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Original research article

THE EFFECTS OF A SWIMMING PROGRAM ON THE FUNCTIONAL ABILITIES OF FEMALE STUDENTS

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Abstract. *The largest number of spirometry tests are applied in the case of patients with lung problems and do not relate to samples of the general population or the effects of physical exercise in children. Therefore, the aim of this study was to determine the effects of the experimental program of swimming on the functional ability of fourth grade female elementary school children. A sample of 100 respondents, aged 11 (± 6 months), was divided into two subsamples. The first subsample, 50 of them, consisted of the school children who only have regular physical education at school. The second subsample was composed of a group of schoolchildren who in addition to regular physical education at school had an experimental program of non-swimmer training, twice a week for 45 minutes (a total of 24 hours). The study included three variables for assessing functional abilities: resting heart rate (HRR), forced vital capacity (FVC) and forced expiratory volume (FEV). The results obtained using the univariate analysis of covariance demonstrated a statistically significant difference in the variable forced vital capacity (FVC), p = .042. In future this research could be a starting point for research in the field of working with non-swimmers and water activities relating to a greater number of hours spent in the water, on a sample of respondents that includes both sexes, different age groups of respondents as well as the possibilities of determining the difference between respondents involved in the training of non-swimmers and those who are involved in the swimming training process.*

Key words: *functional ability, training of non-swimmers, female students, younger school age*

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INTRODUCTION

The beneficial effect of swimming is confirmed by numerous studies that prove that time spent in water and swimming contribute to the harmonious development of abilities and raise the functional abilities of the heart, lungs, nervous system and metabolism (Lee, Folsom, & Blair, 2003; Endres et al., 2003; Rumaka, Aberberga-Augskalne, & Upitis, 2007; Trivun, Tošić, & Marković, 2013; Aydin & Koca, 2014). Swimming as a physical activity whose value is proved by numerous facts, must have a permanent place in the system of physical education of elementary school children. Most authors (Kazazović, 2008; Ruth et al., 2009; Stepankova, 2009; Tošić, 2011; Shashi, Anterpreet, & Pankaj, 2013) argue that children need to be provided with physical engagement and movement in water at an early age.

Swimming training can start very early, because swimming is the most suitable content of physical education at all ages. It is known that stay in water produces positive effects on the lungs by increasing lung capacity and improves the functioning of the lungs (Radovanović et al., 2009; Stanković, Delibašić, & Aleksandrović, 2011; Vaithiyanadane, Sugapriya, Saravanan, & Ramachandran, 2012; Stanković, Milanović, & Marković, 2015). Research papers (Mehrotra, Varma, & Tiwari, 1998; Jevtić & Radovanović, 2011; Wells, Plyley, Thomas, Goodman, & Duffin, 2005; Sable et al., 2012; Klisouras, 2013; Trivun et al., 2013) are mainly related to investigations of the functional abilities of both sexes, different kinds of sports, but also swimming, primarily related to competition results. In contrast, very little is known about changes in functional abilities related to work with non-swimmers. The successful implementation of motion in swimming is undeniably affected by functional abilities as well (Zinman & Gaultier, 1987; Sonneti, Wetter, Pegelow, & Dempsey, 2001; Wang, 2004). Lung function and body weight, body composition and posture can be changed under the influence of water activities. In contrast, it cannot influence factors such as height, age, sex and genetic predisposition (Moncada-Jimenez, 2003, Khosravi, Tayebi, & Safari, 2013, Klisouras, 2013).

Swimming as a motor activity requires specially arranged educational work specific to the aquatic environment, because there are fundamental differences between the movement on the ground and in water. They lie in the specific biomechanical principles of swimming movements and, above all, in the mechanism of the driving forces. The ability to swim is associated with the suppression of automated movements on the ground and tells us that the training of swimming requires a radical reorganization of movement control. Currently, there are a large number of data on the problem of swimming training of people of different ages and sexes. Identified factors directly affect the success of swimming training. One set of factors relates to the organizational and methodological aspects of swimming training, and the second set of factors is related to age and gender, and the personality characteristics of the schoolchildren.

Most studies (Volčanšek, 2000; Trajkovski-Višić, 2002; Findak, Jelenić, & Butterer 2002; Kazazović, 2008) focus on methodological and organizational issues: the means and methods of training of non-swimmers in different conditions (indoor and outdoor pools, swimming training in deep and shallow water, etc.), the emergence of effective implementation of aids in the swimming technique structure adoption stage. According to practical experience, the effectiveness of the training depends largely on the ability of the children and their predisposition to learn. Most studies (Findak et al., 2002; Jevtić & Radovanović, 2011; Stanković et al., 2011) in this direction have been organized with the aim to determine the parameters by which to assess the perspectives of students and their ability to achieve top results.

Based on current statistics from surveys collected for further sports training, trainers receive an average of 3-7% of the trained students, and the remaining 93-97% apply swimming as one of the basic and life-saving habits. However, there are not many studies on this topic. Mostly the works relate to the importance of training and the importance of individual swimming lessons. The aim of this study was to investigate the effects of experimental and control treatments and determine the differences between the experimental and control groups in the functional abilities of female students of a younger school age.

METHODS

The sample of participants

The survey was carried out on a sample of 100 participants aged 11 (± 6 months), fourth grade elementary school children in Niš. The sample was divided into two subsamples.

The control group (n = 50, body height 149.09 ± 6.02 cm and body weight 41.99 ± 7.95 kg) consisted of participants who have regular physical education at school. The experimental group of participants (n = 50, body height 150.02 ± 6.90 cm, weight 41.55 ± 7.06 kg), in addition to regular physical education classes at school had an experimental program of non-swimmer training, twice a week for 45 minutes (a total of 24 hours).

The description of the applied experimental program of non-swimmer training

The experimental program of non-swimmer training was implemented for 12 weeks. The frequency of exercise was twice a week for 45 minutes, and the total number of hours was 24. The experimental treatment was carried out with participants in the fourth grade of the "Bubanjski heroji" elementary school in Niš, while the control treatment was carried out with participants of the fourth grade of the "Stefan Nemanja" elementary school in Niš. Upon completion of the initial measurement and assessment, the treatment was initiated for a period of 24 school classes for the implementation of the planned activities. The experimental program was implemented in the swimming pools of the Sports Centre "Čair" in Niš. The control groups followed the standard physical education curriculum (teaching content from the official program of physical education). The experimental groups worked with the same program content with two additional weekly exercises in the form of swimming lessons. The experimental program of non-swimmer training included: testing knowledge of swimming, working on the ground, breathing and keeping their eyes open during water exercises, getting used to water exercises, exercises to maintain a horizontal position and aquaplaning, water games, diving, jumping and learning basic swimming techniques. Elements that are applied in non-swimmer training (Madić, Okičić, & Aleksandrović, 2007; Kazazović, 2008; Stepankova, 2009; Shashi et al., 2013; Tošić, Kocić, Aleksić, & Tomić, 2012; Stanković et al., 2015) were selected in accordance with the relevant recommendations for non-swimmer training. The aim of the experimental treatment was that the respondents learn to lose their fear of water, to independently enter the water, learn to keep their eyes open under the water, maintaining a lying position on the back and chest, to glide through the water, dive, jump from the edge of the pool feet or head first, and swim 25 to 50 m by any technique.

Measuring instruments

To assess the functional abilities of the participants in this study, the following variables were applied: resting heart rate (HRR in beats per minute), forced vital capacity (FVC in L) and forced expiratory volume (FEV in L). The initial and final assessment for each participant individually was realized by means of a spirometer (VicatestP2A, Mijnhard, Netherlands).

Data processing method

The results of this research have been processed in a way to obtain information about the central and dispersion parameters for all the studied variables, namely: arithmetic mean (Mean), standard deviation (SD), coefficient of variation (Cv%) and the Kolmogorov-Smirnov test (KS-p). To test the significance of differences of arithmetic means on the initial and final assessment of the research results for each group of participants we used the univariate analysis of variance (ANOVA method). For the calculation of the multivariate and univariate significance of the differences in the effects of applying different program contents in the experimental and control group of participants in the final measurement we used the Univariate Analysis of Covariance (ANCOVA method) and Multivariate Analysis of Covariance (MANCOVA Method).

RESULTS

From Table 1 we can see that the functional abilities of the participants of the control and experimental group at the initial assessment are in the expected range.

The mean values of resting heart rate suggest that the control group of participants have a 1.54 beats per minute higher value in relation to the experimental group of participants. The coefficient of variation indicates the homogeneity of the functional abilities of schoolchildren at the initial assessment in both groups of participants.

Table 1 Descriptive indicators and differences at the univariate level among participants at the initial assessment

Var.	Control group				Experimental group				ANOVA	
	Mean	SD	Cv%	KS-p	Mean	SD	Cv%	KS-p	F	p
HRR(in beats/min)	82.68	12.79	15.47	.709	81.14	13.28	16.37	.861	.349	.556
FVC(in L)	2.40	.46	19.07	.946	2.32	.43	18.53	.840	.876	.352
FEV(in L)	2.31	.41	17.69	.878	2.29	.38	16.78	.522	.114	.736

Legend: Mean - arithmetic mean, SD - standard deviation, Cv% - coefficient of variation; K-S(p) - Kolmogorov-Smirnov Test

As $p > .1$ this means that at the initial assessment no significant difference between the groups of participants for the variables: resting heart rate (.556), forced vital capacity (.352) and forced expiratory volume (.736) has been observed.

The obtained assessment values of functional abilities of the participants at the final assessment are summarized in Table 2 and indicate that the values are in the expected range.

Table 2 Descriptive indicators and differences at the univariate level between the participants at the final assessment

Var.	Control group				Experimental group				ANOVA	
	Mean	SD	Cv%	KS-p	Mean	SD	Cv%	KS-p	F	p
HRR	79.48	12.31	15.48	.565	79.72	11.12	13.94	.802	.010	.919
FVC	2.41	.46	19.18	.909	2.42	.46	18.83	.632	.021	.886
FEV	2.31	.41	17.93	.939	2.33	.40	17.01	.325	.083	.774

Legend: Mean - arithmetic mean, SD - standard deviation, Cv% - coefficient of variation; K-S (p) - Kolmogorov-Smirnov Test

The values of the Kolmogorov-Smirnov test (KS-p) indicate that the distribution of values is within the normal distribution in all three studied variables in both groups of participants. Based on the results shown in Table 2, we can conclude that at the final assessment no significant difference between the groups of participants in variables: resting heart rate (.919), forced vital capacity (.886) and forced expiratory volume (.774) has been observed.

Table 3 The significance of differences between the treatment of the participants compared to the functional abilities at the final assessment

ANCOVA	F	p
HRR	.175	.677
FVC	4.240	.042
FEV	1.399	.240

Based on the obtained values of the multivariate analysis of covariance (Table 3), we can conclude that there was no difference between the control and experimental treatment of participants as shown by the state of the three studied abilities.

Table 4 The significance of differences and discrimination coefficients between the treatments of the participants at the final assessment in relation to the state of functional ability by variables

ANCOVA	F	p	Kd
HRR	.175	.677	.003
FVC	4.240	.042	.060
FEV	1.399	.240	.028

The results of the univariate analysis of covariance show a statistically significant difference at the final assessment only for the variable forced vital capacity p = .042. The coefficients of the discrimination indicate that the largest contribution to the discrimination is between the control and experimental group with the variable forced vital capacity with a value of .060. Pulmonary function develops and increases with age.

DISCUSSION

Lung volume and capacity grow to physical maturity. Younger schoolchildren are more prone to tachycardia during exercise because this way they adjust their small cardiorespiratory potential at a given level of load (Radovanović et al., 2009). Considering that the changes of functional ability are very pronounced (Moncada-Jimenez, 2003; Rumaka et al., 2007; Batričević, 2008; Shashi et al., 2013; Khosravi et al., 2013) in the period when it comes to accelerated growth and development (Kazazović, 2008; Ortega, Ruiz, Castillo, & Sjostrom, 2008; Kocić, Aleksić, & Tošić, 2009; Marković, 2009; Stanković et al., 2015) and that there are large individual differences among participants, the results of many studies indicate that the effects of short stay in water on the development of certain lung functions are negligible, but the results do not reject the possibility that lung functions may increase due to the influence of a serious and strong training process with elementary school children. Lung volumes have been researched and Doherty & Dimitrou (1997) and they have come to the conclusion that the inclusion of children of a younger school age in swimming training has a significant impact on the value of forced expiratory volume.

After a year of monitoring lung function in twelve swimmers and the control group of participants that are not included in any of the training process, authors Zinman & Gaultier (1987) concluded that there was no significant association between respiratory muscle and lung volumes. The results of the research of changes of functional abilities of participants related to the training of non-swimmers are somewhat controversial. Some authors (Cuurteix, Obert, Lecoq, & Koch 1997; Mehrotra, Varma, & Tiwari, 1998; Sonneti et al., 2001; Aydin & Koca, 2014; Wells et al., 2005; Vaithiyanadane et al., 2012) have found in their research that values VC and FVC increase after training of non-swimmers, while other authors (Zinman & Gaultier 1987; Hagberg, Yerg, & Seals, 1988; Lakhera, Kain, & Bandopadhyay, 1994) found no significant changes in the functional system after the implementation of activities in water.

Earlier studies question the increase in respiratory functions of children due to the difficulties in implementing the intensity and length of planned activities in this period (Radovanović et al., 2009). Most of the studies include participants of both sexes who are in the long-term training process, where additional water activities do not contribute to the improvement of lung volume. The results of this research show that intensive swimming training processes contribute to the optimal development of the respiratory system, but that on the contrary, activities implemented in water periodically, with less intensity and more shortly, do not lead to the expected changes in the functional abilities of the participants.

CONCLUSION

The obtained differences in the functional abilities of female schoolchildren may be caused by the very duration of the program and the time the participant spent in the water. The research may be a starting point for research in the field of working with non-swimmers and water activities related to the increasing number of hours spent in water, on a sample of participants that includes participants of both sexes and different age groups as well as the possibilities of determining the difference among the participants involved in the training of non-swimmers and those who are in the swimming training process. The first step in the training of non-swimmers is the development and acquisition of certain techniques of movement through the water, which will allow the students to, during water activities, increase the functioning of the respiratory system. The increase in muscle - respiratory strength will lead to the achievement of better results in swimming techniques.

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EFEKTI PROGRAMA PLIVANJA NA FUNKCIONALNE SPOSOBNOSTI UČENICA

Najveći broj testiranja spirometrom primenjuje se kod pacijenata sa plućnim problemima i ne odnosi se na uzorke opšte populacije ili efekte fizičkog vežbanja kod dece. Evaluacija uticaja određenih vežbi u vodi na kapacitete pluća bila bi od velike pomoći kod procene sposobnosti plućnih kapilara da prošire i povećaju svoje kapacitete tokom vežbanja. Samim tim je i cilj ovog istraživanja bio da se utvrde efekti eksperimentalnog programa plivanja na funkcionalne sposobnosti učenica četvrtog razreda osnovne škole. Uzorak od 100 ispitanica podeljen je na dva subuzorka. Prvi subuzorak, njih 50, sačinjavale su učenice koje imaju samo redovnu nastavu fizičkog vaspitanja u školi. Drugi subuzorak, njih 50, sačinjavale su grupu učenica koje su pored redovne nastave fizičkog vaspitanja u školi imale i eksperimentalni program obuke neplivača, dva puta nedeljno u trajanju od 45 minuta (ukupno 24 sata). U istraživanju su primenjene tri varijable za procenu funkcionalnih sposobnosti: frekvencija srčanog rada u mirovanju (HRR), forsiran ivitalni kapacitet (FVC) i forsirani ekspiratorni volumen (FFEV). Rezultati dobijeni pomoću univarijantne analize kovarijanse pokazali su statistički značajnu razliku kod varijable forsirani vitalni kapacitet (FEV), p=.042. U perspektivi ovo istraživanje može biti polazna osnova za istražvanja u oblasti rada sa neplivačima i aktivnostima u vodi koja se odnose na veći broj sati provedenih u vodi, na uzorak ispitanika koji obuhvata oba pola, ispitanike raznih uzrasnih kategorija kao i o mogućnostima utvrđivanja razlika između ispitanika koji su uključeni u obuku neplivača i ispitanika koji su u trenažnom plivačkom procesu.

Ključne reči: *funkcionalne sposobnosti, obuka neplivača, učenice, mlađi školski uzrast*