Yuste, J.L.; García-Jiménez, J.V. y García-Pellicer, J.J. (2015). Intensidad de las clases de educación física en adolescentes / Intensity of Physical Education Classes in Adolescents. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte, vol. 15 (58) pp. 309-323. Http://cdeporte.rediris.es/revista/revista58/artintensidad584.htm
DOI: http://dx.doi.org/10.15366/rimcafd2015.58.007

ORIGINAL

INTENSITY OF PHYSICAL EDUCATION CLASSES IN ADOLESCENTS

INTENSIDAD DE LAS CLASES DE EDUCACIÓN FÍSICA EN ADOLESCENTES

Yuste, J.L.[1]; García-Jiménez, J.V.[2] & García-Pellicer, J.J.[3]

1. Profesor Contratado Doctor. Facultad de Educación. Universidad de Murcia. España. jlyuste@um.es
2. Profesor Asociado. Facultad de Educación Universidad de Murcia. España. jvgjimenez@um.es
3. Profesor Titular de Universidad. Facultad de Educación. Universidad de Murcia. España. jgpelli@um.es

Spanish-English translator: Pilar del Rosario Gómez-Huedo Giménez, pilargomezhuedo@gmail.com

Código UNESCO: 2411 Fisiología Humana; 5899 Otras especialidades pedagógicas (Educación Física y Deporte)
Clasificación Consejo de Europa: 06 Fisiología del Ejercicio; 04 Educación Física y deporte comparado

Código UNESCO / UNESCO code: 2411 Fisiología Humana / Human physiology; 5899 Otras especialidades pedagógicas (Educación Física y Deporte) / Other specialties pedagogical (Physical education and sport)
Clasificación Consejo de Europa / Council of Europe classification: 6 Fisiología del Ejercicio / Exercise physiology; 4 Educación Física y deporte comparado / Physical education and sport compared

Recibido 23 de abril de 2012 **Received** April 23, 2012
Aceptado 16 de mayo de 2013 **Accepted** May 16, 2013

ABSTRACT

Heart rate from 182 students (97 boys and 85 girls) aged between 12 and 18 years was assessed during physical education classes. Results have shown an average time of 21.62±14.33% of lesson time in MVPA (moderate to vigorous physical activity). Though there was no significant gender difference, girls were more active (23.47±14.45% vs 19.99±14.10%). There was no significant effect of session type (team sports, individual sports, traditional games or dancing) on time spent at MVPA values ($p>0.05$; $ES<0.020$),

obtaining the highest values in team sports sessions. Results show that intensity and duration of analyzed classes do not comply with recommendations to become an adequate cardiovascular exercise.

KEYWORDS: Heart rate, physical activity levels, Secondary Education, MVPA, BMI.

RESUMEN

Se registró la frecuencia cardiaca de 182 estudiantes (97 chicos y 85 chicas) de entre 12 y 18 años durante sus clases de Educación Física. Los resultados muestran una media del 21,62±14,33% del tiempo de clase en valores MVPA (moderate to vigorous physical activity). Respecto al género, pese a no ser significativo, los mayores valores corresponden a la chicas (23,47±14,45% vs 19,99±14,10%; p=0,106). No se ha observado efecto del tipo de sesión (deportes colectivos, deportes individuales, juegos tradicionales o bailes) sobre el tiempo en valores MVPA (p>0,05; TE<0,020), obteniéndose los mayores valores en sesiones de deportes colectivos. Los resultados muestran que la intensidad y duración de las clases registradas no cumplen con las recomendaciones para suponer un adecuado trabajo cardiovascular.

PALABRAS CLAVE: Frecuencia cardiaca, niveles de actividad física, educación secundaria, MVPA, IMC.

1. INTRODUCTION

Childhood obesity is one of the most serious public health challenges of the 21st century, where overweight and obese children are likely to stay obese into adulthood and more likely to develop noncommunicable diseases like diabetes and cardiovascular diseases at a younger age.

In Spain, Serra et al. (2000), indicates that 21.8% of adolescents aged between 14 and 17 years, are above the percentile 85 of body mass index (9.3% between percentile 85 and 97; 12.5% over percentile 97). However, Serra et al. (2003), Aranceta et al. (2005), Robertson et al. (2007) and Valera and Silvestre (2009) point out that, according to the trend of increasing overweight and obesity in children and adolescents (5-17 years), the forecast for 2020 is that 30% of European children are overweight or obese, where in Spain this value would reach 36%. Furthermore, for noncommunicable diseases, the most important risks include high blood pressure, high concentrations of cholesterol in blood, inadequate intake of fruit and vegetables, overweight or obesity, physical inactivity and tobacco use. Five of these risk factors are closely related to diet and physical activity (WHO, 2004), where the decrease in physical activity is considered the main factor contributing to the development of overweight and obesity.

In a review of physical activity recommendations, Strong et al. (2005) summarized that School-age adolescents should participate five days a week in

60 minutes of physical activity. With respect to exercise intensity, the American College of Sports Medicine (ACSM) recommends an intensity corresponding to 40-59% heart rate reserve (HRR), called Moderate to Vigorous Physical Activity (MVPA), has been shown to result in improvements in cardiorespiratory fitness and, therefore, it can help prevent the rise in overweight and obesity (ACSM, 2011).

Costa and Lopez (2000) suggest that adolescence, along with childhood, is one of the key stages in the formation and acquisition of healthy lifestyles, where physical activity reduces the risk of cardiovascular and metabolic diseases in adulthood (Aznar and Webster, 2006; WHO, 2007). However, despite of these data, physical activity levels in adolescents have been reduced in recent years (Boreham et al., 2001). International results from the study Health Behavior in School-AgedChildren (HBSC) show that one third of adolescents do not comply with these recommendations. In Spain, values of weekly physical activity (3.68 days per week) are lower than the international average (3.80 days per week) (Moreno et al., 2005). Along these lines, the study of Yuste (2005) shows than only 7.1% of adolescents in school practice physical education during five days per week, which is the recommendation.

In Spain, the only time where adolescents are required to practice physical activity corresponds to the Physical Education (PE). In Secondary Education (12-16 years), Spanish education system establishes two classes of 50 minutes per week. For its characteristics, PE provides a context for regular and structured physical activity participation (Baquet et al., 2002; Fairclough and Stratton, 2005).

In relation to exercise intensity during PE lessons, Sallis and Patrick (1994) suggested that 50% of the class time should involve moderate to vigorous physical activity (MVPA) in order to improve cardiovascular fitness. Baquet et al. (2002), Aznar and Webster (2006), Dudley et al. (2011), Marques et al. (2011) and Howe et al. (2012) have followed this recommendations and guidelines. However, U.S. Department of Health warned about American students, who spent a minimum of 10% of total lessons practically at rest or with low intensity activities.

To assess adolescent physical activity levels, a heart rate monitor is probably the most common objective method, due to its validity and reliability (Durant et al., 1993; Ekelund et al., 2001; Sirardand Pate, 2001; Wang et al., 2004; Laurson et al., 2008; Duncan et al., 2009; ACSM, 2011). The heart rate monitor is also a good tool for assessing MVPA (Stratton, 1997; Sirardand Pate, 2001; Baquet et al., 2002; Aznar and Webster, 2006).

Heart rate analysis has been used to assess intensity in PE for nearly 45 years (Faulkner et al., 1963). Later, other researches monitored children and adolescents to record their heart rate during their PE classes, as carried out with 1200 children from 5 to 16 years during their schooling (Armstrong et al., 1990, 2000; Armstrong and Bray, 1990, 1991, Biddle et al., 1991, McManus and Armstrong, 1995; Welsman and Armstrong, 1997, 1998, 2000),

or Stratton (1997), who analyzed at 177 British adolescents (12 to 16 years), indicating PE time in MVPA intensity.

Along this research line about heart rate recording, Kullina et al. (2003) found that the heart rate pattern in PE varied according to gender and activity. Wang et al. (2004) showed that only 30% of physical education class time was related to MVPA in Portuguese adolescents aged 13-14 years. Similar to this were the results of Fairclough and Stratton (2005) after analysing 102 British adolescents aged 12-16 years. Other investigations carried out in adolescents by Laurson et al. (2008), Adams (2009), Gao et al. (2009), Marques etal. (2011) and Dudley et al. (2011), also showed results on the time spent by students in MVPA intensity, recording values over 50% of PE class time.

Amongst the studies carried out with Spanish population, Sarradell et al. (2011) analyzed the heart rate of 37 adolescents (14 years old) during their PE lesson. They obtained 40% of class time in MVPA values. Also with Spanish population, but working with a lower age group, Sierra-Robles (2005) used heart rate monitors in students (10-11 years old) to analyze heart rate, obtaining an average of 140 beats per minute (bpm) during PE classes. Similar to this, Generelo (1996) and Gavarry et al. (1998) obtained and average of 128 and 133 bpm in their studies with children (8-12 years old).

In summary, previous studies show that there is no uniformity in the results obtained in this field. In cases like Spanish researches, the results do not comply with the recommendations of Sallis and Patrick (1994), Baquet et al. (2002) and Aznar and Webster (2006) about the time spent in MVPA during PE classes (at least 50%). 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 in adolescents during PE lessons, using heart rate telemetry.

2. MATERIAL AND METHODS

2.1. Participants

The subjects of the study consisted of one hundred and eighty two students (97 boys and 85 girls), from five public high schools in the Region of Murcia (Spain), selected by convenience sampling. Nevertheless, only those students who went to the school the day of data taking were included in our study. The students and their parents were informed and gave their written consent to participate in this study, after the details had been explained to them. The study was approved by the Bioethics Committee of the University of Murcia. Characteristics of the students are summarised on Table 1.

Tabla 1. Participant characteristics

Variable	Boys (n=97)						Girls (n=85)					
	Mean	SD	Min	Max	Confidence interval (95%)		Mean	SD	Min	Max Lower limit	Confidence interval (95%)	
					Lower limit	Upper limit					Lower limit	Upper limit
Age (yrs.)	14.78	1.85	12	18	14.41	15.16	14.94	1.62	12	18	14.59	15.29
Height (m.)*	1.69	0.10	1.44	1.89	1.67	1.71	1.60	0.06	1.47	1.77	1.59	1.62
Weight (kg.)*	61.21	13	32.90	105.80	58.59	63.83	56.16	9.72	36.27	91.60	54.06	58.26
BMI (kg/m^2)	21.17	3.20	15.37	31.42	20.53	21.82	21.75	3.51	15.70	38.83	20.99	22.51
Tricipital skinfold (mm)*	12.65	5.34	4.8	28.2	11.57	13.73	18.65	5.43	7.0	34.0	17.48	19.82
Boy fat (%)*	20.95	8.53	7.32	48.78	19.23	22.67	28.68	6.74	14.86	47.80	27.23	30.13
Resting HR (bpm)	62.22	9.68	43	95	60.27	64.17	65.29	8.27	50	92	63.51	67.08

* p≤0.05 significant difference in relation to student gender

2.2. Procedures

Height and weight values were measured following the protocol developed by ISAK (Marfell-Jones et al., 2006). To measure the weight we used a scale TANITA BC-350 (Tanita®, Illinois, USA) with 97% reliability, accuracy 0.1 kg. and a measurement range from 0 to 150 kg. For the height we used a stadiometer TANITA HR001 (Tanita®, Illinois, USA), accuracy 0.1 cm. and a measurement range from 0 to 210 cm.

In order to measure anthropometric values, a dermographic pencil and a plicometer Holtain Skinfold Caliper (Holtain Ltd.®, United Kingdom) were used, with measurement range from 0 to 40 mm and 0.2 mm. accuracy. We also used a Holtain measuring tape (Holtain Ltd.®, United Kingdom). The sum of triceps and leg skinfolds thicknesses were used to estimate percentage body fat (Slaugter et al. 1988),

Data were collected during 9 PE lessons, which were grouped in four different types: team sports, individual sports, traditional games and dancing. All the teachers had earned master's degrees in PE and had at least 5 years of teaching experience. Teachers were instructed to maintain their normal methods of teaching, and students were informed to do everything as normal.

The study involved the monitoring of heart rates (HR) during physical education lessons using Polar Team2 heart rate monitors (Polar Electro®, Kempele, Finland). The students' heart rates were measured during PE class, with all subjects wearing a heart rate monitor during the class session. Telemeters were set to record when the teachers officially began the lessons, and stopped at the

end. 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 to de PC for analysis.

Following the protocol developed by Fairclough and Stratton (2005), resting HR were obtained 10 days before the lessons, while students lay in supine position for a period of 5 min. After calculating the maximum HR by applying the formula 208-0.7 x Age (Tanaka et al., 2001) and the resting HR values, HR reserve (HRR) at 50% was calculated for each student. Percentage of lesson time spent in health enhancing moderate-and-vigorous intensity physical activity (MVPA) was calculated for each student by summing the time spent between 40-59% HRR threshold. This value represents the intensity that may stimulate improvements in cardio-respiratory fitness (Boreham et al. 2002; Aznar and Webster, 2006; WHO, 2007; ACSM, 2011).

2.3. Data analysis

Means and standard deviations were calculated for each of the output measured analyzed. The Kolmogorov-Smirnov statistic was used to check the normal distribution.

Independent sample t-test was carried out to test gender differences and different lesson types, with regard to mean heart rate, time spent in MVPA and percent of lesson in MVPA values. One-way ANOVA was used to identify differences in mean time spent in MVPA in MVPA values between the four PE lesson types (team sports, individual sports, traditional games or dancing), using Bonferroni post hoc test to identify where significant differences occurred. Where data were not normal, Kruskal-Wallis test was used.

Effect sizes were also calculated using Cohen's d for time in MVPA values in relation to gender and session type, interpreted as small (0.20), medium (0.50), and large (0.80).

For all statistical test 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 carried out suing IBM SPSS Statistics 15 for Windows (SPSS Inc®, Chicago, USA).

3. RESULTS

The average duration of PE lessons was 41.35±4.71 min. Results in Table 2 show that heart rate during PE lessons were 132.25±18.13 puls./min. Students accrued 21.62±14.33% of lesson time MVPA, which equated to 8.26±5.64 min.

Table 2. Heart rate values in relation to student gender

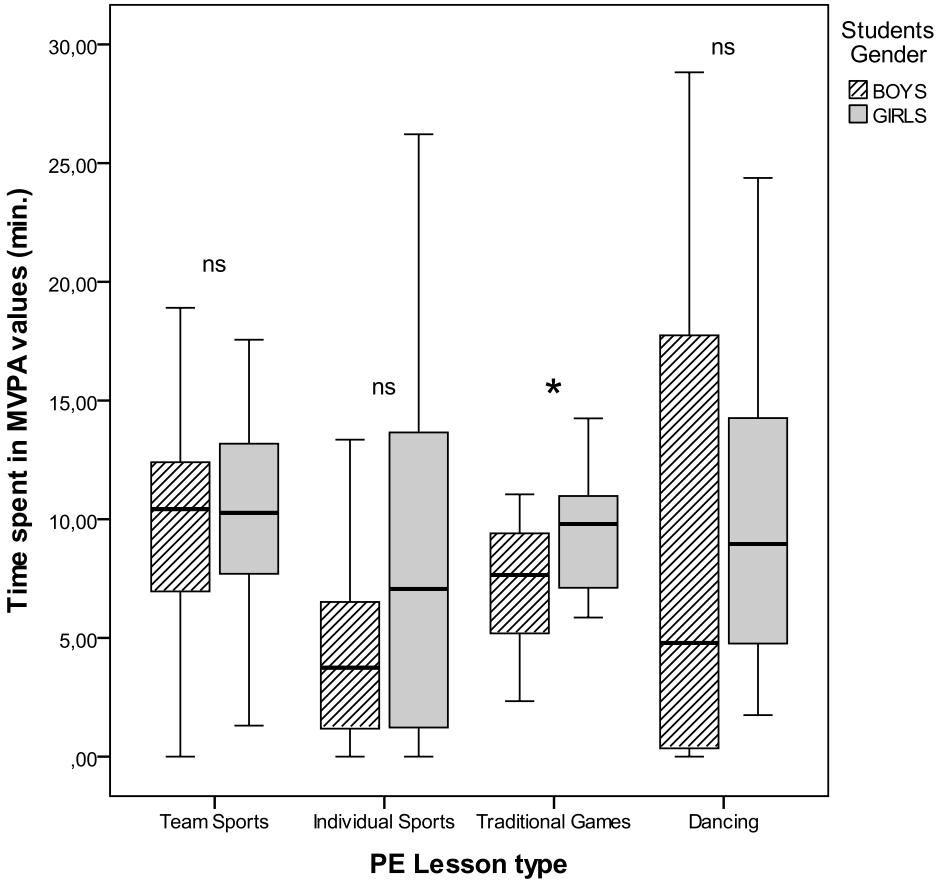
Variable	Boys (n=97)				Girls (n=85)				All (n=182)			
	Mean	SD	Confidence interval (95%)		Mean	SD	Confidence interval (95%)		Mean	SD	Confidence interval (95%)	
			Lower limit	Upper limit			Lower limit	Upper limit			Lower limit	Upper limit
HR (puls./min)	130.02	16.85	126.59	133.45	134.76	19.28	130.58	138.95	132.25^{ns}	18.13	129.57	134.92
PE Time spent in MVPA (min)	8.26	5.83	7.08	9.45	9.70	5.97	8.40	11.00	8.94^{ns}	5.92	8.06	9.81
PE Time spent in MVPA (%)	19.99	14.10	17.12	22.87	23.47	14.45	20.33	26.60	21.62^{ns}	14.33	19.51	23.74

HR (Heart rate); PE (Physical Education); MVPA (Moderate to Vigorous Physical Activity)
^{ns}No significant difference by students gender
* p≤0.05 Significant difference by students gender

Once normality was checked for mean heart rate variable (p=0.200 for both boys and girls), time spent (p=0.189 boys; p=0.200 girls) and percent of time spent in MVPA values (p=0.189 boys; p=0.200 girls) through Kolmogorov-Smirnov statistic, independent sample t-test results showed non significant differences just for time spent in MVPA (p=0.106) in relation to student gender. Also there was no difference related to mean heart rate (p=0.120) and percent of PE time in MVPA (p=0.106).

According to students' gender, time in minutes spent in MVPA value has a normal distribution in each of the different PE lessons (Team Sports: p=0.200 both boys and girls; Individual Sports: p=0.103 boys and p=0.065 girls; Traditional Games: p=0.200 both boys and girls; Dancing: p=0.51 boys and p=0.75 girls). As shown in Figure 1, girls always obtain higher results than boys for time spent in MVPA values. However, only during Traditional Games lessons we can find significant differences (p=0.049; IC=95%; Lower = -4,65 and Upper = -0.16).

For time spent in MVPA the ANOVA indicated no main effect (p=0.081) for lesson type, so this variable cannot influence over time spent in MVPA intensity values.



n.s.: p>0.10; *: p<0.05

Figure 1. Time spent in MVPA values in relation to lesson type

The effect size results shown in Table 3 about the effect of gender on MVPA intensity during different lesson types, would lead us to conclude that there was a low effect (d<0.20), except for Traditional Games, where the lowest value (d=-0.24) is shown. This way, after studying the effect of lesson type on time spent in MVPA values, the results obtained through Cohen's Statistic are all those below 0.20, which indicate a low effect for this variable.

Table 3. Cohen's d effect size for gender and session type in time spent in MVPA values

Intra-groups differences	Cohen's d
Team Sports (boys vs girls)	-0.02
Individual Sports (boys vs girls)	-0.17
Traditional Games (boys vs girls)	-0.24
Dancing (boys vs girls)	-0.04
All lessons (boys vs girls)	-0.03
Team Sports v Individual Sports	0.08
Team Sports v Traditional Games	0.05
Team Sports v Dancing	0.02
Individual Sports v Traditional Games	-0.02
Individual Sports v Dancing	-0.06
Traditional Games v Dancing	-0.10

4. DISCUSSION

The purpose of our work has been to assess heart rate during PE lessons in adolescents, using the time spent in MVPA values (moderate-to-vigorous physical activity), as well as the percent of lesson time spent in those values.

On initial analysis, mean heart rate observed during lessons (132.25±18.13 bpm) is similar from those who analyzed the same population. Thus, Marques et al. (2011) obtained a mean of heart rate of 134±19 bpm with portuguese adolescents. Sarradel eta al. (2011) assessed a mean of 131.7±19.5 bpm during a research with Spanish students.

On the other hand, the analysis of the intensity in our PE lessons shows that mean time spent in MVPA (8.94±5.92 min.) is equal to 21.62±14.33% of lesson time. This value is under 50%, recommended in order to improve the weight control and to fight against metabolic diseases in adolescents (Sallis and Patrick, 1994; Aznar and Webster, 2006; WHO, 2007; ACSM, 2011).

Results about percentage of time spent in MVPA values (21.62±14.33%) obtained in our research are lower than previously reported from other countries. Stratton (1996) found an average of 32.7% of lesson time spent in MVPA value after having assessed 177 British adolescents during their PE lessons. On the other hand in a similar research, Wang et al. (2004) concluded that only 30% of lesson time was related to MVPA values. Along this line, Fairclough and Stratton (2005) obtained a mean of 34.3±21.8% of lesson time in MVPA values after studying heart rate in 102 adolescents. Lastly, in a research about the influence of the type of content on intensity of PE lessons,

Laurson et al. (2008) found 70.23±20.5% MVPA, where the highest values were recorded when the content was physical training (142±24 bpm; 81.7% MVPA).

Recent publications show results about percentage of lesson time higher than ours (21.62±14,22%). Thus, Gao et al. (2009) obtained a mean of 55.43±16.23% in MVPA values after analyzing 146 American adolescents. The study of Adams (2009) showed mean values of 70.2±11.2% MVPA. Marques et al. (2011) obtained a mean of 58.10±10.1% MVPA values studying Portuguese adolescents during PE lessons, while Dudley et al. (2011) showed that Australian adolescents spent 56.9±18.7% in MVPA during their lessons.

In relation to a recent research carried out in Spain, Sarradel et al. (2011) obtained, on average, 39.25±4.73%, while in our study, the target analyzed as MVPA included the time when the intensity of physical activity was also vigorous (VPA), related to FCR values ranged between 60-84%.

In any case, the analysis of our results shows that 8.94±5.92 min. in MVPA values (21.62±14.33% of lesson time) is insufficient in order to improve the cardiovascular work which could be necessary to control the students weight.

In relation to students gender, as it is shown in Figure 1, regardless of lesson type results in girls about time spent in MVPA are higher than boys results. Difference about time in MVPA according to gender has been studied in several researches during recent years. In our study, time spent in MVPA values was higher in girls (9.70±5.97 min; 23.47±14.45%) compared to boys (8.26±5.83 min.; 19.99±14.10%), even though these differences were no significant ($p>0.05$). This result is close to the study of Sarradel et al. (2011), which showed that girls also spent more time in MVPA values than boys (42.6±9.0 versus a 35.9±8.8%)

On the other hand, similar publications obtain higher results for boys than for girls. Nader et al. (2003) found on average 12.3±5.4% MVPA values in boys versus 11.4±5.4% in girls. Wang et al. (2004) concluded that boys spent more time in MVPA values (10.1±5.1 min.) than girls (29.1±23.4 min.)

Lesson type, or lesson contents given during PE will affect the intensity of lessons and, therefore, time spent by students in MVPA values. Stratton (1997) suggested that teachers should guide the PE to more intense practice lessons, strengthen these lessons to team sports. We found similar recommendations in the studies of Fairclough and Stratton (2005) and Laurson et al. (2008). Lastly, Gao et al. (2009) conclude that team sports and physical training sessions significantly affect the fact that students spent 50% of lesson time in MVPA values.

Therefore, it is necessary to analyze and check if lesson type will have any effect on the intensity of PE. In our study, the factorial analysis shows that lesson time does not affect significantly ($p>0.05$) on time spent in MVPA values. In any case, the highest results were registered during Team Sports and Dancing lessons (Figure 1). This result is similar to the one obtained by Kulinna

et al. (2003), Adams et al. (2009) and Sarradel et al. (2011), who analyzed students heart rate according to lesson type. As well as our study, they recommended to include activities that improve the intensity of PE lessons, obtaining higher results in team sports than individual sports and games.

On the other hand, it is remarkable that, after Team Sports, the activity where students spent more time in MVPA values was Dancing. In a recent study, Nelson et al. (2011) obtained a mean of 47% of lesson time in MVPA values, through dancing activities. In the same way, Pelclová et al. (2008) concluded that PE lessons with choreographic activities exceed 50% of lesson time spent in MVPA values.

5. CONCLUSSIONS

Intensity of PE classes analyzed do not comply with recommendations about intensity, frequency and duration to become an adequate cardiovascular exercise and to improve the students corporal composition.

According to the results obtained, and taking into account the target of developing PE lessons which comply with official recommendations, it is recommended to analyze and to select activities which imply a higher physiologic exercise for students.

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