

Intensity of Physical Education lessons in children according to the type of activity: soccer, badminton, aerobics and motor skills.

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Abstract:

Introduction: Due to the increase of childhood obesity, Physical Education becomes the best tool to combat overweight. Furthermore, the type of content may affect the intensity of the lessons. **Objectives:** To check the effect of different activities —soccer, badminton, aerobics and motor skills— on the intensity of Physical Education lessons. **Method:** Non-experimental descriptive-comparative design. The average heart rate of 20 children from the Region of Murcia (Spain) (11 boys and 9 girls), aged between 10 and 12 years, was assessed during 8 different Physical Education lessons. **Results:** The Moderate to Vigorous Physical Activity percentage and the time spent in Moderate to Vigorous Physical Activity are significantly higher ($p=0.020$) for motor skills ($40.80\pm 18.69\%$ MVPA; 12.37 ± 5.66 min) and soccer ($37.77\pm 13.77\%$ MVPA; 11.44 ± 4.17 min) in comparison to aerobics and badminton. Girls attained higher Moderate to Vigorous Physical Activity percentage and time spent in Moderate to Vigorous Physical Activity than boys ($p=0.034$). **Conclusions:** Although results show that intensity and duration of the analyzed lessons do not comply with the recommendations to improve the cardiovascular exercise, the highest heart rate values were observed in lessons with soccer and motor skills as main activity.

Key Words: Physical Education, Heart rate, MVPA, Task structures, Primary Education.

Introduction

The population's lifestyle has been modified by social progress and the development of the welfare state. While most of these changes are associated with social improvements, the hypokinetic behavior of the population can lead to short- and long-term health problems. Inactivity, sedentary lifestyle and improper diet are some of the most common examples that can be found in adults as well as children. The lack of physical activity and unbalanced diet are some of the most influential factors in the development of obesity. Currently, the use of new technologies as a form of fun, poor diet and low level of physical activity has a negative effect on the demand for physical activity by children (Pate, Flynn, & Dowda, 2016). These changes include reductions in active transport increased time spent doing other sedentary activities (McDonald, 2007; Van der Ploeg, Merom, Corpuz & Bauman, 2008; Roberts, Foehr, Rideout & Brodie, 1999).

For that reason, childhood obesity is one of the most serious public health challenges of the 21st century (WHO, 2008). In this sense, the numbers of studies about physical activity and obesity in children have been increased significantly in the last years (Ogden, Carroll, Kit & Flegal, 2012).

For several years, the problem of overweight and obese children and adolescents has been quickly increasing at a global level. In countries like Canada or Australia, the percentage of overweight population has become higher than in the United States. Spain ranks third in Europe in overweight children aged between 7 and 17 years. (Aranceta, Serra, Foz-Sala & Moreno, 2003; Lobstein & Frelut, 2005; Robertson, Lobstein & Knai, 2007; Serra, Ribas-Barba, Aranceta, Pérez-Rodrigo, Saavedra & Peña-Quintana, 2009).

According to Strong et al (2005) school-age youth should take part in a 60-minutes physical activity five days a week. Regarding exercise intensity, the American College of Sports Medicine (ACSM) recommends an intensity between 40-89 % of heart rate reserve (HRR), called Moderate to Vigorous Physical Activity (MVPA). These recommendations have resulted in an improvement in cardiorespiratory fitness and, therefore, they can help prevent the rise of overweight and obesity rates (American College of Sports Medicine, 2011). International results from the Health Behavior in School-Aged Children (HBSC) study show that one third of children do not comply with these recommendations. In Spain, the values of weekly physical activity (3.68 days

per week) are lower than the international average (3.80 days per week) (Moreno, Muñoz, Pérez & Sánchez, 2005).

Concerning exercise intensity, Sallis & Patrick (1994) suggested that 50 % of the Physical Education class time should involve moderate to vigorous physical activity (MVPA) in order to improve cardiovascular fitness. Other studies have followed this recommendations and guidelines. (Baquet, Berthoin & Van Praagh, 2002; Aznar & Webster, 2006; Dudley, Okely, Cotton, Pearson, & Caputi, 2011; Marques, Ferro, Diniz & Carreiro da Costa, 2011; Howe, Freedson, Alazán, Feldman & Osganian, 2012; Stratton, 1997).

Due to its validity and reliability, a heart rate monitor is probably the most common objective method to assess children physical activity levels as well as for assessing MVPA (Aranceta, Serra, Foz-Sala & Moreno, 2007; Durant et al, 1993; Ekelund, 2001; Sirard & Pate, 2001; Wang, Pereira & Mota, 2005; Laurson, Brown, Cullen & Dennis, 2008; Duncan, Badland & Schofield, 2009).

Along this research line, Kulinna, Martin, Lai & Kliber (2003) found that the heart rate pattern in PE varied depending on gender and activity. Wang et al. (2005) showed that only 30 % of physical education lessons time was related to MVPA in 13- and 14-year-old Portuguese children. The results of Fairclough & Stratton (2005) were similar after analyzing 102 British adolescents aged 12-16 years.

According to the type of activity developed in the PE lesson, there are studies with Spanish population. Other studies analyzed the heart rate of adolescents during their PE lesson. The result showed higher percentage of lessons time in MVPA values for team sports than for individual sports (Calderón & Palao, 2005; Sarradel et al, 2011).

To conclude, previous studies have shown that there is no uniformity in the results obtained in this field. Therefore, further research is needed on heart rate response in this environment (PE), in order to check if it complies with official recommendations.

The main purpose of this study has been to assess the intensity of physical activity depending on the type of activity: soccer, badminton, aerobics and motor skills in children during PE lessons, using heart rate telemetry.

Material & methods

The method of this research is quantitative, using a non-experimental descriptive-comparative design. The study subjects consisted of twenty-one students (11 boys and 10 girls), between the ages of 11 and 12, from a Primary School of the Region of Murcia (Spain), selected by convenience sampling. The students' characteristics are summarized on Table 1.

****Table 1. Participant characteristics.****

	(n)	Weight (kg.)*	Height (m.)	BMI (kg/m ²)
Boys	11	47.99±13.81	1.53±0.11	20.15±3.89
Girls	10	46.01±8.13	1.52±0.05	19.90±3.13

The anthropometric values (height, weight and BMI) were measured by a Level II Expert certified by International Society for the Advancement of Kinanthropometry (ISAK), who followed the protocol developed by ISAK (Marfell-Jones, Olds, Stewart & Carter, 2006) and Spanish Kinanthropometry Group (GREC) (Aragonés, Casajús, Rodríguez & Cabañas, 1993). In order to measure the weight, a TANITA BC-350 scale (Tanita®, Illinois, USA) was used, with 97 % reliability, a 0.1 kg. accuracy and a measurement range from 0 to 150 kg. For the height, a TANITA HR001 stadiometer (Tanita®, Illinois, USA) was used, with a 0.1 cm accuracy and a measurement range from 0 to 210 cm.

Data were collected during 8 PE lessons, which were organized in different type of activities: soccer, badminton, aerobics and motor skills. The teachers were instructed to maintain their normal methods of teaching, and students were informed to do everything as normal.

Moreover, the study involved the monitoring of heart rates (HR) during physical education lessons by Polar Team2 heart rate monitors (Polar Electro®, Kempele, Finland). The students' heart rate was measured during the PE lessons. All children wore a heart rate monitor during the lesson time. Telemeters were set to record when the teachers officially began the lessons and stopped at the end. The telemeters recorded hear rate once every 1 second for the duration of the lesson and total lesson time was equivalent to total recording time on the telemeter. At the end of the lessons the telemeters were removed and data were downloaded for analysis. Following the protocol developed by Fairclough & Stratton (2005) resting HR were obtained on 5 non-PE days before the lessons, while students laid in supine position for a period of 10 min. By using the resting and maximum HR values, a HR reserve (HRR) at 40 and 89 % was calculated for each student. The percentage of lesson time spent in health enhancing moderate-and-vigorous intensity physical activity (MVPA) was calculated for each student by adding the time spent between 40-89 % HRR thresholds. This value represents the intensity that may stimulate improvements in cardio-respiratory fitness (American College of Sports Medicine, 2011;

Aznar & Webster, 2006; Boreham & Riddoch, 2001; WHO, 2007; U.S. Department of Health and Human Services, 2000).

Data analysis.

A two-way ANOVA was applied for reliability (intraclass correlation coefficient, ICC), as well as a repeated-measures ANOVA between measurements of researchers to verify the systematic error.

For the descriptive treatment of the different variables analyzed (age, anthropometric variables, average heart rate, time in minutes MPVA and percentage of time in MVPA), average, SD and confidence interval was obtained. The Shapiro-Wilk statistic was used to check the normal distribution.

The Student's t-test for independent samples was applied in order to contrast the average heart rate, time in minutes in MVPA and percentage of time in MVPA by gender and type of PE activity (soccer, badminton, aerobics and motor skills).

For all statistical tests a significance level of $p < 0.05$ was established and in case of Bonferroni test, significance level (α) will be α / k (k: number of comparison). Statistical analysis was conducted using IBM SPSS Statistics 19 for Windows (IBM®, Armonk, NY, USA).

Results

Intraobserver reliability was confirmed by a two-way ANOVA examining the intraclass correlation coefficient (ICC), reaching values that were higher than 0.99 in all the variables analyzed.

Once normality was checked for analyzed variables, independent sample t-test results showed no significant differences for time spent in MVPA ($p = 0.010$) regarding the students' gender. There was no difference related to the average heart rate ($p = 0.074$) and the percentage of PE lesson time in MVPA ($p = 0.291$).

Moreover, the results of the normality test were conducted to check whether the variable to be tested met or not the requirement. The $p > 0.05$ values indicate a normal distribution in all cases.

At the same time, the average duration of PE lessons time was 30.24 ± 2.26 min. The heart rate during PE lessons was 131.23 ± 19.07 . The percentage of lesson time MVPA accrued by students was 18.38 ± 9.72 % which corresponds to 7.60 ± 4.01 min.

Figure 1, represents the values related to MHR for each type of activity. The data obtained for each sport are very similar; although soccer and motor skills highlight, there are no significant differences between them ($p > 0.05$).

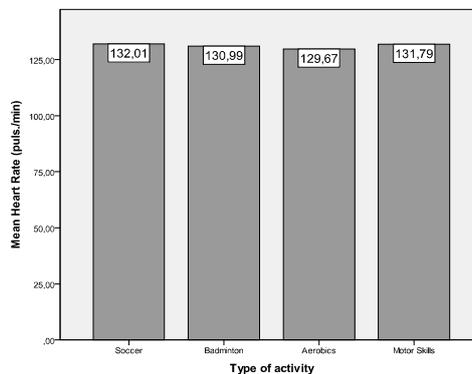


Figure 1. MHR according to the type of activity.

Similarly, the results of the percentage of MVPA regarding the type of activity are described in figure 2. The data obtained are significantly greater for motor skills and soccer than for aerobics or badminton ($p = 0.020$).

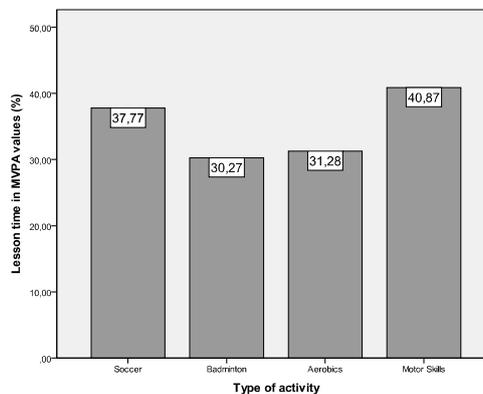


Figure 2. Percentage of lesson time in MVPA according to the type of activity.

Furthermore, figure 3 shows the results of lesson time spent on MVPA values are based on the type of activity. The results were significantly higher in motor skills and soccer than in aerobics or badminton ($p=0.020$).

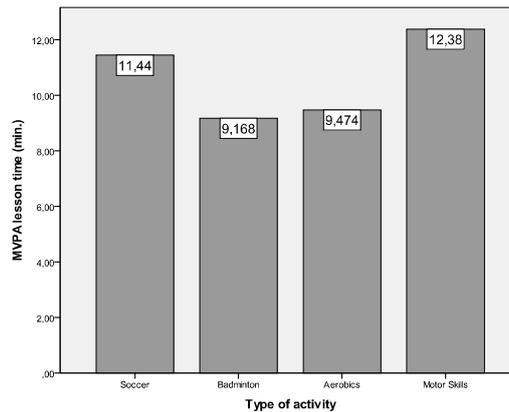


Figure 3. MVPA lesson time values according to the type of activity.

Moreover, after applying the one-way ANOVA, in table 2 we observe a statistical significance in the values associated with the time in minutes in MVPA values and the percentage of lesson time in MVPA values depending on the type of activity ($p=0.020$). According to the Mean Heart Rate, this difference is not obtained ($p>0.05$).

*Table 2: ANOVA depending on the type of activity.**

ANOVA	Sig.	0.020	0.020	0.832
Grouping factor	% MVPA*	Time spent in MVPA (min)*	Mean HR (bbm)	

Abbreviations: MHR (Mean Heart Rate);
MVPA (moderate to vigorous physical activity)
* Significant difference by gender

Regarding the different activities throughout the eight sessions, the results found in percentage of MVPA, lesson time in MVPA and MHR values depending on the type of activity are described in detail on table 3.

Table 3. Percentage of MVPA, time spent in MVPA and MHR based on the type of activity and divided by gender.

		MVPA (%)		TIME SPENT IN MVPA		MEAN HR(BPM)	
		M±SD	p	M±SD	p	M±SD	p
Soccer	Boys (n=11)	31.92±3.07	0.034*	9.67±3.07	0.034*	130.39±8.63	0.751
	Girls (n=9)	45.33±14.41		13.73±4.37		134.10±13.35	
Badminton	Boys (n=11)	29.62±13.84	0.779	8.89±4.19	0.779	131.12±10.44	0.948
	Girls (n=9)	31.11±18.25		9.42±5.55		130.83±15.99	
Aerobics	Boys (n=11)	38.68±13.61	0.883	9.355±4.12	0.883	131.05±8.66	0.412
	Girls (n=9)	31.81±24.48		9.63±7.42		127.95±13.66	
Motor skills	Boys (n=11)	37.38±14.65	0.189	11.32±4.44	0.189	130.92±11.63	0.630
	Girls (n=9)	45.75±22.87		13.86±6.93		133.00±13.92	

Abbreviations: MHR (Mean Heart Rate);
MVPA (moderate to vigorous physical activity)
* Significant difference by gender

The results show that in soccer girls have higher results on the three variables analyzed; there are significant differences ($p=0.034$) in the percentage of MVPA and lesson time spent in MVPA values.

Regarding badminton, the results are also higher for girls on the percentage of MVPA and lesson time spent in MVPA values. However, the differences are not significant.

Meanwhile, regarding the results of aerobics, boys show the highest values based on MVPA percentage and MHR. However, girls report a higher number of minutes in MVPA values. There are no significant differences in any case ($p>0.05$). Finally, in motor skills sessions girls have higher results on the three variables tested, with no significant differences in any case.

Student's t-test was applied in order to know the differences in the intensity values of the sessions by gender. The average results of the descriptive data obtained on the analysis of MHR and MVPA variables during sessions by gender are shown in Table 4.

Table 4. Percent MVPA values, lesson time in MVPA and MHR by gender.

Variables studied	Boys		Girls	
	Mean	SD	Mean	SD
% MVPA*	32.46	13.24	38.49	21.01
Time spend in MVPA (min)*	9.8	4.01	11.66	6.36
Mean HR (bpm)	130.86	9.75	131.49	14.12

Abbreviations: MHR (Mean Heart Rate);
MVPA (moderate to vigorous physical activity)

* Significant difference by gender

In this regard, girls have significantly higher percentage of MVPA values ($p=0.034$), 38.49 ± 21.01 %, while boys have 32.46 ± 13.24 %.

Similarly, as regards the lesson time in MVPA variable, we find some performances in girls 11.66 ± 6.36 , while boys are significantly lower 9.8 ± 4.01 minutes ($p=0.034$). However, MHR data has no significant differences between both genders, being 131.49 ± 14.12 for girls, while the values for boys are 130.86 ± 9.75 , ($p=0.751$).

Discussion

Descriptive data by type of activity.

The results for MHR obtained from the first analysis of this research (131.13 ± 11.79 bpm) were similar to those found by other researchers, such as Marques et al (2011) who received an average score of 134 ± 19 bpm in a Portuguese school. Similarly, Sarradel et al (2011) recorded an average of 131.7 ± 19.5 bpm in a study with Spanish children.

Moreover, according to the intensity of the PE lesson, the average time spent in MVPA values is 10.62 ± 5.22 minutes. Similarly, the average percentage of MVPA values is 35.06 ± 17.23 % MVPA. This value is below the 50 % recommended for improving the control of body weight and the battle against metabolic diseases in young people. (American College of Sports Medicine, 2011; Sallis & Patrick, 1994; Aznar & Webster, 2006; WHO, 2007).

The findings of our study related to the values of average percentage of MVPA session (35.06 ± 17.23 % MVPA) are similar to Fairclough & Stratton (2005), who estimated an average of 34.3 ± 21.8 % of lesson time in MVPA values after the cardiac response study of 102 schoolchildren.

At the same time, there are also other studies with higher results than our findings. Here, Adams (2009) found average values of 70.2 ± 11.2 % MVPA. Gao, Hanno & Carson (2009) obtained average values of 55.43 ± 16.23 % in MVPA values in a study of 146 American school children. Likewise, Marquis et al. (2011) obtained an average of 58 ± 10.1 % of time to analyze cardiac MVPA response of Portuguese students during PE lesson while Dudley et al. (2011) obtained a similar score of 56.9 ± 18.7 % MVPA in young Australians.

The results obtained for the different activities measured: soccer, badminton, aerobics and motor skills, are described below:

Based on the intensity of PE sessions, lesson time in MVPA values and their equivalence to the percentage of MVPA, the results found in motor skills sessions (12.37 ± 5.66 minutes; 40.80 ± 18.69 % MVPA) and team sports: soccer (11.44 ± 4.17 minutes, 37.77 ± 13.77 % MVPA) are higher than those found in individual sports: badminton (9.16 ± 4.74 minutes, 30.27 ± 15.67 % MVPA) and aerobics (9.47 ± 5.72 minutes, 31.27 ± 18.91 % MVPA).

Comparing the data obtained in our study with other researches, there are similarities with Fairclough & Stratton (2005) who analyzed the cardiac response of 122 British children (11-14 years), obtaining a percentage of 43.2 ± 19.5 % in MVPA values in team sports sessions in comparison to values of 22.2 ± 20.0 % MVPA in individual sports sessions.

However, our results differ from those found by Kullinay et al (2003) who reported lower data for team sports, with an average of 37.26 ± 21.25 % MVPA in comparison with individual sports (57.46 ± 24.96 % MVPA), in a study with 505 students aged 12 years. Yuste, García-Jiménez & García-Pellicer (2013) found significantly higher results in MHR and in the percentage of MVPA for team sports (141.77 ± 14.75 ppm; 45.13 ± 18.01 %) than for individual sports (119.06 ± 19.20 ppm; 23.81 ± 25.85 %).

Heart Rate, percentage of MVPA in PE lesson according to gender.

Initially, the results of MHR in terms of gender are higher in girls (131.49 ± 14.12 bpm) than in boys (130.86 ± 9.75 bpm), but there are not significant differences between them ($p=0.751$).

Fjortoft, Löfman & Halvorsen Thorén (2009) conducted a study with 84 school children, comparing the results by gender, and concluded that girls had higher average HR values during PE lesson.

On the other hand, regarding the percentage of lesson time in MVPA in school, in our study girls have higher values (38.49 ± 21.01 % MVPA) than boys (32.46 ± 13.24 % MVPA), with significant differences between them ($p=0.034$). Similarly occurs with variable lesson time in MVPA minutes, finding some performances in girls (11.66 ± 6.36 min), while the boys' values (9.8 ± 4.01 min) are significantly different ($p=0.034$).

By contrasting these results with existing researches, we find similarities with the studies carried out by Laurson et al (2008) where girls (70.9 ± 29.8 % MVPA) recorded higher values of percentage of MVPA than boys (64.2 ± 31.5 % MVPA).

Similarly, in Nader's (2003) study 40 boys have higher results (12.3 ± 5.4 %MVPA) than girls (11.4 ± 5.4 %MVPA). Likewise, in Fairclough & Stratton's (2005) the results showed higher values of percentage of MVPA for boys (39.4 ± 21.8 % MVPA) as compared to girls (29.1 ± 23.04 %), with significant differences between the data ($p \leq 0.05$). These authors justify their results with the fact that those students with greater physical skills were more active and participating in the lesson than the less skilled, who used to be girls.

Analysis by type of activity according to gender.

Furthermore analyzing the results based on the type of activity we can observe that in team sports, the results in terms of MHR, percentage of lesson time in MVPA and MVPA minutes are lower for boys (31.92 ± 3.07 % MVPA; 9.67 ± 3.07 min, 130.39 ± 8.63 bpm) as compared to girls (45.33 ± 14.41 % MVPA; 13.73 ± 4.37 min, 134.10 ± 13.35 bpm). There are significant differences in the percentage of time in MVPA and MVPA minutes ($p=0.034$) and not significant ones in MHR ($p=0.751$). Some researches, conclude with higher percentage results in MVPA in girls in comparison to boys during team sports lessons. (Laurson et al, 2008; Kulinna et al, 2003; Sarradel et al, 2011; Gavarry et al, 1998).

With regard to badminton (individual sport), the results show higher data for girls in terms of the percentage of time in MVPA and MVPA, but lower compared to MHR. The data found for boys are 29.62 ± 13.84 % MVPA, 8.89 ± 4.19 min, 131.12 ± 10.44 bpm, and for girls, 31.11 ± 18.25 % MVPA, 9.42 ± 5.55 min; 130.83 ± 15.99 bpm, with no significant differences in any case ($p=0.779$).

The results of our investigation are similar to those obtained by Adams (2009) and by Sarradel et al (2011), where the values obtained by girls in individual sports sessions (140 ± 11.1 bpm; 51.6 ± 5.0 % MVPA) were higher than those recorded in boys (132 ± 10.3 , 42.6 ± 3.0 % MVPA).

Regarding aerobics, the analysis shows that the results in terms of percentage of MVPA, lesson time in MVPA and MHR are higher for girls (31.81 ± 24.48 % MVPA, 9.63 ± 7.42 min; 127.95 ± 13.66 bpm) than for boys (38.68 ± 13.61 % MVPA; 9.355 ± 4.12 min, 131.05 ± 8.66 bpm), but are not significantly different ($p > 0.05$).

Finally, the results of motor skills based on the analysis of the percentage of MVPA, lesson time MVPA and MHR are higher for girls (45.75 ± 22.87 % MVPA; 13.86 ± 6.93 min, 133.00 ± 13.92 bpm) than for boys (37.38 ± 14.65 % MVPA; 11.32 ± 4.44 min, 130.92 ± 11.63 bpm), but are not significantly different ($p > 0.05$).

Conclusions

The intensity of PE lesson analyzed does not meet the recommendations of intensity and duration in order to be an appropriate cardiovascular workout that may help control schoolchildren's body weight.

Motor skills and soccer lessons led to higher values of MHR, MVPA and percentage of lesson time in MVPA in comparison with badminton and aerobics lessons. Depending on gender, girls had higher values regarding the percentages of lesson time in MVPA than boys.

Conflicts of interest - There is not potential conflict of interest.

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