ORIGINAL ARTICLE

Comparison of adolescents with different annual quota of Physical Education classes in anthropometric parameters, physical fitness tests, and grades achievements

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Abstract

This study compared different groups yearly based on the different annual quota of Physical Education (PE) classes in anthropometric parameters, physical fitness tests, and grades achievements. The study included adolescents from 14 to 18 years of age, at the Croatian Industrial School in Slavonski Brod. They were 225 participants in the 2015-2016 academic year, 213 in 2016-2017, 200 in 2017-2018, and 318 in 2017-2018. Groups were determined yearly by the different annual quota of PE classes (1 or 2 per week) in the teaching program. Anthropometric measures (body height, body weight, BMI), physical fitness tests (standing long jump, sit-ups, run for 1000 m), grade in the PE class, and the general achievement grade at the end of the school year were conducted. Data collected from the 2015-2016 until the 2018-2019 academic year. Analysis of variance (ANOVA) was used to assess the differences between groups for each school year separately. Results for sit-ups and run for 1000 m test in 2015-2016, BMI in 2018-2019, and the grade of PE class in 2017-2018 and 2018-2019 academic year indicated significant differences between groups ($p<0.05$). The groups with 2 PE classes per week were made better results compared to the groups with 1 PE class. Therefore, increasing the number of PE classes per week should be necessary for achieving the positive, beneficial, physical, and mental outcomes of Physical Education.

Keywords Physical Education • adolescents • academic achievement • anthropometry • fitness test.

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Introduction

Physical Education (PE) is the only subject in the school curriculum which concentrates on adolescent's physical, mental, and social development together. Moreover, it stimulates them for a healthy lifestyle, in which physical activity (PA), besides nutrition, has a primary key.

Participation in PA is essential for adolescent's growth and development. In addition, it has been demonstrated that PA maintain and improve health (Donnelly et al., 2016), muscular and cardiorespiratory fitness (World Health Organization, 2018a), and mental wellbeing (Grgantov & Miletić, 2016; Triaca, Frio, & França, 2019; Vedøy, Sigmund, Hege, Knut, & Thurston, 2020). Specifically, having PE classes is associated with higher PA (Silva, Chaput, & Tremblay, 2019), because children who engaged will tend to be more active throughout the day; and have lower sedentary behavior (Silva et al., 2018). PA in scho-

ol presents a significant component of the adolescents daily PA (Frömel, Svozil, Chmelík, Jakubec, & Groffik, 2016; Groffik, Mitáš, Jakubec, Svozil, & Frömel, 2020). It is also important to remain that PA in childhood is a great predictor for activity level in adulthood (Grgantov & Miletić, 2016).

Despite the numerous health benefits, adolescent's PA levels have been declining in the past decade, and the majority do not meet the recommended PA guidelines (Guthold, Stevens, Riley, & Bull, 2020). Furthermore, it is alarming how the unhealthy lifestyle habits like sedentary behaviors increased (80% of adolescents are insufficiently physically inactive), which can be related with a risk factor for cardiovascular diseases, cancer, diabetes (World Health Organization, 2018a), obesity (Batzios, Provatidou, Christoforidis, Sidiropoulos, & Cassimos, 2020) and other risks for health (Guthold et al., 2020). Accordingly, it remains an open question why PE classes are still underestimated in the school curriculum and has a lower importance and value than other subjects. Furthermore, we can ask for the required type, amount, and intensity of PA at PE classes to effect on adolescent's dimensions of their psychosomatic status.

Evidence indicates a marginalization of PE in schools. The idea that PE only takes adolescents time from increasing school performance may explain the low allocation of PE compared to the other subjects (Marques, Gómez, Martins, Catunda, & Sarmento, 2017). In contrast to that belief, there is a growing literature suggesting that PA has a beneficial effect on learning abilities such as academic achievement (Marques et al., 2017), grade in PE (Vedøy et al., 2020), and cognition (Donnelly et al., 2016).

Generally, two hours of PE in Croatia have been present for more than a century (Findak, 2016). Ever since the responsible Ministry implemented these measures, there have been numerous polemics regarding these restrictions. There is no reason to believe that a reduced number of classes from 2 to 1 are adequate for adolescence, referring to the European Union documents about the mandatory PE classes (Findak, 2016). Increasing the number of PE classes is necessary for children's health and ensuring the basic need for movement (Petrić, 2016) in schools.

Therefore, this study aimed to compare yearly different groups for evaluating the influence of different annual quota of PE classes at adolescents. We hypothesized that there are differences between programs with different annual quota of PE classes, measured in anthropometric parameters, physical fitness tests, and grades achievements and also, that the increased number of PE classes would have a positive, better impact on adolescents in the measured parameters.

Method

This study used a cross-sectional design yearly and included adolescents ranging from 14 to 18 years of age at the Croatians Industrial School in Slavonski Brod. Table 1 shows the study population, which included 225 participants in the 2015-2016 academic year, 213 in 2016-2017, 200 in 2017-2018, and 318 in 2017-2018. Adolescents were classified annually in two types of groups based on the weekly quota of PE classes (1 or 2) in the teaching programs, as shown in Table 2. Programs are regulated by the general program specified at the documents of the Ministry of Science, Education, and Sports of the Republic of Croatia. The aim and tasks are identical from first to third grade, for both classes with 35 and 70 PE annual quota, but the teaching units and topics are significantly reduced in the classes with fewer PE classes per week.

Anthropometric characteristics were estimated by body height (BH), body weight (BW) and body mass index (BMI). The measurements were conducted with standard and calibrated instruments: weight scale with kg precision for BW, and anthropometer with 1 mm precision for BH. BMI (kg/m2) was calculated as BW by squared with BH. These measurements were conducted following the IBP standard.

Table 1. Basics characteristics of the sample

Academic year	Weekly PE classes							
	1				2			
	Sample		Age		Sample		Age	
	n	%	M	SD	n	%	M	SD
2015-2016	120	53.3	14.92	1.65	105	46.7	15.25	1.62
2016-2017	132	62.0	14.85	2.11	81	38.0	15.93	1.96
2017-2018	103	51.5	15.17	1.87	97	48.5	15.54	1.74
2018-2019	172	54.0	15.24	1.96	146	46.0	15.56	1.92

Table 2. Number of measured courses with different quote of PE classes per week

Academic year	Weekly PE classes					
	1			2		
	Number and type of programs (courses)		Number of adolescents	Number and type of programs (courses)		Number of adolescents
2015-2016	7	1.C, 1.F, 1.G, 1.H, 2.C, 2.F, 2.J	120	5	1.B, 1.E, 2.A, 2.D, 2.K	105
2016-2017	8	1.C, 1.F, 1.G, 1.H, 1.J, 2.C, 2.F, 2.J	132	4	1.I, 2.A, 2.K, 3.A	81
2017-2018	6	1.C, 1.F, 1.H, 2.C, 2.J, 3.C	103	5	1.C, 1.F, 1.H, 2.C, 2.J, 3.C	97
2018-2019	6	1.G, 1.J, 2.C, 2.F, 2.G, 2.H	172	5	1.D, 2.A, 2.B, 2.E, 2.I	146

Legend: A Metal fabricator B; CNC operator; C Auto mechatronics; D Driver; E Technical designer; F Photographer, Car bodyworker; G Plumber, Gas mechanic, Air conditioning and heating mechanic; H Electrician, Car electrician; I Electronic technician, Electro-mechanic, Telecommunications technician; J Car mechanic, Car bodyworker; K Metal fabricator

Physical fitness was tested by the following tests: standing long jump (SLJ), sit-ups (SU), and run 1000 m (R1000). These tests were conducted during PE classes according to the teaching program. Lower body muscular strength (explosive power) was assessed by the standing long jump test from the EUROFIT fitness test battery. Participants had to jump as far as possible with their feet together and remaining upright. Distance was measured by centimeter tape with 1 cm precision (Ortega et al., 2015). Abdominal muscular endurance and strength were assessed by sit-ups test. The test was scored by the maximum number of sit-ups from a lying position (Bianco et al., 2015). Cardiorespiratory fitness was assessed by the run for a 1000-meter test. Subjects had to run a 1000 m distance, from the start to the finish line. Their time was measured with a digital watch calibrated with 1-second precision (Sammito, Gundlach, & Böckelmann, 2016).

Grade for PE class and the general achievement grade are taken from the official entries of classes grade books.

Data were collected at the beginning of every school year in September and October (except for the grades). The same PE teacher carried out all the measuring through regular classes of PE.

Descriptive characteristics were calculated for all variables. ANOVA was used to evaluate the differences between groups. The significance level was set at $p<0.05$. All analyses were conducted using SPSS (Statistical Package for the Social Sciences 25.0).

Results

Descriptive statistics for the anthropometric measures, physical fitness tests, grades of PE class, and general achievement grades at the end of the school year presented in Table 3 for the period between 2015-2016 and 2018-2019 academic year. Anthropometric measures for 2015-2016 left out because of technical reasons; also, the general achievement grade for 2018-2019 was not included due to the earlier end of the research.

Table 3. Differences between groups according to anthropometric measures, physical fitness tests, grades by academic years from 2015-2016 until 2018-2019

	1 class per week	2 class per week		
Variable	M±SD	M±SD	F	p
2015/16				
Standing long jump (cm)	195.11±28.66	200.97±24.42	2.64	0.11
Sit-ups (n/60s)	44.11±7.82	46.48±7.21	5.29	0.02
Run for 1000 m (s)	308.72±57.17	285.31±45.44	10.72	0.01
Grades in general achievement (out of 5.00)	3.33±0.83	3.26±0.79	0.33	0.57
Grades in PE (out of 5.00)	4.40±0.72	4.22±0.84	2.88	0.09
2016/17				
Body height (mm)	1747.61±75.53	1759.73±84.00	0.90	0.34
Body weight (kg)	66.41±15.16	68.88±18.21	0.89	0.35
BMI (kg/m^2)	21.63±4.17	22.04±4.69	0.33	0.56
Standing long jump (cm)	205.87±146.25	198.41±28.05	0.20	0.65
Sit-ups (n/60s)	43.42±8.26	44.96±6.48	1.99	0.16
Run for 1000 m (s)	302.75±58.62	288.40±44.14	3.45	0.07
Grades in general achievement (out of 5.00)	3.39±0.66	3.38±0.72	0.01	0.95
Grades in PE (out of 5.00)	4.22±0.83	4.30±0.85	0.50	0.48
2017/18				
Body height (mm)	1762.00±66.77	1762.59±78.68	0.01	0.96
Body weight (kg)	68.40±17.16	67.79±16.86	0.06	0.82
BMI (kg/m^2)	22.04±4.82	21.57±4.40	0.42	0.52
Standing long jump (cm)	197.53±25.61	199.55±29.23	0.27	0.61
Sit-ups (n/60s)	45.30±7.83	45.39±8.13	0.01	0.94
Run for 1000 m (s)	298.54±45.19	286.28±47.39	3.09	0.08
Grades in general achievement (out of 5.00)	3.59±0.68	3.71±0.77	1.29	0.26
Grades in PE (out of 5.00)	4.23±0.87	4.47±0.74	4.24	0.04
2018/19				
Body height (mm)	1774.26±62.56	1781.98±61.34	0.52	0.47
Body weight (kg)	70.90±14.17	67.55±15.01	2.94	0.09
BMI (kg/m^2)	22.50±4.18	21.26±4.61	4.33	0.04
Standing long jump (cm)	195.33±26.73	201.90±23.66	2.90	0.09
Sit-ups (n/60s)	44.90±7.06	46.95±7.45	3.24	0.07
Run for 1000 m (s)	297.33±49.81	285.97±36.41	2.45	0.12
Grades in PE (out of 5.00)	4.07±0.83	4.46±0.77	9.91	0.01

The results of ANOVA ($p<0.05$) also are shown in Table 3. There were significant differences between groups in anthropometric measure: BMI (2018-2019); physical fitness tests: SU (2015-2016), R1000 (2015-2016); and in GPE (2017-2018, 2018-2019); where groups with 2 PE classes performed better. In summary, PE with a higher weekly number, had a better, positive impact on anthropometric measures, physical fitness tests, and academic achievement.

Also, it is interesting to note from Table 3 that in every academic year group with 2 PE classes per week had better results for physical fitness tests (SLJ, SU, R1000) except for SLJ in 2016-2017; and also, for BMI in 2017-2018 and 2018-2019. Furthermore, differences between groups in SLJ and SU were marginally close to be significant in 2018-2019. From Table 3, we can see that there are no statistically significant differences in the variables GGA between groups over the time, although, in 2015-2016 and 2016-2017, it was slightly better for groups with 1 PE class.

Discussion

Our study compared adolescents for evaluating the influence of different annual quota of PE classes through anthropometric measures, physical fitness tests, and academic achievement. We hypothesized that there are differences between programs with different weekly (1 and 2) and yearly (35 and 70) quota of PE classes. Furthermore, the higher number of PE classes would have a positive, better impact on adolescents in the measured parameters. The results demonstrated that the increased number of PE classes weekly could be related to better results at anthropometric measures (BMI), physical fitness tests (SU, R1000), and academic achievements (GPE). That can be another indicator to regulate the PE system, i.e., to increase the weekly number of PE classes at least for 3, besides the Europen document (Schmidt, 2007).

The necessary time for PE classes' benefits is underestimated with reduced PE classes (1 and 2 class per week), like in this Croatian vocational school. PE is frequently allocated less time than other subjects in the curriculum and canceled more often (Ken, 2008). Suggestions and propositions (Findak, 2016), as well as the European Union documents referring to the amount of PE in schools of at least 3 per week, should implement to increase the effects of the aims of this educational area. In contrast to the propositions, there is usually a gap between the policy and practice. Groffik et al. (2020) also support the increasing number of weekly PE. Their research examined two different education systems (Czech Republic with 2, and Poland with 4 PE classes per week), and the Polish system was associated with increased daily vigorous PA among adolescents.

Group with 2 PE classes in the last year of the observation had significantly lower values in BMI. So, there was a negative trend during the research for this anthropometric measure. Not adequate, high BMI potentially leads to a worldwide leading health problem, called obesity (Batzios et al., 2020).

Children and adolescents are less fit nowadays than the earlier generations, caused by less PA (Schmidt, 2007). The unhealthy foods (high in fat and sugar) combined with physical inactivity caused a rise in overweight and obesity (Mura et al., 2015). Discourages, average results from high school students during five years of anthropometric monitoring indicate that negative trend as a forecast for the next generation in assessed anthropological characteristics. There is no doubt that these results are certainly contributed in part by a short duration of PE classes (90 minutes or less) (Petrić, 2016), whereas adolescents do not have that much of opportunity for PA. On the other hand, some PA is even better than none (World Health Organization, 2018a).

Differences in physical fitness tests are only significant at the baseline for SU (2016) and R1000 (2016). The difference in SU values can be attributed to the concept of the teaching program in which there was a more significant emphasis on the development of repetitive power. SLJ does not vary among the two groups, which was expected if we know that the explosive power is mostly innate.

As well known, the school has an essential role in the promotion of PA (World Health Organization, 2018b), and for many children, PE is the only way to engage in organized PA opportunities during the school day (Petrić, 2016; Piekarz-Porter et al., 2020). The main problem is that more time for PE in the curriculum does not necessarily increase moderate to vigorous PA (MVPA) (Smith, Monnat, & Lounsbery, 2015). For adequate promotion and contribution to PA, PE classes must include a content that fit interest all students (World Health Organization, 2018b) to be organized in a more fun for girls, and more exercise-related forms for boys (Kuśnierz, Zmaczyńska-Witek, & Rogowska, 2020), with a plan of delivering moderate and vigorous goals in mind (Fairclough & Stratton, 2004); to achieve the daily recommendation of 60 minutes of MVPA, and the 150 minutes of

moderate or 75 minutes of vigorous PA through the week (World Health Organization, 2018a). Moreover, PA may be influenced by the environmental factors (class size, location, or lesson contexts) (Skala, Springer, Sharma, Hoelscher, & Kelder, 2012) and the state requirements of PE (Lin et al., 2020).

The difference between weekly and annual quota of PE classes can be observed through outcomes of education. Also, there is no reason to believe that physical fitness is not related to academic achievement, whereas physically active adolescents perform better academically (Singh, Uijtdewilligen, Twisk, Mechelen, & Chinapaw, 2012) contrary with inactive individuals. Our results demonstrate the positive impact of increased PE classes on academic achievement because groups with 2 PE classes per week had a significant improvement in GPE (2017, 2018), and positive trend from the baseline. Better PE grades can be related to increased opportunities to acquire the necessary teaching program compared to a group with lower PE weekly quota.

As mentioned earlier, the belief that spending time on PA during school hours inhibits changes to be successful as a student. Various studies demonstrated a contradictory fact that there is a positive correlation between PA and academic achievement (Howie & Pate, 2012; Singh, Uijtdewilligen, Twisk, Van Mechelen, & Chinapaw, 2012), brain function (cognition) and fitness (Donnelly et al., 2016). Similarly, to previous studies, Kim & So (2012) investigated the association between school performance and attendance for < or ≥ than 3 PE classes per week. Their results showed that attending ≥3 PE classes per week improved school performance and academic achievement in Korean adolescent students, and it was highly associated with reading, speaking, writing, and understanding.

If all the previous things are considered, it can conclude that PE classes must be under discussion in the school curriculum. Furthermore, the limitations of this study are also worth considering. First, it is restricted to only a single geographical area. Second, this study has monitored a limited number of adolescents. Third, the differences were determined only in one way of testing. Fourth, the difference between 1 class per week and 2 class per week is not big enough for the transformation influence to be generally significant. Fifth, it has a cross-sectional design. Future studies should include a larger sample of examinees from different high schools involving courses with 3 PE classes and including other, standardized methods for better highlighting the importance and the positive outcomes of PE classes. Studies should have a longitudinal design.

The results of this study generally indicate differences between groups defined by the number of PE classes per week (1 and 2) in the observed parameters at the Industrial School in Slavonski Brod. PE with a higher weekly number, had a better, positive impact on adolescents measured through anthropometric measures, physical fitness tests, and academic achievement. Therefore, schools (like this vocational school) with a reduced number of PE classes, require changes in its curriculum, i.e., to increase the quota of PE classes to achieve the necessary positive, beneficial physical and mental effects of PE.

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