EFFECTS OF PHYSICAL EDUCATION CLASSES ON BODY COMPOSITION AND MUSCULAR FITNESS IN PRIMARY SCHOOL CHILDREN

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Abstract

It is well known that regular physical activity can induce changes in body composition and overall body power of skeletal muscles. Aim of the study was to evaluate effects of regular physical education classes on changes in body composition and muscular fitness in primary school children. Overall 38 school age male and female children (age: 13± 0.34 years; weight: 49.74±9.07 kg; height: 157±10.36 cm) performed regular physical education classes for 90 min per week (for 8 weeks). Results suggest that significant change occurred in body weight (increase $p<0.001$), fat free mass (increase $p<0.05$) jump height and flight time ($p<0.001$). Male subjects significantly achieved better jump height results compared the female participants ($p<0001$). Regular physical education classes can cause increase in muscle mass and lower limb muscular power performance. It is unclear whether this occur due to biological maturation or under the influence of regular physical activity.

Key words*: school, sport, children, jump, BMI*

Introduction

Physical education classes are recommended for all age children due to its proven health related benefits through physical activity (Sallis et al., 1999). Since 1987 there was an official propaganda for increasing children participation in physical activity, especially in physical education classes by raising awareness and initiating culture of healthy living (Pfister, 2003). However, since 1996 there was an observation that sudden decay of physical education is present (Shephard, J., 1997). Physical activity and programs are related to increased intellectual capacity since exercise can stimulate present and initiate development of new neural connections (Sallis et al., 1999). Physical education-based activity is associated with selected advantages in cognitive functions such as math, acuity and reaction time (Bouchard et al., 1994; Pellegrini & Smith, 1998). Motivational aspect of physical education classes is important and related to high-quality motivated engagement in physical activity which is an avenue for empirical and applied investigation (Standage & Ryan, 2012).

Changes in muscular fitness and body composition are evident in school age population and can be present due maturity differences among children of same age. This is caused by different rate of biological development in puberty age. Skeletal age, chronological age, height, weight, and their interactions in explaining motor fitness components are reported in numerous of studies (Beunen et al., 1981). Evidence from study of Buenen et al. (1981) suggested that chronological age combined with height was related to trunk strength. Most sensitive age where difference in anthropometric measures and static strength is present was for children in range of 14-15 years.

Participation in physical activity and physical education classes has motor and health related components (Koutedakis & Bouziotas, 2003; Likić et al., 2018) and can affect levels of strength and body morphology (Ortega et al., 2008; Ćirić et al. 2015). Physical education classes can aid the development of motor abilities and create great base-ground for overall health including cardiovascular fitness, metabolic functions and muscle fitness. Low physical activity is related to various risk factors and low aerobic fitness. Physical education classes in school provide the best opportunity to fulfil activity needs for all children. As recommended by American College of Sports Medicine (ASCM) at least 180 minutes of aerobic activity is necessary to cause changes in level of body fat so it is interesting to see weather physical education classes can cause changes in the level of body fat. Strong and associates (2005) have determined that physical education classes can improve muscular strength. However, some studies reported that level of physical activity in physical education classes is not sufficient to promote and develop optimal health structures (Armstrong, N., 1997; Koutedakis & Bouziotas, 2003).

Present study aimed to investigate changes in body composition and muscular fitness influenced by physical education classes in primary school according to curriculum of Canton Sarajevo – Bosnia and Herzegovina. We assumed that changes will be present due to: i) intensive physical effort in

physical education classes ii) biological development of the children in puberty period. Secondly, we aimed to distinguish and explain changes caused by physical efforts and changes occurred as effects of physical activities.

Methods

Study design

Study was intended to investigate the short-term effects of physical education classes. Primary school children in Canton Sarajevo (Bosnia and Herzegovina) are obliged to attend regular classes of physical education twice a week for 45 minutes on separate days (in total 90 minutes per week). Prospective study designed featured initial testing of children follow up by 8 weeks of regular classes and final testing. Two physical education teachers were in charged for conducting activities which were planed annually. Activities included variety of games with basic elements of basketball, volleyball and football along with basic sport activities such as running jumping and throwing. Each physical education class was conducted according to prepared contents and by three experienced professors of physical education with research background as part of the investigation team. Observation and notation were used to objectify each class activities. Notation included written notes on attendance, content and organization. Effects of the program was evaluated for 8 weeks in the middle of first school semester. During each class teachers participated in the activities and were assisted in planning their personal program of regular physical activity. Classes were held in school facility attended for physical education classes. Prior to the study, presentation of study design and procedures were explained to children's legal guardians. Legal guardians signed written consent allowing participation in the study, with possibility to withdraw at any time. A questionnaire was used to asses' additional level of physical activity such as training of specific sport or recreational activities in nature. All the procedures were done by recommendation of the Helsinki committee and ethical standards of University of Sarajevo ethical commission.

Participants

All the subject (both male and female) attended seventh and eighth grade of local primary school. Primary school children, in overall 38 of them (age: 13±0.34 years; weight: 49.74±9.07 kg; height: 157±10.36 cm) participated in present study. Female share was 23 (age:13.1±0.54 years; weight: 50.39±8.58 kg; height: 158.17±6.45 cm) compared to 15 male (age: 13±0.1 years; weight: 48.7± kg; height:157.3±8.11 cm)(Table 1). During the preparation of study specific observations, such as gender, type of extra physical activity and satisfaction during physical education classes. For participation inclusion criteria was set: i) regular attendance of physical education classes ii) no neuromuscular or any other conditions which could be dangerous and worse by physical activity, iii) attendance rate of at least 90% of classes, iv) no more than 210 minutes of intense additional physical activity per week.

Fitness and anthropometric measures

Muscular fitness was expressed as flight time and jump height performed using squat jump. Squat jump was performed on specifically designed mat (Just Jump System by Perform better, USA) which was portable and easy to use and requires no external power supply. Just Jump Mat Plyometric System is designed for determining explosive power and vertical jump height which is related to muscular fitness and the level of leg power along with functionality of central nervous system (Enoka D, 1996). Just jump system is reliable and valid when it comes to measuring jump performance (Leard et al, 2007). Squat jump test procedure featured that subject stands on the jump mat with his feet firmly to the ground. Subject slowly squats to the angle of 90 degrees with his arms placed above hip level. After taking squat position, it makes voluntary maximal jump (figure 1). Test was performed three times in a row and best result was recorded. Controller with small display was connected to jumping mat and immediately after performed jump flight time and jump height were showed and recorded in previously prepared sheet.

Body composition was measured using Tanita scale (Tanita BC-418, Tokyo Japan). Tanita is bioelectric scale which uses bioelectric impedance to measure the body conductivity trough hydrated muscle. When it passes to fat tissue it makes resistance This resistance, known as impedance, is measured and input into scientifically validated Tanita equations to calculate body composition measurements. Depending on the monitor, body composition measurements are provided in under 20 seconds. All the subjects performed same procedure. After overnight fasting a 200 ml of water was digested prior to scaling. Wearing only underwear subjects were stand barefoot on Tanita scale. Results were displayed and recorded in matrix sheet.

Measurement procedure

All subjects were measured prior to the physical education class. Measurement took place in school gym using same procedures as described during initial and final measurement. Body composition was measured in the morning (around 8:00 – 8:30 am local time) after which squat jump test was performed for three consecutive times. Experienced measurers noted flight duration and jump height for each individual jump using the best attempted in the analysis. Data matrix was created for body composition and muscular power after testing.

Simultaneously, well trained person took notes about age, gender and the level of activity per week.

Complete procedure lasted about 40 minutes.

Figure 1 Squat jump test performed as measure of muscle power

Statistical analysis

Analysis was performed using SPSS (IBM Corp. NY). Intention to treat was used when necessary. All data were checked for accuracy and normality of distribution using Kolmogorov-Smirnov test. To determine difference in performance of muscular fitness and body composition a paired sample t test was used. For determining difference across 8 weeks of physical education classes program and the possible differences in adaptation of male and female we used factorial analysis of variance (ANOVA time*gender). Partial eta squared was used to determine the level of the effects as small, medium, or large if η^2 is 0.01, 0.06, and 0.14 by variance explained (Cohen, 1998). Results are presented as mean and standard deviations in tables and graphs. Statistical significance was set at conventional 95%.

Results

All data were normally distributed and were suitable for further analysis. As showed in Table 3 significant differences after 8 weeks of physical education classes were observed for Flight duration (higher hang time by 0.016±0.03 sec. at final measurement; 95% CI (-0.007; -3.86); p<0.001), Jump height (higher jump height by 2.10±3.72 cm at final measurement; 95% CI (-0.87; -3.48); p<0.001), Body mass (lower body mass by 0.83±0.94 kg at final measurement; 95% CI (-0.53; -5.49); p<0.001), Fat free mass (higher amount of fat by 0.51±1.22 kg at final measurement; 95% CI (-0.11; -2.59); p<0.05) and total body water (higher amount of water by 0.37±0.89 kg at final measurement; 95% CI (-0.08; -2.58); p<0.05).

Significant change between males and females during 8 weeks of physical education classes (Table 3 and Figure 1) was observed for the Jump height (F=3.973; p=0.003; η^2 =0.13) only. No other significant differences between gender during the 8 weeks were noted.

Table 1 Sample specifics for gender, age, weight and height

	Age	Weight	Height
Male	13± 0.1	48.75± 9.86	157.3± 8.11
Female	13.1± 0.54	50.39± 8.58	158.17± 6.45

Table 2 Changes for muscular fitness and body composition after 8 weeks of physical education classes

	Initial	Final	Difference in mean	±95% CI
Flight duration (s)	0.52± 0.05	0.53 ± 0.06	0.016 ± 0.03**	(-0.007; -3.86)
Jump height (cm)	33.73 ± 6.81	35.83± 7.42	2.10± 3.72**	(-0.87; -3.48)
Body height (cm)	157± 8.20	158 ± 8.22	0.75± 1.0	(0.45: 1.7)
Body mass (kg)	49.33 ± 9.17	50.16± 9.09	-0.83± 0.94**	(-0.53; -5.49)
Fat mass (%)	20.02 ± 7.37	20.38± 7.36	0.36± 2.16	(0.35; -1.03)
Fat mass (kg)	10.26 ± 5.37	10.58± 5.39	0.32± 1.09	(0.03; -1.84)
Fat free mass (kg)	39.07 ± 5.81	39.58± 5.79	0.51± 1.22*	(-0.11; -2.59)
Muscle mass (kg)	37.05 ± 5.54	37.55± 5.51	0.50± 1.16	(-0.12; -2.65)
Total body water (kg)	28.60 ± 4.25	28.97± 4.24	0.37± 0.89*	(-0.08; -2.58)
Total body water (%)	58.56 ± 5.38	58.31± 5.37	-0.26± 1.56	(0.8; 1.01)
Body mass index (kg/m^2)	19.75 ± 2.90	19.90± 2.85	0.14± 0.83	(0.1; -1.08)

*** significant at p<0.001; * significant at p<0.05; ±95% CI – lower and upper confidence intervals*

Table 3 Gender differences and effects of school physical education program

			Gender *time interaction
	Gender	Mean ± SD	η^2
Flight duration (s)	Male	0.54± 0.054	0.008
	Female	0.52± 0.055	
Jump height (cm)	Male	36.66± 7.45	0.13**
	Female	33.55± 6.76	
Body height (cm)	Male	157.13± 10.36	0.001
	Female	158.17± 6.45	
Body mass (kg)	Male	48.75± 9.86	0.002
	Female	50.39± 8.58	
Fat mass (%)	Male	15.59± 6.44¥¥	0.002
	Female	23.21± 6.25	
Fat mass (kg)	Male	7.85± 4.33	0.004
	Female	12.09± 5.32	
Fat free mass (kg)	Male	40.90± 7.41	0.001
	Female	38.30± 4.16	
Muscle mass (kg)	Male	38.78± 7.08	0.003
	Female	36.34± 3.95	
Total body water (kg)	Male	29.94± 5.42	0.002
	Female	28.04± 3.05	
Total body water (%)	Male	61.82± 4.66	0.006
	Female	56.23± 4.58	
Body mass index (kg/m)	Male	19.61± 3.00	0.005
	Female	19.96± 2.78	

** significantly different at 95% for gender*time interaction;
¥¥ significantly different at 95% to female
ηp^2 – partial eta squared

Discussion

The main aim of this study was to investigate changes in body composition and muscular fitness influenced by physical education classes in primary school according to curricula of Canton Sarajevo – Bosnia and Herzegovina. Preliminary outcome was that jump height and flight time during broad jump significantly increased compared before classes of physical education. Secondary, overall body mass and fat free mass was increased with significant difference between man and female participants. Outcomes of the study suggests that physical education classes tend to improve lower limb power and muscle gain.

Many studies (Gutin, B et al. 1994; Caprio, S et al. 1996; Daniels, S et al. 1999; Owens, S et al. 2000) have confirmed the fact that children and young people who are not involved in physical activity and who have increased body fat (% FM) have a high risk of cardiovascular diseases. Therefore, it is very important to examine existing ways and also to find new appropriate ways of preventing these diseases.

The results of this study point to the fact that the existing classes of physical and health education positively affect the body composition and muscular fitness in primary school age children. Janssen, I., & LeBlanc, A. G. (2010) in their review study state that the improvement of the body composition and, consequently, of health, depends of a large extent on physical activity. By inspecting the obtained results of this research, we can see that all variables have improved except for TBW% (Total Body Water) variable. Positive changes in body composition including BMI, Fat%, Body mass, Fat free mass, Total body water confirm the fact that physical activity in schools plays a major role as the main center of strategy and the promotion of the importance of preventing obesity in school age children (Harris, K. C et al. 2009). Although the (Summerbell, C. D. 2005) study suggests that physical activity in the school does not show significant changes in the improvement of body composition, this study showed quantitative statistically significant changes in their improvement.

Squat jump is used to assess the explosive power of the lower extremities as one of the basic tests for assessing abilities in various sports (Klavora, P. 2000), but also when it comes to students in schools (Clutch, D. 1983). With this research it became clear that high-quality and well-planned work positively
influenced the improvement of muscular fitness on children, as in both variables (flight duration and jump height) were statistically significant changes. When we look at the normative values of Jump height research (Taylor, MJ 2010 (AS 32.4 + SD 6.5), it can be seen that respondents in this study achieved an average of more values (AS 35.83 ± SD 7.42) in the
final measurement, which additionally points to the fact that the program of physical activity has a positive impact on the improvement of these values. The limitations of this study are reflected in the inability to measure the physiological and training

load on the class of physical education in order to determine the adequacy of stimulation for the development of certain motor skills.

Present study had several weaknesses: a) study should compare changes based on the different quantity of overall physical activity during week, b) study should compare changes between highly active kids who attending classes and those who do not attend physical education class.

Future research should evaluate the correlation between the development of motor skills versus the chronological and biological age of children born due to physical activity in the classes of physical education. Additionally, it should scientifically evaluate the PE classes effects differentiated by the intensity of the class contents and in combination with different additional sports activities.

Conclusion

Research has shown that perceptual motor skills are improving in children who have an increased physical activity. Physical education classes have significantly different content compared to everyday physical activity and sports in which are children involved. Physical activity at physical education classes can greatly improve the health status regardless of age. Research has shown that body mass in students is on the rise regardless of increased physical activity and is reflected in the increase in muscle mass and the reduction in subcutaneous fatty tissue. It is also important to point out that the power measured by the height of the jump has increased significantly among male students compared to girls.

The results of this study suggest that increased body mass is conditioned by biological growth with pronounced variability in girls. Throughout the ripening period, physical performance grows, and it is necessary to determine precisely whether they occur as a result of increased physical activity or the process of growing up.

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SATOVI TJELESNOG I ZDRAVSTVENOG ODGOJA POZITIVNO UTIČU NA SASTAV TIJELA I MIŠIĆNI FITNES KOD DJECE ŠKOLSKOG UZRASTA

Sažetak

Dobro je poznato da redovna tjelesna aktivnost može izazvati promjene u sastavu tijela i ukupnoj snazi tijela. Cilj istraživanja bio je procijeniti učinke redovnih tjelovježbi na promjene u sastavu tijela i mišićni fitnes kod djece školskog uzrasta. Istraživanje je sveukupno obuhvatilo 38 dječaka i djevojčica (13 ± 0,34 godina, težina: 49,74 ± 9,07 kg, visina: 157 ± 10,36 cm) koji su osam tjedana obavljali redovnu nastavu tjelesnog i zdravstvenog odgoja po 90 minuta tjedno. Rezultati sugeriraju da se značajna promjena dogodila u tjelesnoj težini (povećanje p <0,001), masnoća bez masti (povećanje p <0,05), visini skoka i vremenu leta (p <0,001). Muški ispitanici značajno su postigli bolje rezultate skoka u usporedbi sa ženskim sudionicima (p <0001). Redovni satovi tjelesnog i zdravstvenog odgoja mogu uzrokovati povećanje mišićne mase i snage mišića donjih ekstremiteta. Nije jasno je li to došlo zbog biološkog sazrijevanja ili pod utjecajem redovne tjelesne aktivnosti.

Ključne riječi: *škola, djeca, sport, skok, BMI*

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