10 years of age. MTI counts were converted to METs using a regression equation developed for children. The number and average duration of periods of activity by intensity were calculated for each child during a 30 minute recess: rest or mild physical activity (≤ 2.9 METs), moderate physical activity (3.0-5.9 METs,), vigorous physical activity (6.0-8.9 METs) and very vigorous physical activity (≥ 9.0 METs). Boys and girls spent about 50% of the recess in physical activity. Physical activity was characteristically done in very short bursts with intervals of rest or mild physical activity. The number of episodes of physical activity of all intensity levels was lower in older children while the inverse occurred at rest or mild physical activity. Boys engaged in higher intensity activity than girls and in general spent more recess time in physical activity.

Key Words: *Children; Physical Activity; Recess; Gender*

Introduction

Physical activity (PA) behavior in children and adults is important for health promotion. Regular PA is associated with a number of positive health outcomes in youth[1] and adults.[2, 3] Childhood is considered an important age period for acquiring and establishing habits of regular PA which may persist into adulthood, although tracking of PA from childhood and adolescence into adulthood has not been studied extensively.[4] The current level of PA of a population is of interest, specifically whether or not the population meets recommended criteria of PA that are believed to be associated with good health. It is important to evaluate characteristics of PA related to intensity (moderate versus light) and mode (intermittent versus continuous) in the context of potential health benefits, particularly among children. Children enjoy play, especially activities that require whole body movements.[5, 6] Given the opportunity, most children choose games and other physical activities of a diverse sort.[7] It has been reported that children are naturally active[8], though patterns of physical activity vary with age. Children are often characterized as having short bouts of relatively intense activity interspersed with frequent rest periods.[9, 10] However, relatively few studies have analyzed the pattern of spontaneous physical activity in young children that would confirm this generalization.

One study has investigated simultaneously the intensity, duration and frequency of young children's physical activity.[11] The "tempo" of children's physical activity was assessed via observation. "Tempo" was defined as the patterning of activities in terms of frequency, duration and intensity and of intervals between bouts of activity. The observational method used recording periods of 3 seconds, which was the shortest possible interval between observations without loss of accuracy. It is possible that a shorter interval can be used to provide a more precise characterization of spontaneous physical activity in children, especially with improved technology.

School recess is an adequate setting for evaluating spontaneous physical activity because children ordinarily play freely without inhibitions with only space, available materials and other children as constraints. Recess is a potentially important time during which children can achieve a major portion of daily physical activity and for many children recess may represent the primary opportunity for physical activity during the school day. Guinhouya et al.12, found that recess contributes up to 26% of children's daily moderate-to-vigorous PA. Some intervention studies with school recess indicated a significant increase in PA and energy expenditure.[13, 14] Nevertheless, there is considerable variation among schools in providing time for a daily recess. In Portugal, one recess period of 30 min for every half day (mornings and afternoons) is officially prescribed for primary schools.

The objectives of this study were to characterize the spontaneous physical activity of primary school children (intensity, duration) during school recess, and to analyze variation associated with gender and age.

Methods

Sample

The sample included 271 children (140 boys and 131 girls), 6 to 10 years of age ($\overline{X}$ = 8.0±1.3 years). Somatic characteristics (height, weight and BMI) of the children are summarized in Table 1. The students attended five primary schools of the Bragança council, in the northeast of Portugal. The five schools were randomly selected from the 10 primary schools of Bragança council. Informed written consent was obtained from parents of the children and school principals.

Physical activity assessment

The MTI actigraph (former CSA) Model 7164 (Manufacturing Technology, Inc., Fort Walton Beach, FL, USA) was used as the objective measure of PA. The validity of the MTI actigraph has been established with indirect calorimetry [15] (r = 0.86) and doubly labeled water[16] (r = 0.39 to r = 0.58) as criterion measures. The MTI 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. The epoch period was set to 1 second since it is possible to gather information across a large spectrum of intensity and duration of PA during this interval. The actigraph was firmly attached over the child's non-preferred hip with an elastic belt. Based on equipment limitations, 20 children were randomly selected to be evaluated at the same time during a recess period of 30 min duration. Each child was evaluated once. All evaluations were conducted outdoors (weather permitting) from April to June. In some schools, recess was scheduled in the morning and in others in the afternoon. School grounds were available for activities. For most part, the space was

an open area with some grass and children were free to do activities of their choice. The only equipment available was swings and slides. Children could also play with balls and ropes.

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* (1997) [17] 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.

Since epoch periods were 1 second, it was possible to gather the large spectrum of intensity and duration of PA variability. The equation incorporates minutes; hence, counts in each 1 second epoch were multiplied by 60 before they entered into the equation. 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 seconds) 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).

Statistical analysis

Descriptive statistics were calculated for all variables by gender and age. Normality tests were initially calculated for all variables with Kolmogorov-Smirnov test. Non-normal variables (average time in rest or mild PA, MPA, and VVPA) were log-transformed. Factorial ANOVA (gender X age) was used to analyze differences by gender and age groups. Repeated measures ANOVA was used to analyze differences between PA intensity categories in each gender independent of age. Significance was set at $p \leq 0.05$.

Results

Descriptive statistics for the number of episodes and average duration of each PA level are shown in Tables 2 and 3 for girls and boys, respectively. The large standard deviations and ranges indicate considerable inter-individual variation in number of episodes and mean duration.

Differences in the number of episodes and intensity of PA were significant in each gender [girls: $F(128, 3) = 460$; $p < 0.001$; boys: $F(137, 3) = 362.667$; $p < 0.001$]. In both girls and boys, the highest number of episodes occurred in MPA, followed in order by episodes in rest or mild PA, VPA and VVPA. Overall, the longest average duration of episodes occurred in rest or mild PA in both genders, while the shortest average duration occurred in VPA in both genders.

The average duration of episodes at different intensity levels differed significantly by gender [girls: $F(128, 3) = 200.517$; $p < 0.001$; boys: $F(137, 3) = 180.842$; $p < 0.001$]. The most frequent periods at each PA intensity level were as follows: rest or mild PA, 5 seconds in girls and 7.5 seconds in boys; MPA, 1.95 seconds in girls and 2 seconds in boys; VPA, 1.5 seconds in both girls and boys; and VVPA, 3 seconds in girls and 2.5 seconds in boys. The average duration of the episodes of VVPA and rest or mild PA were asymmetric to the right in both boys and girls, indicating a larger number of episodes with short average duration.

The sum of all episodes of MPA, VPA, and VVPA exceeded the total rest or mild PA episodes. However, the mean duration of rest or mild PA was greater than durations of PA at other intensity levels. Mean time at each PA intensity level as a percentage of total recess time is presented by age and gender in Table 4. The length of time spent in rest or mild PA varied between 54.5% and 61.9% in girls and between 45.3% and 64.6% in boys. Older children (9-10 years) had a higher percentage of rest or mild PA than younger children in both boys and girls. The mean percentage of total recess time at other intensities of PA declined with age. MPA was the highest and VPA was the lowest in both genders and in all age groups.

The gender and age interaction was significant only for duration of VPA episodes [$F(4, 260) = 4.113$; $p = 0.003$]. Girls of 9-10 years had a higher average duration of VPA than boys. This trend for VPA was not evident at the younger ages. Gender differences were significant only in VVPA for number of episodes [$F(4, 260) = 3.952$; $p = 0.048$] and average duration of episodes [$F(4, 260) = 4.140$; $p = 0.043$]. Boys had a higher number of VVPA episodes than girls, although the mean of average duration of each episode was higher in girls than in boys.

Significant differences among age groups were evident in the number of episodes at all intensity levels of PA [rest or mild PA: $F(4, 260) = 6.425$, $p <$

0.001; MPA: F (4, 260) = 7.449, p < 0.001; VPA: F (4, 260) = 5.460, p < 0.001; VVPA: F (4, 260) = 5.048, p = 0.001]. Significant differences occurred at all intensity levels only between 9 year and 6, 7 and 8-year-old children. The number of episodes decreased between 6 and 9 years. The average duration of episodes differed significantly only for rest or mild PA (F (4, 260) = 6.365; p < 0.001) with an increase in duration until 9 years.

Discussion

The objectives of the present investigation were to characterize the duration and intensity of spontaneous physical activities and to evaluate variation associated with gender and age in children 6-10 years of age. Spontaneous PA for sample of children was monitored with MTI actigraph accelerometers during 30-minute recess periods at school between April and June. The MTI actigraph provided a record of 1-second periods (*epochs*). This short recording period documented most of the variability in PA of children in terms of intensity and duration.

Children are active by nature and given the opportunity both spatially and temporally, they frequently engage in physical activities of play that vary in kind and intensity and that are usually of brief duration.[18] High inter-individual variability in duration and intensity of episodes of PA characterized the children in this study. The sum of episodes of MPA, VPA and VVPA was higher than total episodes of rest or mild PA. Mean duration and percentage of time indicated that children spent almost the same recess time in rest or mild PA or in MPA, VPA and VVPA. Episodes of rest or mild PA occurred through the duration of recess, often between episodes of MPA, VPA and VPA. MPA showed a higher frequency of episodes compared to PA of other intensity levels in both boys and girls. The duration of episodes of PA at any intensity were quite short, the most frequent episodes was 3 seconds length. The duration of the episodes of PA at any intensity level did not exceed 17 sec.

Results with an observational system that registered PA at 3 second intervals over 12 hours are consistent with present observations.[11] The median duration of episodes of MPA and VPA were 6 and 3 seconds, respectively. About 95% of periods of VPA lasted less than 15 seconds and only 1% had duration of 1 minute.[11] In the present study, episodes of MPA, VPA and VVPA were longer, although periods of rest or mild PA were proportionally longer. In another observational study, only 31% of children had continuous periods of 20 minutes of moderate-to-vigorous PA, but approximately 95% of the children had periods of 5 seconds of moderate-to-vigorous PA.[19] Results of the present study confirmed the transient nature in the pattern of physical activities among young boys and girls. The pattern of PA was characterized by short periods of activities ranging from moderate to very vigorous intensity with intervals of rest or mild PA between bursts of activity.

The most recent PA recommendation for American school age youth 6-18 years of age calls for 60 minutes or more per day of moderate to vigorous physical activity.[1] The recommendation emphasizes the need for variety in physical activities that are developmentally appropriate and enjoyable. Other recommendations call for 30 to 60 minutes per day of moderate to vigorous PA, which could result from the accumulation of shorter periods of activity.[20-22] All periods of MPA, VPA and VVPA in the present sample of Portuguese children 6-10 years of age were of very short duration, 1 to 3 seconds, but the sum of episodes of MPA, VPA and VVPA corresponded about 50% of total recess time, i.e., 15 minutes. Stratton and Mullan[23] suggested that children should be physically active for 50% of recess time in order to achieve PA recommendations. Given the opportunity, it is possible for children to achieve a significant proportion of the recommended daily physical activity during recess. It may be advisable to include another recess period in the daily routine of primary school children or to increase the time available for recess. Guinhouya et al.[12] reported that an increase of 1.2% of time spent at recess resulted in a 6.6% increase of PA by the children. Since few primary schools in Portugal require physical education, the reorganization of the schedule and duration of school recess has the potential to facilitate opportunities for children to meet their physical activity needs. Boys are generally more active than girls beginning prenatally and continuing through childhood.[24, 25] Observations in the present study are generally consistent with the literature. Boys had significantly more episodes of VVPA than girls. Although girls showed episodes of higher duration, the duration was not sufficient to compensate for the lower number of episodes; girls in fact spent a greater percentage of recess time in rest or mild PA. The reasons underlying gender difference in PA levels are not well known. Bjorklund[26] suggest that the difference in PA play behavior could be related to gender differences in spatial cognition developed during the evolutionary of *Homo sapiens*. Physical play of boys often involves activities that require eye-hand (or foot) coordination, as evident in a variety of ball games.[27] These activities promote the development of spatial cognition to a higher level in

boys compared to girls, and require more intense movement, which perhaps account for higher physical activity levels in boys than in girls. Conversely, girls are more likely to engage in less intense activities.[27]

The number of episodes of MPA, VPA and VVPA was lower in the older children and the inverse occurred in rest or mild PA. Although the data refer only to recess, they are consistent with the literature in showing a decline of PA throughout age.[25, 28, 29] In summary, boys and girls spent about one- half of a 30 minute recess period in rest or very light physical activity, but the other half was occupied with PA of moderate to very vigorous intensities. These physical activities were done in very short bursts with intervals of rest or mild PA. Children's physical activity was characterized by a transient pattern. The number of PA episodes of all intensity levels during recess was lower in the older children and the inverse occurred in rest or mild PA. Boys engaged in higher intensity activity than girls and in general spent more recess time in PA.

The present study is limited to recess which may or may not reflect the overall pattern of daily PA in primary school children. Recess is only one context that includes potential for PA; others include physical education, after school activities at home or in the neighborhood, transport to school (walking, bicycling), and perhaps early organized sports. Care is thus warranted in making inferences from observations during recess to overall physical activity.

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Table 1. Somatic characteristics of the sample

	Age (year)	n	Height (cm)	Weight (kg)	BMI (kg/m^2)
Girls					
	6	31	119.7±6.2	22.9±4.3	17.9±2.2
	7	7	129.6±6.2	29.9±5.6	17.7±2.3
	8	30	132.7±5.9	30.3±5.1	17.1±1.9
	9	16	137.9±7.2	36.9±9.7	19.2±3.3
	10	17	141.5±6.2	35.6±5.8	17.7±2.2
Boys					
	6	32	121.9±4.6	26.2±4.3	17.6±2.5
	7	35	127.0±6.4	28.9±7.7	17.7±3.6
	8	36	135.4±4.9	33.8±6.6	18.4±2.8
	9	25	140.4±6.0	35.2±5.0	17.9±2.3
	10	12	146.3±8.1	44.7±4.5	20.9±0.2

Table 2. Means, standard deviations and ranges (Min-Max) of the number of episodes (#) and average duration (Sec) at each PA intensity level in girls.

Age	6		7		8		9		10	
	M±sd	Min.-Max.	M±sd	Min.-Max.	M±sd	Min.-Max.	M±sd	Min.-Max.	M±sd	Min.-Max.
Rest or Mild PA										
#	132.3±32.4	73.0-194.0	136.4±25.6	93.0-188.0	127.4±34.5	21.0-212.0	108.1±34.0	56.0-176.0	126.8±22.7	87.0-176.0
Sec.	8.1±4.2	3.4-19.1	6.9±2.3	3.9-14.0	10.5±13.3	4.2-79.4	11.8±6.3*	4.1-26.4	9.0±2.5	6.2-14.5
MPA										
#	190.3±55.9	92.0-287.0	202.2±39.7	134.0-286.0	181.7±50.7	34.0-273.0	159.0±52.6	76.0-286.0	173.8±27.0	128.0-212.0
Sec.	1.9±0.2	1.4-2.4	2.0±0.2	1.6-2.8	2.0±0.3	1.4-3.0	2.0±0.3	1.6-2.6	2.1±0.5	1.6-3.0
VPA										
#	108.1±56.8	20.0-204.0	125.5±41.2	39.0-234.0	106.3±40.8	19.0-212.0	95.3±49.7	32.0-181.0	92.3±26.6	34.0-135.0
Sec.	1.5±0.2	1.1-2.0	1.5±0.2	1.2-1.9	1.5±0.2	1.2-2.0	1.6±0.3	1.3-2.2	1.6±0.2	1.2-2.0
VVPA										
#	76.5±42.9	7.0-146.0	82.5±31.4	28.0-182.0	69.1±33.7	11.0-181.0	59.0±29.9	23.0-113.0	55.0±20.6	14.0-87.0
Sec.	3.6±2.8	1.5-16.6	3.8±1.5	1.8-7.6	3.7±1.5	1.8-7.1	3.7±1.5	1.9-6.7	3.5±1.1	2.0-5.7

Table 3. Means, standard deviations and ranges (Min-Max) of the number of episodes (#) and average duration (Sec) at each PA intensity level in boys.

Age	6		7		8		9		10	
	M±sd	Min.-Max.	M±sd	Min.-Max.	M±sd	Min.-Max.	M±sd	Min.-Max.	M±sd	Min.-Max.
Rest or Mild PA										
#	135.1±29.6	39.0-193.0	127.5±26.1	62.0-178.0	127.8±27.9	64.0-187.0	99.2±44.0	32.0-209.0	123.3±57.3	54.0-218.0
Sec.	7.1±6.8	3.4-43.1	7.1±4.6	3.0-26.6	7.8±4.7	2.8-22.3	16.6±14.5	3.7-55.1	12.3±10.5	3.9-30.0
MPA										
#	212.8±46.6	45.0-308.0	207.1±47.6	66.0-272.0	200.7±54.2	73.0-279.0	145.7±75.1	30.0-281.0	178.3±84.9	64.0-291.0
Sec.	2.1±0.3	1.7-3.4	2.1±0.4	1.6-4.1	2.1±0.3	1.7-3.5	1.8±0.3	1.2-2.8	2.0±0.3	1.5-2.3
VPA										
#	135.3±51.6	13.0-228.0	140.9±49.9	18.0-225.0	129.8±54.7	40.0-255.0	82.2±65.7	1.0-220.0	107.3±62.1	23.0-176.0
Sec.	1.6±0.2	1.2-2.2	1.7±0.3	1.3-2.5	1.6±0.2	1.3-2.2	1.5±0.2	1.0-1.9	1.4±0.1	1.3-1.5
VVPA										
#	89.8±44.2	5.0-168.0	98.0±45.1	2.0-189.0	84.6±40.9	19.0-167.0	57.2±47.9	0.0-169.0	70.0±47.5	6.0-115.0
Sec.	3.1±1.5	1.4-7.9	3.3±1.6	1.0-6.9	3.5±1.5	1.4-7.8	3.3±2.4	0.0-12.7	2.5±0.8	1.5-3.5

Table 4. Minutes and mean percentage of the total time of recess spent in PA at each intensity level, by age and gender.

Age		Girls		Boys	
6		Minutes	%	Minutes	%
	Rest or Mild PA	16.3	54.4	13.9	46.2
	MPA	6.2	20.6	7.6	25.5
	VPA	2.7	9.0	3.7	12.3
	VVPA	4.8	15.9	4.8	15.9
7					
	Rest or Mild PA	15.1	50.3	13.6	45.3
	MPA	6.6	22.0	7.3	24.4
	VPA	3.2	10.8	3.9	12.9
	VVPA	5.1	16.9	5.2	17.4
8					
	Rest or Mild PA	17.0	56.7	14.8	49.3
	MPA	6.0	20.2	6.9	23.1
	VPA	2.7	9.1	3.5	11.6
	VVPA	4.2	14.0	4.8	16.0
9					
	Rest or Mild PA	18.6	61.9	19.4	64.6
	MPA	5.2	17.5	4.7	15.8
	VPA	2.6	8.7	2.2	7.2
	VVPA	3.6	11.9	3.7	12.4
10					
	Rest or Mild PA	18.2	60.6	18.2	60.6
	MPA	6.1	20.3	5.9	19.8
	VPA	2.6	8.6	2.5	8.5
	VVPA	3.2	10.5	3.4	11.2