Original Article

Specific heart rate values of 10-12-year-old physical education students during physical activity

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Published online: September 26, 2016

(Accepted for publication August 14 2016)

DOI:10.7752/jpes.2016.03127

Abstract

Students who participate in well-planned and structured physical education (PE) lessons engage in significantly higher levels of physical activity than children who do not. Heart rate monitoring a useful tool to help both students and teachers understand the efficiency of the physical activity. The purpose of this study was to analyze primary school children's body compositions and heart rates when performing different types of physical activities (gymnastics, mixed activities, ball games, athletics, and games). The sample included 10-12-year-old primary school boys (N=46) and girls (N=63) from the university's cooperating school. To estimate their body compositions, standard anthropometric techniques were used. Polar RS400 heart rate monitors were used to monitor the heart rate of each child during the main parts of different types of physical education lessons. There were no differences between the genders for the body composition or for the maximal heart rate values in the different PE content areas. The lowest heart rate was recorded during gymnastics (148 beat*min⁻¹), and the highest values were detected during the game activities and athletics (164.60 and 163.83 beat*min⁻¹). For the mixed activities and ball games, the heart rates ranged between 154.06 and 156.52 beat*min⁻¹. Physical activities that result in higher heart rate values required a greater contribution and adaptation of the cardiovascular system. However, activities that elicit a lower heart rate likely focus more on skill learning and acquisition. This data can be used as a resource for physical education teachers when planning and structuring PE classes.

Key Words: activities, physical education, heart rate monitor, body composition

Introduction

In the last few decades there has been an observable decrease in physical activity and, with that, an increased level of sedentariness among children (Doak et al., 2006). Contributing to this fact is that only a small percentage of school-aged children meet the recommended amount of sixty minutes of moderate to vigorous physical activity per day (Mackintosh et al., 2011).

This trend has been an important public health concern in several aspects (Zhdanova et. al. 2015). It has been understood that the obesity level of school-aged children is one major concern for most societies in Europe (Chekhovska, 2015). It is reported that around 17% of 2-19-year-old children had a body mass index (BMI) at or above the 95th percentile, while 32% were overweight or obese (Ogden et al., 2010).

The increasing level of obesity along with the decreasing level of physical activity not only poses serious health risks, but has been also shown to negatively affect the quality and development of motor skills (Matthews, O'Neill & Kostelis, 2014). According to research, obese boys and girls are 17-20% less likely to successfully pass basic physical and fitness tests compared to children in a normal weight range (Castetbon & Andreyeva, 2012). This issue also makes engagement in regular health-conscious physical activity in an attempt to learn and improve motor skills highly important. It is important for all teachers and sport professionals to understand that students with greater motor proficiency and greater abilities are more likely to engage in physical activity and less likely to adopt a sedentary lifestyle (Fairclough & Stratton, 2005; Wrotniak et al., 2006).

The role of physical education in healthy active living

Physical education (PE) programs are a vital means of promoting healthy active living and developing different motor skills and fitness levels for every student (Arto, 2015). School PE is the primary societal

institution responsible for promoting and assisting regular health-conscious physical activity for all 6-18-year-old students (Sallis et al., 1997).

With specific standards and benchmarks, one of the main goals of PE is to help children develop their physiques, body compositions and different types of psychomotor skills (Matthew, 2015). However, there is evidence that this goal is not being adequately fulfilled in many schools (Sallis and McKenzie, 1991). Mackintosh et al. (2011) reports that children will tend to participate in more physical activity if they perceive themselves to be physically capable. If PE programs are able to assist children with the development and improvement of their skills and also with a feeling of success, then children will more likely develop a regular participation in lifelong physical activity.

Students who participate in well-planned and structured PE lessons engage in significantly more physical activity in school than children who do not (Sallis et al., 1997; Ribeiro et al., 2010). This fact makes school PE a key contributor to health- and fitness-related physical activity for the recommended amount of sixty minutes of moderate to vigorous physical activity. According to Mackintosh et al. (2011) only 5.1% of boys and 0.4% of girls are currently meeting these guidelines.

According to the Hungarian National Core Curriculum (NCC, 2012), physical education, besides skills and exercise, is expected to emphasize prevention and to develop healthy active lifestyles through different types of physical activities. The content of PE in primary schools (6-14-year-old students) mainly comprises ball games, athletics, gymnastics and other types of games.

Heart rate levels in PE

The quantitative and qualitative characteristics of adaptation processes established by physical load are relatively well known in the case of adult age groups. However, there is less reliable data regarding the physical adaptation phenomena of school-aged children in school PE programs. In agreement with the conventions formed in the “training” activities of adults, adaptation in children can also be planned along the three features of physical load (or a combination of them) as well, which are frequency, range and intensity (Strong et al., 2005; Lonsdale et al., 2013).

One way to measure the level and adaptation of physical activity is the heart rate monitor. Heart rate control can be a useful tool to support students and teachers in evaluating the efficiency of the physical activity. It also aids the PE teacher with the planning of PE lessons and units as well (Freedson and Miller, 2000; Wang et al., 2005). Hence, the purpose of this study was to analyze primary school children’s heart rates as related to the different types of physical activities in school physical education.

Material and Methods

Sample

A cooperating school of the Széchenyi István University teacher training program was selected to participate in this study. The sample included those 10-12-year-old primary school boys (N=46) and girls (N=63) who participated in five 45-minute physical education lessons per week throughout the academic years of 2014-2015. Those students not involved in daily PE in this period were exempted from this study. The students represented grades 5-6, and their age was between 10-12 years old ($M_{\text{age, boys}}=11.37\pm.64$; $M_{\text{age, girls}}=11.43\pm.64$).

Data collection

Data collection took place in the spring of 2015. At least one of the authors was always present for the data collection. For the estimations of physique and body composition, standard anthropometric techniques were used. When taking the required body dimensions, the prescriptions of the International Biological Program (Weiner and Lourie, 1969) were followed. Official and authenticated anthropological equipment (Sieber-Hegner anthropometer and Inbody 720 body composition analyzer) were used for analysis.

Polar RS400 heart rate monitors were used for monitoring the heart rate of each child during the different types of physical education lessons. The chest strap and watch were placed on the students at the beginning of class. During the lesson, the instructor would mark each time the activity in the class changed using the Polar watch. When the data was downloaded from the device, these markers were obtained. During data download, the specific content activities performed and also the heart rate for each activity was recorded.

Among the varied content of the PE activities, attention was given to those which are most frequent in Hungarian PE programs. The types of PE activities measured were gymnastics, athletics, ball games and mixed activities and games (other than ball games).

The heart rates were measured during the main part of the PE lessons. The warm up and the cool down were also measured, but those were not analyzed in this study. The main parts of these lessons lasted for 28-34 minutes (out of a 45-minute PE lesson).

For the evaluation of maximal heart rate, the 20m shuttle run test was used (Legert et al., 1988). Maximal heart rates and the heart rates measured during the different types of physical activities were chosen for analyses to reflect loads because.

Data analysis

Descriptive statistics (mean, standard deviation, minimum, maximum and coefficient of variation) were calculated for both genders. T-test of independent samples was also conducted to analyze the differences between boys and girls. The differences between the different types of physical education classes were analyzed by *F*-test after a one-way Analysis of Variance (ANOVA). In the case of significant *F* values, Scheffé's critical differences were also calculated. The maximum effect of random error was determined to be consistently below 5%. Statistica for Windows software (version 7.1, StatSoft Inc., Tulsa, OK 74104, USA, 2006) was used for the statistical analyses.

Ethical considerations

The study was ethically approved by the University's Ethical Committee. Ethical consent was signed by every student and also their parents and the anonymity of the participants was ensured.

Results

Table 1 presents the descriptive statistics of the anthropometric characteristics of the sample and Maximal heart rate (MHR). The standard deviations seem high in Weight and BMI and quite low in Height and MHR. The coefficients of variations are also high in both Weight (boys 26.48%, girls 23.56%) and BMI (boys 20.07%, girls 17.52%). There were no differences found between boys and girls in these parameters.

Table 1: Anthropometric parameters and Maximal heart rate (MHR) of sample ($N_{\text{boys}}=46$, $N_{\text{girls}}=63$)

	MEAN $\pm$ SD		Range		t-value	P
	Boys	Girls	Boys	Girls		
Height	152,39 $\pm$ 7,98	154,52 $\pm$ 8,23	136-170	133-171	-1,353	0,1788
Weight	45,09 $\pm$ 11,94	48,30 $\pm$ 11,38	28,5-89,4	27,3-76,4	-1,421	0,1580
BMI	19,23 $\pm$ 3,86	20,03 $\pm$ 3,51	14,8-31,9	14,1-28,3	-1,125	0,2627
MHR	202,33 $\pm$ 6,82	201,67 $\pm$ 7,18	179-216	183-210	0,4832	0,62987

The heart rates, as related to the different types of activities, are demonstrated in Table 2. There is a noticeable trend in the means and ranges of both boys' and girls' heart rates, but there were no differences between the genders among the different types of PE activities.

Table 2: Heart rate (HR) parameters of sample ($N_{\text{boys}}=46$, $N_{\text{girls}}=63$)

Type of activity	MEAN $\pm$ SD		Range		t-value	p
	Boys	Girls	Boys	Girls		
HR Gymnastics	148,52 $\pm$ 14,91	147,62 $\pm$ 14,57	133-170	133-175	0,3163	0,7523
HR Mixed activity	152,96 $\pm$ 7,67	154,86 $\pm$ 11,61	138-170	129-192	-0,966	0,3359
HR Ball games	156,33 $\pm$ 13,01	156,67 $\pm$ 12,87	134-172	130-176	-0,135	0,8922
HR Athletics	163,96 $\pm$ 15,76	163,75 $\pm$ 15,07	140-193	146-195	0,0706	0,9438
HR Games	165,11 $\pm$ 16,26	164,22 $\pm$ 17,54	126-200	128-198	0,2686	0,7887

Due to the fact that there were no statistically meaningful differences in the heart rate values between boys and girls, the comparative statistics among the activity types were analyzed altogether in the whole sample ($N=109$). The heart rate values according to type of PE activity are shown in Table 3.

The lowest heart rate value was recorded in gymnastics (148 beat $\cdot$ min $^{-1}$), and the highest value was detected in the games types of activities (164.60 beat $\cdot$ min $^{-1}$). The values of ball games and mixed activities produced quite similar results.

Table 3: Heart rate values by type of PE activity (N=109)

Type of activity	MEAN±SD	Range
HR Gymnastics	148,00±14,65	133-170
HR Mixed activity	154,06±10,14	129-192
HR Ball games	156,52±12,87	134-176
HR Athletics	163,83±15,29	140-195
HR Games	164,60±16,94	126-200

Table 4: P values in Post hoc analysis for types of PA as related to heart rates ($p < 0,05$)

Scheffe test, Variable: pyhsical activity. Probabilities for Post Hoc Tests Error: Between MS = 200,78, df = 540,00					
Types of Physical Activity	Gymnastics (M=148,00)	Mixed activities (M=154,06)	Ball games (M=156,52)	Athletics (M=163,83)	Games (M=164,60)
Gymnastics		0,042506	0,000655	0,000000	0,000000
Mixed activities	0,042506		0,799106	0,000042	0,000006
Ball games	0,000655	0,799106		0,006266	0,001587
Athletics	0,000000	0,000042	0,006266		0,997052
Games	0,000000	0,000006	0,001587	0,997052	

According to ANOVA, there were significant differences among the different types of PE classes as related to heart rates ($F=26.2606$; $p=0.000$) (Table 4). Conversely, the differences were not significant between athletics ($M=163.83$), games ($M=164.60$), ball games ($M=156.52$) and mixed activities (Mean=154.06).

Graph 1: Heart rate differences among the types of activities

Discussion and Conclusions

There were no gender differences in the anthropometric parameters. Also, the heart rate values produced no differences between boys and girls. The measurement took place before the 10-12 year-old students' growth and development accelerates. Therefore to examine heart rate values, genders were put together for analyses.

The detected heart rate values show that different activity types of PE produce different effects on children's bodies. This is an important piece of information because it allows for the analysis of heart rate responses associated with different types of physical education content performed during PE class. This result can be used as a resource for physical education teachers when planning and structuring their PE classes. It is important to highlight that skill development and fun is also part of PE, and so should be taken into consideration when teaching the curriculum.

Considering the main aim of PE is to help children develop their fitness level and different skills through different types of physical activities (Sallis & McKenzie, 1991), an analysis of the content planned and performed in the PE classes is suitable in meeting this goal. The wide range of reported heart rates demonstrates that the children are involved with a wide range of activity levels, which require them to work at different intensity levels. Physical activities that resulted in higher heart rates require a greater contribution and adaptation of the cardiovascular system, while activities that elicited a lower heart rate probably focus more on skill learning and acquisition.

The results demonstrate how the heart rate responses of different contents areas can be used as a tool when structuring classes and also inform teachers about how some of the performance values of different activities should be performed with each other. PE teachers with greater expertise have been shown to achieve greater improvement in children's physical fitness and skill acquisition than those who with less expertise (Starc & Strel, 2012).

The games portion of the class consistently produced the highest heart rates. The only activities to report a higher average heart rate were activities containing intensive running (e.g., athletics, games, ball games, etc.). When the main part of the class consisted of gymnastics or mixed activities, there were smaller heart rate values.

It is believed that the PE classes observed could be planned, developed and structured better in this aspect. Poorly structured PE classes have been shown to result in significantly less improvement and success (Starc & Strel, 2012). Fairclough & Stratton (2005) show that higher activity levels are associated with structured PE classes and result in more vigorous activity. If the PE classes analyzed were structured in such a way that the main part was made up of moderate to vigorous activity while the warm-up period was used to prepare the students for the given activity, the classes could prove more beneficial to the students in all aspects.

Future Research

This study served its purpose in analyzing heart rate values in different activities performed in physical education classes. However, there is an opportunity for further research in this area. One area which is important to examine is how much time children spend performing moderate to vigorous physical activity during PE classes. The authors recommend that students engage in moderate to vigorous physical activity for at least 50% of the class.

Another area for further research could be in how both skill acquisition and level of physical activity can be improved during PE class. It seems an important aspect of what type of PE lesson to be conducted because new tasks, refinement, application, fitness or mixed lessons have different emphases and, therefore, a varied outcome as related to performance and heart rate values (Ribeiro et al., 2010).

Conclusions and Limitations

The results which were found could serve as a useful and beneficial means for physical education teachers to plan and manage lessons. They provide them with information about heart rates associated with different types of content and activities to structure their classes along the main goals of PE.

One limitation of the study is the relatively small sample size. This time only one of the local university's cooperating schools was selected to participate in this study. For more generalizable results, a bigger sample would be needed. Also, a wider age range, specific goals of the PE lessons and the experience of the teachers could play an important role in terms of meaningful data.

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