EFFECTS OF POLYGON TRAINING ON AEROBIC CAPACITY VO_2MAX IN MALE CHILDREN

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Abstract
Many children become less active as they age which increases their risk of developing of chronic conditions. Traditional forms of physical activity may not be optimal for them. There is a need for more attractive form of training to try and increase physical activity levels and improve the fitness of children. The aim of this study was to determine the effects of performing polygon training on measures of functional capabilities. The subjects (13 years +/- 6 months) old boys were randomly allocated to one of two groups: trampoline training group (EG, N=33) and control group (CG, N=29) to examine effects of 15-week polygon training (1 time per week). Results of study shows that additional programme based on overcoming polygons in combination wih regural classes of physical education gives positive effects on improving of functional capabilities VO, max. Polygon training is an effective intervention to improve functional capabilities.
Key words: *functional capabilities, effects of training, VO, max*

INTRODUCTION

Physical education (PE) in schools as an integral part of the educational process has basic meaning for harmonius development of all psychosomatic characterictics of students and their adaption to contemporary living and working conditions. Special attention should be paid to the principles concerning the transformation of the antropological status of elementary school student through targeted motor activities. The education process requires maximum adaptation to the needs, abilities and interests of the child (pupil). Teaching is active, flexible process whose effectiveness depends on the factors mentioned above and on the motivation of students to exercise. (Lorger, 2009).

The development of motor and functional abilities is possible to realize through the teaching process of physical education(PE), which would be carried out by planning, rationally organizing and hence it should be first planned and programmed, and then realized and controlled. Testing of certain motor and functional abilities (Gredelj et al., 1975) and comparing them with the existing norms provides us with a better overview of the abilities of the entire group (class). Like any teaching or training process, when performed for a long time and systematically, and with a supraliminal load volume, with an emphasis on the "principle of individualization", produces quantitative changes in terms of different anthropological characteristics of the entities. Additional engagement in sports activities increases the results of the basic goal of physical education. Actually in the first years of sports preparation overall motor development should be included that is mostly provided by doing gymnastics and acrobatics (Mujanović, Atiković & Nožinović Mujanović, 2014).

There is a question is it more efficient to come to classes two or three times in a week. Will the classes conducted on daily basis give even better results? The European Organization for Physical and Health Culture (EUPEA) recommends an increase in the number of hours of physical and health education due to an increasingly frequent sedentary lifestyle. In the early years of education (pre-school and elementary school), daily physical exercise is recommended, and later in the subject teaching and secondary school it is recommended to take three hours a week (180 min), and it's advisable to take an extra hour of training that doesn't have to be a part of curriculum. (Hardman, 2008).

According to the etymology, the word "polygon" belongs to the military dictionary, and it represents a specially designed, equipped and programmed indoor and outdoor area, with the task of forming and improving certain motor skills and abilities (Antunović, 2017). In the process of physical exercise, polygons are used in order to form certain motor activities of complex character. There are more training positions in order to perform the same motoric activity on different gadgets or in different combinatons. The tasks of the polygon are performed without a pause, where the students constantly move from task to task by overcoming them faster or slower. Use of the polygon is practically unlimited in terms of gender, age, student

status, ability, level of knowledge and achievement, and regardless of the place of work, season, working conditions, etc. It can be applied during the whole year.

During the process of setting a polygon, we must pay attention to the following criteria: a) setting of a polygon can be in the form of semicircles, circles, squares, rectangles, straight lines, ellipses, eights, etc., b.) time for activities can be measured i.e. overcoming the tracks of polygon or number of repetitions in one time unit c.) time for a pause can be planned between two activities or after one serie if it's a shorter type of polygon.

The polygon can be divided into several ways: outdoor polygon, an indoor polygon, natural (natural obstacles), artificial (devices, accessories, requisites, etc.), combined, general physical training preparation, athletic, gymnastic obstacle polygon , polygon for sports games, a obstacle polygon for motor skills and achievements, a polygon for motor skills, a complex obstacle polygon.

According to (Findak, 1999) there are several types of obstacle polygons: a) according to the place of performance (outdoor polygon, indoor polygon or in the room polygon b) according the way of formation (natural, artificial, combined), c) according to purpose (polygon in relation to general physical preparation, obstacle polygon for sports games, obstacle polygon for motor skills and complex polygon), d) according to the number of tracks (simple, double-sided and multi-track).

In schools, polygons are used as a system of obstacles with the successive performance of a certain number of tasks in order to acquire different psychomotor skills and knowledge. Examples of diverse training areas for the physical activity of schoolchildren would be to help reduce and address the problem of the implementation of the entire schedule of physical and health education in primary schools, which is mainly caused by the lack or limitations associated with sports halls, and in a smaller number of cases, the existence or condition of the school yard. Spatial-technical conditions at school, as well as location selection, are key factors for the use of a multifunctional set of kinesiological aids, they also affect enthusiasm and satisfaction with the potentialities of the use of the polygon for the physical activity of school children and its use.

The small scope of work in the teaching of physical education is not sufficient for the harmonious development of anthropological characteristics and the preservation of the health of children in Bosnia and Herzegovina, which is confirmed by the research on obesity in elementary schools and faculties. Therefore, it is necessary to increase the intensity of physical exercise in teaching which can be achieved by applying complex methodological organizational forms of work (work in series, work on the track, circular forms of work and obstacle polygon) which are not so frequently present in practice.

An obstacle polygon is methodical organizational form of work that involves performing a number of different exercises in a series, on a standard or improvised track with obstacles. It contains the successive performance of a certain number of physical exercises where a student needs to overcome natural or artificial obstacles that are set indoor or outdoor in shortest time possible. Tasks in the obstacle polygon are performed without a break, which means that students move from obstacle to obstacle by overcoming them at a greater or lesser speed and in the most appropriate way for each obstacle in the polygon (Findak, 1999).

Polygon has a multiple impact on the biopsychosocial development and anthropological status of students. In the physical education classes, it is applied for the improvement of motor skills and to raise the level of motor achievement, the development of motor skills (Findak, 1999), the improvement of acquired motor skills, the learning of correct and responsible task solving, competition and mutual cooperation. When overcoming the tasks in the obstacle polygon, simple motor movements are carried out, without delay and according to the predetermined order. The application of the polygon is almost unlimited in terms of age, gender, current state of ability, level of knowledge and achievement and place of work, season, working conditions and similar (Findak, 1999).

The aim of this research is to study the effects of the suggested experimental program as an extra hour in teaching, within 15-week time (1 time per week), in which gymnastic polygons serve as mean and play a primary role for the transformation of one of the segments of the anthropological space.

MATERIALS AND METHODS

Participants

The subjects (13 years +/- 6 months) old boys were randomly allocated to one of two groups: experimental training group (EG, N=33) and control group (CG, N=29) of the male gender,

who have not actively been involved in organized extracurricular physical activity and sport, and who have classes of physical and health education as the only organized sport activity. All subjects were in stable medical condition and were able to participate actively in the research. All respondents willingly agreed to participate in research with the permssion of parents and school.

Exercise Testing

Shuttle run (VO_2 max)

The Beep test was developed by (Léger, 1982), and the test is used to evaluate the cardiorespiratory fitness and assess improvements during the training process in boys and girls of 5-18 years, and can also be used to estimate aerobic abilities in the adult population. The satisfactory reliability and validity of this test was determined (r = 0,975, SEE = 2.0 ml×kg-1×min-1) (Léger & Lambert, 1982). The Beep test estimates the values of maximum oxygen reception (VO_2max). Description of the test: The subjects run between two lines at a distance of 20 m according to the tempo dictated by the audio signal from the CD. For each acoustic signal the subject must be with both feet across the line. The goal of the test is that the respondent runs as many sections as possible. The starting speed is 8.5 km / h (20m in 9 sec.) and corresponds to the easy running. Every minute the speed increases by 0.5 km / h. The test stops when the subject is no longer able to follow given tempo, or when he repeatedly does not reach the line for three times when the buzzer sounds.Quiting of the respondents is recorded as the measured past time (min, sec) with the stopwatch. It's applicable for all ages (Leger & Lambert, 1982; Ramsbottom et al., 1988; Leger & Gadour, 1989; Vučetić, 2004).

Study Design

Additional programme lasts for 15-weeks (1 time per week) of application of specialised gymnastic polygons.Students working on a regular program two times a week plus additional program - once a week for 60 minutes. During the program, after a 5-minute general warm-up exercises, 7-minute special warm-up exercises specific to gymnastic. Later, the polygon forms (15 forms, 4 - 6 repetitions, pauses of 60 s between the series). The methods, content and intensity of the activities are coordinated with the development characteristics of the respondents. After the experimental treatment was carried out, the final testing of the control and experimental group was done. The program content includes those moving activities that are represented in the regular program, but expanded and adapted to the program. All program contents are carefully selected from sports activities that are in the regular program as well as some new moving activities. All respondents of the experimental group are divided into two groups of students, so the groups are not too numerous in order to realise the program in the best possible way. It was organised in a way that the additional program would be on days when children do not have a regular program so that the classes are evenly distributed during the working week. All additional classes were realized between 12:30 - 13:15 between the two school shifts, and they were considered as free activity for the students, since all the participants volunteerily participate in the program. The program requires to apply each time a new polygon.

Statistical Analysis

We calculate basic descriptive statistics for all variables: n – number of performances; M – mean; SD – standard deviation. The dependent t-test was used to compares the means of two groups to determine whether there is a statistically significant difference between these means. For this analysis, the significance level is 0.05. Data obtained in this study were analyzed using a software system SPSS 24.0 (SPSS Inc, Chicago, USA).

RESULTS

With the T-test of independent samples the results of the VO_2max test or the maximum consumption of oxygen or aerobic capacity are compared for the control and experimental group during the first and second measuring.

With the T-test of independent samples the results of the VO2 max test or the maximum consumption of oxygen or aerobic capacity is compared for experimental group during first amd second measuring.Significant differences in the results were determined with the following tests at the first and second measurements: E1distance- E2disance t (32) = -3,378, p = .002, d = -1.194, r = 0.512, E1VO2MAX - E2VO2MAX t (32) = -3,356, p = .032, d = -1.186, r = 0.510.The experimental group achieved better result expressed in run meters by 82 meters, while the control group ran 13 meters longer after two measurements without additional program. It can be stated that there are statistically significant differences between the experimental group in the tests VO2 max estimate or the maximum consumption of oxygen or aerobic capacity between the two measurements.

Table 1. Descriptive statistics for applied variables of control and experimental group on initial and final measurement

Variables		Mean	N	Std. Dev.
Pair 1	EG1_level	6.560	33	9.987
	EG2_level	5.354	33	1.976
Pair 2	CG1_level	3.510	29	1.311
	CG2_level	3.586	29	1.419
Pair 3	EG1_distance	638.79	33	376.694
	EG2_distance	720.00	33	368.103
Pair 4	CG1_distance	390.34	29	225.238
	CG2_distance	403.45	29	246.928
Pair 5	EG1_VO2max	29.109	33	7.174
	EG2_VO2max	30.690	33	6.852
Pair 6	CG1_VO2max	24.358	29	4.578
	CG2_VO2max	24.603	29	4.946

Table 2. T - test initial – final measurement

Initial - final measurement variables		Paired Differences					t	df	p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Lower			
Pair 1	EG1_level EG2_level	1.206	9.741	1.695	-2.247	4.660	.711	32	.482
Pair 2	CG1_level CG2_level	-.075	.272	.050	-.179	.027	-1.501	28	.144
Pair 3	EG1_distance EG2_distance	-81.212	138.107	24.041	-130.183	-32.242	-3.378	32	**.002**
Pair 4	CG1_distance CG2_distance	-13.103	46.067	8.554	-30.626	4.419	-1.532	28	.137
Pair 5	EG1_VO2max EG2_VO2max	-1.581	2.707	.471	-2.541	-.621	-3.356	32	**.002**
Pair 6	CG1_VO2max CG2_VO2max	-.244	.935	.173	-.600	.110	-1.410	28	.170

DISCUSSION

The obstacle polygon, as a methodological and organizational form of work, is practically applicable in all conditions and age categories, whether it is in the pre-school age (Pejčić, Trajkovski Visić & Malacko, 2009) in some other process of education or in the process of sports training. Different authors describe this method of work in similar ways: as a methodological and organizational form of work that involves performing a number of different exercises in sequence (one after other) in short time possible on a standard or improvised track (Findak, 1999), as a form of movement characterized by the overcoming of various natural or artificial obstacles (Findak et al., 1987) and as a performance of a certain number of bodily movements or different exercises successively one after another on a natural track or on a course that is standardly set indoor or outdoor (Zdanski, 1986).

The application of the obstacle polygon enables the raising of the level of general coordination, the adoption of running and jumping techniques, and the development of motor skills (Findak et al., 1987). Since the use of the polygon has almost no limitations in terms of gender, age, conditions and location of work, level of abilities, knowledge and achievements (Findak, 1999), this form work has a number of advantages. In addition to this, this form of work encourages the "boldness of participants in the exercise" by overcoming obstacles (Findak et al., 1987) raises students' motivation during exercise, and adapts to their personality (Zdanski, 1986) in order to successfully overcome the tasks on the polygon in the most optimal way. Equally, the work on the polygon raises the level of emotional state (satisfaction) and thus "refreshes" (Findak, 1999) teaching process.

Certain disadvantages of this methodical form of work may appear in the impossibility of an individual dosing the load, in the inability to

correct errors during exercises as well as possible passivity of others that can be additional burden for pupils who overcomes the tasks of the polygon (Zdanski, 1986). Possible passivity, however, can be compensated by an appropriate organising of exercises for pupils who are waiting for execution (for example, by introducing additional exercises) if it is word about individual measuring of time for a certain activity.

Hmjelovjec, Kalić & Hmjelovjec (2005) present different forms of polygons that can be used in physical and health education curriculum. The authors claim that the polygon can be used from pre-school age through game, and for this age group polygons are composed exclusively from elements and tasks based on natural forms of movement such as creeping, walking, rolling, dragging, raising, rebounding, jumping, carrying, shooting, switching, rolling, shooting, running, drawing, etc. When compiling the obstacle polygon, it must be taken care of purpose, the complexity of the polygon, the number and distribution of the obstacles, the material conditions, the type of polygon and the what's the goal of that physical education class. When choosing an obstacle, it is necessary to follow didactic principles: from easier to difficult, from unknown to known, ie, pay attention to the length of the track, the height of the obstacles, the number of tasks, and whether they are appropriate for the age to which the polygon is set Hmjelovjec, Kalić & Hmjelovjec (2005)

Some scientific studies clearly indicate that it is necessary to establish adequate kinesiological programs and construct reliable and valid instruments to monitor the degree of motor and other skill and knowledge acquisition like polygon (Bavčević, Babin & Prskalo, 2006; Žuvela, Božanić & Miletić, 2011; Jelaska, Maleš & Kuna, 2011). Lovrić, Jelaska & Bilić (2011) in results clearly point to a very high applicability of the polygon in the physical education curriculum as an instrument for assessment and verification of fundamental movement skills among six-year-old children. Lorger (2009)claims that the obstacle polygon as a methodological organizational form contributes to the intensity of work during classes, and as a demanding movement provokes a sharp increase in the number of heartbeats.

Slačanac, Oreški and Lipovac (2012)are also concerned with the use and importance of polygons in teaching. The obstacle polygon as a methodical means and form of work, in which simple motor actions are performed, without delay and according to the pre-determined order, and has a multiple impact on the bio-psycho-social development and anthropological status of students. The obstacle polygon, as a methodical organizational form of work, also contributes to the intensity of work during the course. It can be applied in the introductory, the main and the final part of the class. Pavlovic & Marinkovic (2015) tried to determine the effects of polygon application as a curriculum in the teaching of physical and health education. All respondents were tested with four motor tests in order to assess: speed, coordination, explosive strenght and repetitive strenght. It was found that subjects of the experimental group at the end of the test were statistically significantly better than the control group at the general level. By analyzing the T-test for independent samples, it was found that the subjects of the experimental group significantly advanced in all motor tests. Pavlović, Pelemiš & Martinović (2017) for purpose of this study was to evaluate the effects of the sports activity polygon application on motor coordination of children. The results of the paired T-test indicated that the EG improved significantly in measured motor coordination abilities. The sports activity polygon appears to be an effective way of improving children's coordination performance.

The application of an experimental exercise program through various forms and forms of a polygon can represent a cybernetic model in the transformation of abilities in children, and as such it can be used as a non-institutional form of work with children. The results of this, as well as previous research, indicate that the polygon is a methodical tool, but also programmed modified exercise. Another fact that supports this research is that the curriculum applied by the subjects of the control group differed greatly from the experimental one. In the experimental group, it effectively affected the student. In fact, it is one of the most important advantages of using the teaching method - polygon. By encouraging a competitive spirit and a desire to win, most students tend to achieve the best result. This contributes to the significant engagement of students both in terms of intensity and scope.

Then, the diversity of the elements (obstacles) that the polygon possesses during the work requires a comprehensive engagement of students, and therefore students engage different groups of muscles and parts of the body. The classes were dynamic, polygons were versatile, and students were eager to receive new information, exercises and knowledge. Unintentionally , through such an atmosphere, it was possible to achieve desired goals. In a funny and diligent way, the respondents showed a proper attitude towards exercise and

programmed teaching in which the polygon is applied as a method-organizational tool.

Also, the obtained results will enable comparison with the previous results in the Republic of Bosnia and Herzegovina and corresponding results from European countries and regions. Consequently, a "starting point" will be created from which the relevant institutions can move towards the adoption of appropriate measures in the field of planning and development and introducing mandatory program contents for this population in order to improve health, motor and functional abilities.

CONCLUSION

In conclusion, 15-week (1 time per week) of controlled polygon training had a positive effect on maximal aerobic capacity. The results of the study show the effect of the experiment, which reflects in the improvement of the value of functional abilities in the experimental group. Therefore, it would be absolutely justified that most of the educational content that was applied in the program model of the experimental group should be included and implemented in global plans based on defining the program content of this population. The research gives an irrefutable argument that besides regular education and physical education, it is important to introduce additional hours of physical education as well which would primarily meet the needs of children for physical activity and would be a kind of prevention of various types of diseases that happens due to obesity and insufficient activity of children.

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