



# SPORTSKE NAUKE I ZDRAVLJE

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# SPORTSKE NAUKE I ZDRAVLJE

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## Poštovani čitaoci,

U novom izdanju našeg Časopisa, od velikog broja pristiglih radova, Uredništvo je uvrstilo dvanaest radova, autora iz Indonezije, Makedonije, Srbije i Bosne i Hercegovine. U ovom broju ćete pročitati članke koji se odnose na zdravstveni fitness, strukturu motoričkih stereotipa karatista, validaciju skale za procjenu kvaliteta života osoba sa lumbalnim sindromom, kvantitativne pokazatelje motoričkih znanja učenika pod uticajem redovne nastave fizičkog vaspitanja, analizu razlika u brzini plivanja kraul tehnikom kod plivača i vaterpolista, relacije indeksa tjelesne mase i kardiorespiratorne izdržljivosti sa rizikom metaboličkog sindroma kod adolescenata, obrazovanje za demokratsko građansko obrazovanje za ljudska prava u fizičkom vaspitanju, relacije morfoloških karakteristika i aerobne izdržljivosti kod fudbalera, stanje kičmenog stuba kod adolescenata sa različitim nivoima fizičke aktivnosti, sportskog menadžmenta i primjenu pilatesa u treningu plesača sportskog plesa.

Zahvaljujemo se svim autorima, recenzentima i članovima uredništva na uloženom trudu. Nadamo se da će i ovaj broj ispuniti očekivanja šire čitalačke populacije.

“Ars longa, vita brevis”.

Uredništvo Časopisa

## Dear Readers,

In the new edition of our Journal, from a large number of papers that we have received, the Editorial Board has accepted twelve articles and authors are from Indonesia, Macedonia, Serbia and Bosnia and Herzegovina. In this issue you will read articles related to health fitness, structure of the motor stereotype karate competitors, validation of the scale intended for the assessment of the quality of life of people with lumbar syndrome, quantitative indicators of motor skills of students under the influence of regular teaching of physical education, analysis of swim swing speed differences in swimmers and water polo players, relationship between body mass index and cardiorespiratory endurance with metabolic syndrome risk in adolescents, education for democratic civic education for human rights in physical education, relation of morphological characteristics and aerobic endurance to footballers, spinal column status in adolescents with different levels of physical activity, sports management and application of pilates in the training of dancers of sports dance.

We thank all authors, reviewers and members of the editorial team for their efforts. We hope that this number will also meet the expectations of the wider readership population.

“Ars longa, vita brevis”.

Journal editorial

# RELATIONSHIP OF BODY MASS INDEX AND CARDIORESPIRATORY FITNESS WITH METABOLIC SYNDROME RISK IN ADOLESCENTS

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**Abstract:** **Objectives** The prevalence of obesity in childhood and adolescence is a major public health problem and has increased dramatically over the last few decades. More attention is needed because it is closely related to some non-communicable diseases and metabolic syndrome. The aim of this study was to investigate the correlation of body mass index and cardiorespiratory fitness to the prevalence of metabolic syndrome in adolescents. **Methods** The sample of the study was 44 adolescents. This research is an observational analytic study. The sample of this study measured body mass index, cardiorespiratory fitness, and metabolic syndrome through measurement of abdominal circumference, blood pressure, triglycerides, HDL-cholesterol, and blood fasting glucose. **Results** The results of the simultaneous test showed that both body mass index and cardiorespiratory fitness had a significant effect on the risk of metabolic syndrome ( $p = 0.000$ ). The higher BMI tended to have metabolic syndrome 1.746 times higher than not having metabolic syndrome. The propensity of the unfit condition of cardiorespiratory having metabolic syndrome is 4.283 times higher than the one that has the fit condition. This logistic regression model is quite good because it can predict correctly 72.7% of the conditions that occur. **Conclusions** This study showed that the higher body mass index and cardiorespiratory fitness conditions can be used as predictors of metabolic syndrome in adolescents.

**Keywords:** Body mass index, cardiorespiratory fitness, metabolic syndrome, adolescent

## BACKGROUNDS

The prevalence of childhood and adolescent obesity is a major public health problem and has increased dramatically over the last few decades (Ng M et al, 2013). This is a massive public health problem worldwide (de Onis et al, 2010). Great attention is needed because it is closely related to some non-communicable diseases and metabolic syndrome (WHO, 2010), defined as a combination of three or more metabolic abnormalities, consisting of abdominal obesity, high blood pressure, dyslipidemia, and dysglycemia. Epidemiological studies have shown that obesity and poor cardiorespiratory fitness performance contribute significantly to the prevalence of cardiovascular disease, where the factor is found from childhood to adolescent. Obesity in childhood is also a significant risk factor for some types of cancer and type 2 diabetes mellitus in adulthood (Perez and Huffman, 2008).

Much evidence suggests that this set of metabolic indicators is prevalent in adolescents, this occurs parallel to the increasing prevalence of obesity worldwide. For example, among North American, Asian and European adolescents, the prevalence of metabolic syndrome in adolescents with normal weight is <1%, whereas in obese adolescents it ranges from 18-50% (Tailor et al., 2010). Among the Chinese adolescents, the 3.7% prevalence was found in the overall sample but for the prevalence of 35.2%, 23.4%, and 2.3%, respectively, in the obese group, overweight and normal weight (Li Y et al, 2008). In addition, a recent review of the prevalence of metabolic syndrome in children from North America, Latin America, Europe, Asia and Australasia (Tailor et al, 2010) shows an overall prevalence ranging from 1.2 to 22.6%, only counting children with excess body weight or obesity this value reaches 60%. It has been widely recognized that the prevalence of childhood obesity has increased not only in industrialized countries but also in developing countries (United Nations, 2012). In developing countries, a systematic overweight and obesity

increase is a consequence of the transition process associated with the adoption of western lifestyles, characterized by the consumption of high energy-dense foods, low levels of physical activity and increased longer sitting time. For example, in Brazil, the prevalence of childhood obesity increased from 4.1 to 13.9% from 1974-1997; In Thailand, the observed increase was from 12.2 to 15.6% between 1991 and 1993; And in India, the prevalence increased from 9.8 to 11.7% between 2006-2009 (Gupta *et al.*, 2012). In Indonesia, the prevalence of obesity in children aged 6-15 years increased from 5% in 1990 to 16% in 2001 (Soegondo, 2008), and currently, the prevalence of obesity is increasing at 5-12 years 18.8 %, age 13-15 years 10.8% and age 16-18 years 7.3% (Riske das, 2013).

Recent studies have shown that cardiorespiratory fitness levels are closely related to metabolic risk in adolescents in Europe and North America (Steele *et al.*, 2008), suggesting that high physical fitness reduces the effects of obesity on risk indicators for metabolic syndrome. Decreased physical activity in children and adolescents has also been reported (Muthuri *et al.*, 2014; Mak and Day, 2010), can negatively impact their physical fitness levels. It is possible that these changes, associated with an increase in overweight and obesity, may have a negative impact on overall public health. Physical activity is important for improving cardiorespiratory fitness. Several studies have shown that children who are more active have better cardiorespiratory fitness than those who are not active (Aires *et al.*, 2011; Boddy *et al.*, 2011; Parikh and Stratton, 2011). These findings suggest a link between physical activity and physical fitness, especially in improving cardiorespiratory fitness. Children with high cardiorespiratory fitness and low body mass index (BMI) have a lower risk of metabolic syndrome than those with low cardiorespiratory fitness and high BMI (Padilla-Moledo *et al.*, 2012; Wang *et al.*, 2011).

Previous studies have shown that gender does not affect the relationship between cardiorespiratory fitness and obesity in childhood (Oda, 2008). Health professionals should design programs to tackle childhood obesity by recognizing the correlation between sex, BMI, and cardiorespiratory fitness, especially in geographic areas with high prevalence of obesity. This will help alleviate chronic diseases and future problems caused by obesity. Studies show that healthcare professionals need to encourage better fitness and overcome obesity-related problems in children to ensure overall positive health during their childhood and into adulthood.

Examining the association of metabolic risk indicators with weight status and cardiorespiratory fitness in adolescents living in different environments may help develop more efficient public health strategies to reduce the incidence of health hazards during this lifetime as well as in adulthood. Research on the relationship of cardiorespiratory fitness levels and body mass index to the risk of metabolic syndrome in these adolescents is rarely performed in Indonesia. This study aims to determine the effect of cardiorespiratory fitness and body mass index on the risk of metabolic syndrome in adolescents. So hopefully this research can contribute much to improving the degree of public health in Indonesia.

## METHODS

**Ethical considerations:** The study was approved by the Ethics Review Committee of Dr. Moewardi Hospital with the number 809/VIII/HREC/2017. All research subjects have given their informed consent for participation in this research study.

### Participants

The study recruited 44 adolescents (22 males and 22 females) in second grades of Senior High School at Bojonegoro Regency. The purpose of this study was explained to all participants, and written consent was obtained from all participants prior to their participation. Potential participants were excluded if they had a history of cardiorespiratory illness.

### Anthropometric measurements

Height and weight were measured to the nearest 0.1 cm and 0.1 kg (OneMed Microtoise, JMI Co Ltd, Indonesia; GEA EB-9063, MPM Co Ltd, Indonesia), with the participants barefoot and in light clothing. Body mass index (BMI) was calculated as weight (kilograms) divided by height (square meters). Waist circumference (WC) was measured at the midpoint between the bottom of the rib cage and the top of the lateral border of the iliac crest with participants in the standing position at the end of a normal expiration. Blood pressure was measured twice at a five-minute interval. Blood pressure readings were taken from the right arm, after a rest period, by use of a sphygmomanometer (Omron HEM-7120; OMRON Co Ltd, Japan).

### **Blood specimens**

Blood samples were collected in the morning after participants had been seated for 30 minutes and had fasted overnight (at least 12 hours). Serum fasting glucose, triglycerides (TG), and high-density lipoprotein (HDL) were measured using a Roche Hitachi 902 Chemistry Analyzer System (HITACHI Co Ltd, Japan).

### **Definition of metabolic syndrome**

This study used the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) guidelines with some modified from IDAI and Yoshinaga *et al.*, (2005) research to determine the presence of metabolic syndrome in adolescents. Abdominal obesity was determined by waist circumference. To address ethnic and regional factors in the diagnostic criteria, abdominal obesity was defined by the Asia-Pacific criteria for waist circumference (APC-WC) (Laaksonen *et al.*, 2002). The study used the recent International Diabetes Federation (IDF) metabolic syndrome definition (Lamonte *et al.*, 2005), which includes criteria established by the NCEP, IDAI, and Yoshinaga. Participants were considered to have metabolic syndrome if three or more of the following five criteria were met: 1) high blood pressure ( $\geq 95$ th percentiles for boys and girl by height); 2) hyperglycemia (fasting plasma glucose  $\geq 100$  mg/dL); 3) hypertriglyceridemia ( $\geq 110$  mg/dL); 4) low HDL cholesterol ( $<40$  mg/dL); and 5) abdominal obesity (waist circumference  $\geq 90$ th percentiles for boys and girls by age).

### **Assessment of CRF**

All participants underwent the Multistage Fitness Test (MFT) to determine their CRF values. This test involves continuous running between two lines 20m apart in time to recorded beeps. For this reason, the test is also often called the ‘beep’ or ‘bleep’ test. The participants stand behind one of the lines facing the second line and begin running when instructed by the recording. The speed at the start is quite slow. The subject continues running between the two lines, turning when signaled by the recorded beeps. After about one minute, a sound indicates an increase in speed, and the beeps will be closer together. This continues each minute (level). If the line is reached before the beep sounds, the subject must wait until the beep sounds before continuing. If the line is not reached before the beep sounds, the subject is given a warning and must continue to run to the line, then turn and try to catch up with the pace within two more ‘beeps’. The test is stopped if the subject fails to reach the line (within 2 meters) for two consecutive ends after a warning.

The subject’s score is the level and a number of shuttles (20 m) reached before they were unable to keep up with the recording. Record the last level completed (not necessarily the level stopped at). This norms table below is based on personal experience and gives you a very rough idea of what level score would be expected for adolescents, using the standard Australian beep test version. For analysis purposes, the participant’s data were categorized into one of two groups according to CRF, fit and unfit.

### **Statistics**

This research is a descriptive study with the observational analytic approach. The adolescent’s sample of this study calculated body mass index by measurement of height and weight, measurement of cardiorespiratory fitness level (VO<sub>2max</sub>) with Multistage Fitness Test (MFT), and risk of metabolic syndrome through measurement of abdominal circumference, blood pressure, triglycerides, HDL-cholesterol, and blood fasting glucose. To determine the association of metabolic syndrome prevalence with CRF and BMI, logistic regression analyses were performed after adjusting for age. Metabolic syndrome was assigned as a dependent variable, CRF and BMI were assigned as independent variables. A two-sided analysis with  $p < 0.05$  was considered statistically significant. All data are presented as mean  $\pm$  standard deviation (SD) and percentages. All statistical analyses were conducted using SPSS version 22.0 for Windows.

## **RESULTS**

The sample of the study was 44 adolescents (22 male and 22 female), the measurement data can be seen in table 1. The subject of 44 samples obtained the result of normal BMI 38.6%, 36.4% overweight, and 25.0% obese. Unfit conditions were found in 54.5% of subjects and fit conditions were found in 45.5% of subjects. From the classification of metabolic syndrome, 36.4% did not suffer from metabolic syndrome, 36.4% had the risk of metabolic syndrome, and 27.3% had metabolic syndrome (table 2).

**Table 1.** Measurement data

Measurement data	Mean ± SD	Unit
Age	16,18 ± 0,45	years
Weight	68,42 ± 18,46	kg
Height	1,61 ± 0,08	m
Body mass index	26,27 ± 6,25	Kg/m <sup>2</sup>
VO <sub>2</sub> max	29,77 ± 6,76	mL/kg/minutes
systole	131,34 ± 16,99	mmHg
diastole	83,82 ± 11,15	mmHg
Waist circumference	81,95 ± 15,02	cm
Triglyceride	103,43 ± 46,88	mg/dL
HDL	57,45 ± 8,51	mg/dL
BFG	82,52 ± 4,88	mg/dL

**Table 2.** Subject characteristic and data distribution

Sample characteristic	n (%)
Gender	
Boy	22 (50)
Girl	22 (50)
Body mass index	
Normal	17 (38,63 )
Overweight	16 (36,36 )
Obese	11 (25)
Cardiorespiratory fitness	
Fit	20 (45,5)
Unfit	24 (54,5)
Metabolic syndrome	
No	16 (36,4)
Risk	16 (36,4)
Yes	12 (27,3)

Samples are categorized as an adolescent with metabolic syndrome if there are at least 3 criteria met, as the risk of metabolic syndrome if 1 or 2 criteria are met, and as not suffering from metabolic syndrome if none of the criteria are met. From the criteria results, the sample can be categorized as follows (Table 3).

**Table 3.** Categorical data according to the criteria of metabolic syndrome

BMI	Fitness	Metabolic syndrome = n (%)		
		No	Risk	Yes
Normal	Fit	13 (29,5)	2 (4,5)	
	Unfit	2 (4,5)		
Overweight	Fit		3 (6,8)	1 (2,2)
	Unfit	1 (2,2)	7 (15,9)	4 (9,1)
Obese	Fit		1 (2,2)	
	Unfit		3 (6,8)	7 (15,9)

The results of the simultaneous test showed that both body mass index and cardiorespiratory fitness had a significant effect on the risk of metabolic syndrome ( $p = 0.000$ ). Through the partial test, the correlation of body mass index to metabolic syndrome had a significant effect ( $p = 0.000$ ), but the correlation of cardiorespiratory fitness to metabolic syndrome was not significant ( $p = 0.451$ ), the result can be seen in table 4. The higher BMI tended to have metabolic syndrome 1.746 times higher than not having metabolic syndrome. In poor condition of cardiorespiratory

fitness, the propensity to have metabolic syndrome is 4.283 times higher than the one that has good cardiorespiratory fitness. Both high body mass index and inadequate cardiorespiratory conditions had a higher influence on the prevalence of metabolic syndrome. This logistic regression model was quite good because it could predict correctly 72.7% of the conditions that occur (Table 5).

**Table 4.** Simultaneous and partial test

Effect	Model Fitting Criteria		Likelihood Ratio Tests	
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Simultaneous	60.971	34.955	4	0.000
BMI	78.789	17.819	2	0.000
CRF	62.563	1.593	2	0.451

**Table 5.** Prediction test

Observed	Predicted			Percent Correct
	No MS	Risk MS	Yes MS	
No MS	14	2	0	87.5%
Risk MS	2	11	3	68.8%
Yes MS	0	5	7	58.3%
Overall Percentage	36.4%	40.9%	22.7%	72.7%

## DISCUSSION

Reductions in physical activity and CRF are associated with increased prevalence and incidence of metabolic syndrome. In our study, we found that a lower level of CRF was associated with increased prevalence of metabolic syndrome in an adolescent. A low level of CRF is a known risk factor for both cardiovascular disease and type 2 diabetes (Vaughan *et al.*, 2009). A prior study has validated the Multistage Fitness Test (MFT) as an appropriate measurement to indicate cardiorespiratory fitness (Laaksonen *et al.*, 2002). In comparison to the other more elaborate and expensive test approaches previously used to obtain VO<sub>2</sub> max, the Multistage Fitness Test (MFT), used in the present study, is a relatively quick and easy method that can be used in most epidemiological and clinical settings (Lamonte *et al.*, 2005). Findings from the current study also indicate that the association between CRF and the prevalence of metabolic syndrome was somewhat gender dependent, although this relationship was less clear when the combined association of BMI and CRF with metabolic syndrome prevalence was examined (Hsieh *et al.*, 2014).

The association between CRF and metabolic syndrome has been reported previously. Laaksonen *et al.*, (2002) reported a significant inverse association between CRF and prevalence of metabolic syndrome even after adjustment for major confounders. In addition, Lamonte *et al.*, (2005) reported that the incidence of metabolic syndrome was significantly reduced among fit individuals compared with the least fit individuals. The current study and previously reported studies suggest that fitter individuals are less likely to develop metabolic syndrome compared with those who are unfit. However, physical fitness is not the only contributor to the development of metabolic syndrome (Neto *et al.*, 2011).

There are other factors independent of CRF that influence the development of metabolic syndrome. In our study, approximately 63.3% of obese individuals had metabolic syndrome. Similarly, several previous studies found that the components of metabolic syndrome were closely associated with obesity (Despres and Lemieux, 2006). In a prospective cohort study, Katzmarzyk *et al.*, (2005) reported that overweight men were 4.5 times (95% CI: 4.2-5.3) more likely to develop metabolic syndrome, and obese men were 30.6 times (95% CI: 26.7-35.0) more likely to develop metabolic syndrome. It is not surprising that more obese individuals have a higher prevalence of metabolic syndrome; one of the five metabolic syndrome components directly reflects the degree of adiposity. In our study, we also confirmed that more obese individuals are more likely to have metabolic syndrome (dos Santos *et al.*, 2015).

The current study has several limitations. First, the level CRF from the MFT might be affected by BMI. The high BMI group could have an increased body mass so they can't run effectively on MFT. Despite this limitation,

this MFT test has been frequently used in clinical settings as a representative CRF test (Kim et al, 2014). Second, due to the cross-sectional nature of this study, it was not possible to control some confounding factors as their daily diet and physical activity that may have affected the results. Factors that could have produced confounding influences included the fact that the participants were recruited in this study by using convenience sampling, a relatively small sample size was used, and the limited age range for the group. Due to these biases and limitations, it is difficult to maintain that the findings of the present study accurately represent the Indonesian adolescent population in general.

## CONCLUSION AND SUGGESTION

In conclusion, we found that participants with a high level of CRF have a lower risk of metabolic syndrome. The prevalence of metabolic syndrome increased as the degree of adiposity increased. However, high levels of CRF were associated with lower prevalence of metabolic syndrome among obese individuals. Our findings suggest the importance of physical fitness in the prevention of metabolic syndrome. This study showed that the higher body mass index and inadequate cardiorespiratory fitness conditions can be used as predictors of metabolic syndrome in adolescents.

### *Conflict of Interest*

The authors certify that have NO affiliations and conflict of interest with any organization or entity with any financial interest or nonfinancial interest in the subject matter or materials discussed in this manuscript.

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# STRUCTURE OF SITUATION MOTOR STEREOTIPS OF KARATE COMPETITORS AND KARATE REPRESENTATIVES

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**Abstract:** This survey was conducted on a deliberate sample of 32 respondents, 16 karate competitors and 16 karate representatives, male, from the Republic of Macedonia. The main goal of this research was to determine the structure of situational motor stereotypes (situational karate tests) between karate competitors and karate representatives in a sports fight for each category separately. In the study, a total of 15 variables of karate elements applied in a sports karate combat divided into 5 spaces were used: three variables of attack with one hand strike, three variables of attack with two hands techniques, three variables of attack with three hands techniques, three variables of attack with one stroke with leg and three variables of attack with combined techniques of hands and legs. The results of the factor analysis obtained by this study show the extraction of 3 significant latent dimensions in the category of competitors and 5 significant latent dimensions in the category of representatives.

**Keywords:** situational karate tests, karate elements, sports fights, competitors and representatives, factor analysis

## INTRODUCTION

It is a fact that in one particular fight a single situation is never repeated twice in the same way, athletes are forced to reorganize learned stereotypes of motion in a short period, depending on whether they are in the phase of attack or defense. In the karate training program a great attention is paid to the development of anthropological characteristics in accordance with their specific preparation (power, speed, coordination, balance and flexibility). Although these are probably the most important skills for success in karate, it is hard to calculate their independent effect on the very success. In fact, some of these skills are different at karate athletes who belong to different weight and age categories. The value of these researches in the field of karate sports consists of finding and determining the most economical and most effective factors that are important for achieving the top results, by revealing the personality structure and finding suitable measuring instruments. In order to achieve the desired goal, as much information as possible should be properly incorporated and used in the process of building the personality of the karate athlete. Therefore determining the structure of situational motor stereotypes (situational karate tests) is of great importance in karate sports. Modern karate competitions consist of two individually important karate disciplines kumite and kata. Due to the fact that they are based on different selections of motion techniques, their kinematic and kinetic parameters, they differ in their anthropometric and physical performance. Kumite competitions are characterized by the complex technical structure and specific abilities of the competitors in the area of combined attack techniques (Chaabène, H., et al. 2014).

## METHODS OF WORK

This survey was conducted with a deliberate sample of 32 participants, 16 karate competitors and 16 karate male and female from the Republic of Macedonia. Respondents were recorded in simulated fighting in a training match where, during a 3-minute combat, they were supposed to perform as many attacks with karate techniques as the subject of the research: a one-handed attack, an attack with two hand techniques, an attack with three hands techniques, an attack with one stroke with leg and an attack with combined techniques of hands and leg (techniques that are commonly used in a sports fight). Each of the respondents individually produced five bouts (with breaks between each fight), which included all five groups of attacks with karate techniques. Also, it was necessary to meet certain criteria

on the day of carrying out the measurements: to be psycho-physically healthy on the day of the check, to regularly attend training in their clubs, to be competitors in the respective categories and during the measurement to maximally and conscientiously they carry out the tasks set, which would give a realistic picture of the examined state. In the research, a total of 15 variables of situational motor tests were applied (according to Kostovski, Ž. et all. 2014 and Zaborski, B. 2012), divided into 5 spaces, of which:

- three variables of attack with one hand strike (kizame tsuki KC, kizame tsuki back step and KCZS, tsako tsuki DzC),
- three variables of attack with two hands techniques (kizame tsuki- tsako tsuki jodan KCDzCJ, kizame tsuki-tsako tsuki chudan KCDzCC and tsako tsuki-tsako tsuki jodan DzCDzCJ),
- three variables of attack with three hands techniques (kizame tsuki-tsako tsuki-step tsako tsuki KCDzCDzC, tsako tsuki-kizame tsuki-tsako tsuki DzCKTsDzC and kizame tsuki-step tsako tsuki-tsako tsuki other hand KCI2DzC)
- three variables of attack with one leg stroke (mawashi geri, uramawashi geri and mawashi geri with a back leg) and
- three variables of attack with combined techniques of hand and leg (kizame tsuki-tsako tsuki-mawashi geri back leg).

KCDzCMG, tsako tsuki chudan-mawashi geri chudan-mawashi geri jodan DzCMGJ and kizame tsuki-tsako tsuki-mawashi geri jodan KCDzCMGJ).

### STATISTICAL METHODS FOR DATA PROCESSING

The data obtained from this research according to the characteristics and size of the selected sample are processed in several programs. For the purposes of this research, the following were calculated: Mean - arithmetic mean, SD - standard deviation, Min., Max., Skew - symmetry of distribution, Kurt - according to the roundness of the distribution of the results, the homogeneity of the results in a certain biomotor test, KS - Kolmogorov-Smirnov, which determines the normal distribution of results and factor analysis.

### RESULTS AND DISCUSSION

The basic descriptive statistical parameters (competitors) of the specific - motor skills are shown in table no. 1 from which it can be concluded that the standard deviation (Std.Dev) in the applied variables is with normal values, ie, is less than 1/3 of the arithmetic mean. Minimum and maximum values are logical and expected and do not indicate the existence of extreme values that indicate that the grouping of results mainly moves around its own arithmetic mean.

From the analysis of the projection of the Gaussian curve (Skew.), which determines the symmetry of the distribution of the result, it can be concluded that the displayed coefficients range within the limits of the recommended values (-1 + 1), with the exception of the variable direct attack tsako tsuki - tsako tsuki jodan (DzCDzCJ = -1.03), which suggests that in this variable, most of the respondents show slightly higher values.

From the values of the curvature of the Gaussian curve (Kurt.), a platykurtic distribution is observed, that is, all the variables show consistency and none of them can be seen deviation.

The distribution of the results of the variables obtained by the Kolmogorov-Smirnov method shows that the values of all the examined variables do not depart from the normal distribution of the results.

**Table 1.** Descriptive statistical parameters of specific motor skills in the participants - competitors and representatives

	Mean	Std. Dev.	Min.	Max.	Skew.	Kurt.	K-S	Sig	Mean	Std. Dev.	Min.	Max.	Skew.	Kurt.	K-S	Sig
KC	15.13	3.95	10.00	22.00	0.12	-1.06	0.66	0.78	15.31	1.85	11.00	19.00	-0.45	1.25	0.83	0.50
KCZS	11.25	1.81	8.00	14.00	-0.12	-0.87	0.64	0.80	13.19	2.46	9.00	19.00	0.53	0.92	0.48	0.97
DzC	14.94	3.97	8.00	22.00	0.41	-0.28	0.87	0.43	14.75	2.79	10.00	21.00	0.55	0.68	0.86	0.45
KCDzCJ	11.63	1.75	8.00	14.00	-0.54	-0.36	0.64	0.81	11.31	1.78	8.00	14.00	-0.13	-0.86	0.85	0.46
KCDzCC	11.38	1.41	9.00	13.00	-0.28	-1.02	0.75	0.62	10.94	1.57	8.00	13.00	-0.83	-0.53	1.25	0.09
DzCDzCJ	11.56	1.71	8.00	14.00	1.03*	0.72	0.90	0.39	11.13	1.41	9.00	13.00	0.08	-1.23	0.65	0.79
KCDzCDzC	7.94	1.77	5.00	12.00	0.60	0.53	0.69	0.72	8.88	0.89	7.00	10.00	-0.39	-0.28	0.97	0.30
DzCKTsDzC	7.44	1.36	5.00	10.00	0.51	0.21	1.00	0.27	8.63	1.41	7.00	11.00	0.44	-1.10	0.94	0.35
KCI2DzC	7.13	1.36	5.00	10.00	0.47	-0.40	0.93	0.35	7.56	1.21	6.00	9.00	-0.04	-1.58	0.78	0.58
AWMG	13.06	2.14	10.00	17.00	-0.05	-0.95	0.68	0.75	13.19	1.64	11.00	16.00	0.17	-1.23	0.71	0.69
UMWG	9.63	1.75	6.00	13.00	-0.20	0.54	0.69	0.73	10.75	1.13	9.00	13.00	0.24	-0.40	0.74	0.64

MWGZN	13.13	2.36	9.00	18.00	0.35	-0.23	0.51	0.95	13.06	2.35	10.00	17.00	0.20	-1.20	0.58	0.89
KCDzCMG	8.19	1.56	5.00	12.00	0.61	2.07	1.19	0.12	7.88	0.96	7.00	10.00	0.80	-0.23	1.03	0.24
DzCMGJ	6.19	1.11	4.00	8.00	-0.42	-0.76	1.07	0.20	6.81	1.05	5.00	9.00	0.42	-0.20	0.87	0.43
KCDzCMGJ	8.06	1.53	6.00	10.00	-0.25	-1.49	0.92	0.36	7.44	0.96	6.00	9.00	0.46	-0.59	1.20	0.11

The values of the variables based on the standard deviation (Table no. 1), clearly show that this is a homogeneous group of respondents, since there is no deviation greater than one third of the arithmetic mean of the examined variables. The minimum and maximum results obtained are characteristic for the selected sample. Also, from the values of the distribution of the results of the skewness (Skew.), It is evident that it is a normal distribution of them, that is, in the range of moderate symmetry (-1 + 1). The degree of curvature at the top of the curve (Kurt.) is platycurtic, indicating that all the values obtained are less than 3. The homogeneity and distribution of the results in these variables (K-S) is in the range of the normal values and shows no deviation.

On the basis of the inter-correlation matrix of the applied manifest variables of specific motor skills, the characteristic roots (lambda), which explain the common variance of each isolated main component in the first row space, are derived (Table no 2).

**Table 2.** Extraction Method: Principal Component Analysis - competitors

Component	Principal component			Varimax		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.54	50.30	50.30	5.41	36.05	36.05
2	2.27	15.12	65.42	3.00	20.01	56.06
3	1.56	10.38	<b>75.80</b>	2.96	19.74	<b>75.80*</b>

The applied Gutman-Kaiser criterion extracted 3 significant latent dimensions. The first of them with its own value (total = 5.41) explains 36.05% of the total variation of the variables, the second with value (total = 3.00) explains 20.01% of the total variance and the third with its own value of (total = 2.96), explains 19.74% of total variability. The total explanation variance by the extracted latent dimensions is 75.80% of the common variance of the entire system and appears to be sufficient to explicate the variability and covariance of the manifest variables applied to the sample competitors.

**Table 3.** Principal component in Varimax - competitors

	PC1	PC2	PC3	Com	V1	V2	V3
KC	0.68	-0.32	0.33	0.67	<b>0.82</b>	0.03	0.05
KCZS	0.57	-0.53	0.03	0.60	<b>0.68</b>	-0.26	0.27
DzC	0.89	-0.03	0.14	0.81	<b>0.78</b>	0.33	0.31
KCDzCJ	0.81	-0.15	-0.19	0.71	0.62	0.14	<b>0.56</b>
KCDzCC	0.59	-0.09	-0.75	0.92	0.17	0.00	<b>0.94</b>
DzCDzCJ	0.74	0.08	-0.57	0.88	0.30	0.25	<b>0.86</b>
KCDzCDzC	0.81	-0.37	0.19	0.83	<b>0.88</b>	0.01	0.23
DzCKTsDzC	0.81	-0.08	0.21	0.70	<b>0.77</b>	0.27	0.21
KCI2DzC	0.80	0.41	0.08	0.82	<b>0.50</b>	<b>0.70</b>	0.30
AWMG	0.88	-0.18	0.07	0.81	<b>0.80</b>	0.18	0.37
UMWG	0.33	0.68	0.32	0.68	0.12	<b>0.80</b>	-0.14
MWGZN	0.36	0.83	-0.05	0.82	-0.08	<b>0.88</b>	0.19
KCDzCMG	0.75	-0.14	-0.12	0.60	<b>0.60</b>	0.14	0.47
DzCMGJ	0.67	0.11	0.51	0.71	<b>0.71</b>	<b>0.44</b>	-0.12
KCDzCMGJ	0.65	0.57	-0.20	0.78	0.18	<b>0.72</b>	<b>0.48</b>

From the heights of the projections of the manifest variables of the first major component of the Varimax factor matrix, one can conclude that most variables have significant, medium to moderately high and high projections, which could mean that the factors obtained are in a relatively significant correlation. The value of communalities is high, which

means that the system of factors relatively well defines the variability and co-variability of manifest variables.

*The first latent dimension (F1)* is a **factor of a relatively complex structure of segmental movements in a sagittal plane with circular movements in three planes**. It saturates the medium and high projections of the variables represented by techniques of attack with one hand stroke (kizame tsuki, kizame tsuki with the back step and tsako tsuki), techniques of attack with three hands strokes (kizame tsuki - tsako tsuki - step tsako tsuki, tsako tsuki - kizame tsuki - tsako tsuki i kizame tsuki - step tsako tsuki jordan/cudan). Hands and legs techniques in karate sports are the dominant techniques by which competitors win points or win the fight. Previous research of modern technical and tactical indices in karate battles suggests that hand techniques have a very big impact (Vidranski, T. 2011). Also, according to Mattias, B. (1999) of the predominance of manual techniques in achieving points and the impact of mawashi geri with front leg, one can see their connection. Mawashi geri is a very useful strike when the fight takes place in a close or manual combination because it is difficult for the opponent to see the impact that comes from his circular path. In this situation, either the front or back leg can be used, although kicking with the front leg is faster, and virtually impossible for the opponent to block.

*The second latent factor (F2)* can be defined as a **factor of circular techniques with leg**. It is represented with high values from the variations of karate techniques of leg attack (ura mawashi geri and mawashi geri with the back leg), relatively high value of the variable from the group of techniques of combined attack by hand and leg (kizame tsuki - tsako tsuki - mawashi geri chudan). In cases where there is a medium or long distance, these leg strikes can be easily combined with the arms and legs. According to the theoretical arguments taken from previous studies (Mattias, B. 1999), these techniques can be used as quick combinations, which is vital for sparring. Also, due to the rotation of the hip, which provides greater acceptance than the mae-geri, the body is well positioned against the opponent, for which it will be more difficult to reach a counter-strike (which is impossible with a linear stroke like the mae-geri).

*The third latent dimension (F3)* is defined by very high projections of the variables that are representative of the group of attack techniques with two hands strokes (kizame tsuki - tsako tsuki jordan, kizame tsuki - tsako tsuki chudan and tsako tsuki - tsako tsuki jordan) and represents a relatively clean **factor of karate attack with two hands techniques**. It is believed that there are five techniques by hand in the karate fight: tsako tsuki jordan, tsako tsuki chudan, kizami tsuki, oi tsuki and uraken uchi. Hand strokes are more natural than impacts, they are faster, easier to control, and it's harder to block or avoid them, which can be easily explained why they are more commonly used in karate fight than kicking (Vidranski, T. 2011). These hand and leg techniques according to the literature so far are one of the most commonly used when it comes to the sporting struggle. Karate players used multiple upper limbs (76.19%) as opposed to lower extremity techniques (23.80%). Kizame tsuki was the most used technique with 29.1% of all other techniques used according to Chaabène, H., et all. (2014). From here comes the conclusion that hands and legs strokes can be easily combined, including close, intermediate and long distances. According to the results obtained from the research conducted by Vidranski, T. et al. (2015), the results in the technical and tactical combat concept were influenced by the rapid techniques used by combatants as a means of tactical surprise for gaining preference in the attack phase, ie karate fighting was primarily conquered using simple techniques.

The characteristic roots and the explained variance of the motor manifest variables by the significant main components in the first row are given in Table no 4. The applied Gutman-Kaiser criterion extracted 5 significant latent dimensions that explain 84.50% of the common variance of the entire system and are sufficient to explicate the variability and co-variability of manifest variables applied to the sample of examinees - representatives.

**Table 4. Extraction Method: Principal Component Analysis - representatives**

Component	Principal component		Varimax			
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.71	38.10	38.10	4.36	29.09	29.09
2	2.96	19.72	57.81	2.39	15.95	45.04
3	1.85	12.33	70.14	2.33	15.55	60.59
4	1.15	7.64	77.78	2.13	14.18	74.77
5	1.01	6.72	84.50	1.46	9.73	<b>84.50*</b>

Individually, the first one with its own value (total = 4.36) explains 29.09% of the total variance of variables, the second with value (total = 2.39) explains 15.95% of the total variance, the third with its own value of (total = 2.33), explains 15.55 % of the total variability, the fourth with a value (total = 2.13) explains 14.18% of the total variance and the fifth with its own value of (total = 1.46), explains 9.73% of the total variability.

**Table 5.** Principal component and Varimax - representatives

	PC1	PC2	PC3	PC4	PC5	Com	V1	V2	V3	V4	V5
KC	-0.39	0.73	-0.14	0.31	0.33	0.91	-0.16	<b>-0.88</b>	0.31	0.00	0.09
KCZS	0.05	0.79	0.21	0.33	-0.31	0.87	0.16	-0.32	<b>0.85</b>	-0.14	0.02
DzC	0.14	0.80	0.52	-0.04	0.00	0.93	-0.05	-0.18	<b>0.87</b>	<b>0.37</b>	0.08
KCDzCJ	0.82	0.15	-0.11	0.17	-0.25	0.79	<b>0.82</b>	0.18	0.25	0.12	-0.11
KCDzCC	0.79	0.30	0.24	-0.02	0.00	0.77	<b>0.57</b>	0.19	<b>0.42</b>	<b>0.48</b>	0.03
DzCDzCJ	0.70	0.36	-0.05	-0.54	0.11	0.92	<b>0.36</b>	0.11	0.22	<b>0.74</b>	<b>-0.44</b>
KCDzCDzC	0.77	0.31	-0.15	0.12	-0.22	0.77	<b>0.77</b>	0.05	0.33	0.17	-0.19
DzCKTsDzC	0.86	-0.11	0.15	0.05	-0.15	0.81	<b>0.70</b>	<b>0.47</b>	0.15	0.27	0.07
KCI2DzC	0.84	0.07	-0.42	-0.07	-0.01	0.90	<b>0.82</b>	0.06	-0.09	0.33	-0.33
AWMG	0.64	-0.45	0.39	0.10	-0.19	0.81	<b>0.45</b>	<b>0.71</b>	0.02	0.10	0.31
UMWG	0.76	-0.25	-0.13	0.23	0.32	0.82	<b>0.73</b>	0.11	-0.30	0.35	0.25
MWGN	0.03	-0.30	0.73	0.47	0.28	0.93	-0.08	0.26	0.09	0.05	<b>0.92</b>
KCDzCMG	0.64	0.13	0.25	-0.27	0.61	0.93	0.26	0.05	0.02	<b>0.91</b>	0.19
DzCMGJ	0.55	-0.29	-0.52	0.45	0.18	0.89	<b>0.80</b>	-0.13	<b>-0.47</b>	-0.05	0.13
KCDzCMGJ	0.21	-0.58	0.42	-0.19	-0.17	0.62	-0.05	<b>0.75</b>	-0.13	0.05	0.18

From the heights of the projections of the manifest variables of the first major component of the Varimax factor matrix, one can conclude that most variables have significant, medium to high projections, which could mean that the factors obtained are in high correlation.

The value of communalities is high, which means that the system of factors relatively well defines the variability and co-variability of manifests variables. The orthogonal varimax solution has led to the creation of structures that satisfy the simplicity conditions of the same, with the exception of some manifest variables (with relatively lower values) that have projections with close values of more than one latent dimension. The interpretation of the obtained factors would be in the following directions:

*The first latent dimension (F1)*, which can be defined as a **factor of combined and complex attack**, is composed of medium and relatively high projections of variables represented by: techniques of attack with two hands strokes (kizame tsuki - tsako tsuki jodan, kizame tsuki - tsako tsuki chudan i tsako tsuki - tsako tsuki jodan), techniques of attack with three hands strokes (kizame tsuki - tsako tsuki - step tsako tsuki, tsako tsuki - kizame tsuki - tsako tsuki and kizame tsuki - step tsako tsuki jodan/chudan) two legs strokes (mawashi geri and uramawashi geri) and one combined technique of strokes by hand and leg (tsako tsuki - mawashi çudan - mawashi jodan). Karate competitions are characterized by a complex technical structure and specific competitive abilities in the area of combined attack techniques (Kostovski, Ž., et all. (2013). Different techniques such as kizame zuki and tsako tsuki are the most used competitive techniques, which are structurally simple and safe movements and therefore most commonly applied. The results of the conducted researches indicate that direct impacts are the most effective techniques of attack, where they have the advantage of hitting the legs as strokes. These types of attacks can be used as: single attack, counter attack or in combination of both (Vidranski, T. 2011).

In the structure of the *second latent factor (F2) - complex factor of continuous attack*, there are intermediate to relatively high projections of three variables belonging to different sets of techniques. The variable kizame tsuki (KC), belonging to the group of techniques with one hand stroke, variable ashi mawashi geri (AMG), and kizame tsuki - tsako tsuki - mawashi geri chudan (KCDzCMGJ) belonging to combined techniques by hand and leg. The variable DzCKTsDzC (tsako tsuki - kizame tsuki - tsako tsuki), which belongs to the group of techniques with three hand strokes, with a much higher projection participates in the definition of the first factor and therefore is not inter-

preted here. If we analyze the substance of this factor more deeply, it can be noted that in fact all three techniques, although belonging to different groups, repeat and complement one another. This is also the conclusion of the research by Mikić, B. et all. (8) that competitive efficiency depends on the speed of movement with the arms and legs, the segmental hand speed, and the explosive power of the lower limbs.

*The third latent factor (3)* consists of two hands techniques with one stroke kizame tsuki with back step (KC) and tsako tsuki (DzC), which enter with high projections and define it as the **factor of segmental single attacks**. According to (Vidranski, 2011), the most common pointer technique is tsako tsuki jodan in the attack phase, which is 25.87% of the total pointing techniques in 274 fights. This structure makes the most commonly used karate technique in the phase of technical and tactical attack. In the second place between the technical and tactical attack and the counter-attack phase is the situational efficiency of the kizame tsuki technique. According to the reference study, we can conclude that competitors with bigger skills and winners of the match achieved an overall higher value with kizame tsuki in the attack phase. Therefore, we can conclude that more competitors who had greater skills used the technique of kizame zuki to get an initiative in the fight and achieve a higher situational efficiency in the attack phase. In addition, the technique of kizame tsuki is often used because of the low degree of biomechanical complexity and minimum requirements for amplitude in achieving points (Vidranski, T. 2011). In the context of the above, we will follow up on some of the previous studies according to which karate competitions are characterized by a complex technical structure and specific competitive abilities in the area of combined attack techniques (Jovanović S, et all. 1995). Different techniques such as kizame tsuki and tsako tsuki are the most widely used competitive techniques, which are structurally simple and safe movements and therefore are most commonly applied.

*The fourth latent dimension (F4)* is represented by a very high projection of the variable of the combined techniques by hand and leg kizame tsuki - tsako tsuki - mawashi geri (KCDzCMG) and the variable from the group of hand techniques with two strokes tsako tsuki - tsako tsuki jodan (DzCDzCJ). The acquired factor can be defined as a **factor of double attack by hand and leg**. As mentioned earlier, hands techniques correlate well with each other when combined, and mawashi geri (according to some of the previous studies previously mentioned in the above-mentioned text) also combines well with groups of attacks with manual techniques. The justification in the interpretation of this factor can be sought in the experience of the representatives, in the wider range of performing a number of related and combined techniques (based on the greater training and competitive experience) and in the training processes that they perform together in the pre-trial periods.

*The fifth latent factor (F5)* is defined by the presence of the variable MGZN (mawashi geri with the back leg), which in the creation of its structure participates with very high projection and defines it as a **single leg attack factor**. According to the above-mentioned study, (Kostovski, Ž., et all 2014), it can be concluded that the competitors and the winners of the matches achieved higher values of situational efficiency of the technique mawashi geri chudan at the attack stage. It could also be noted that the group of contestants winners differed most from the group of defeated contestants in the situational efficiency of the said technique of the legs. It could be concluded that the winners of the competitions perform complex and difficult techniques, while those who were motorically inferior to their opponents can not perform these techniques. In addition to the aforementioned reasons, the technique "mawashi geri čudan" is often used as a second and third choice technique in composite combinations. The reasons for such classification are: the lowest biomechanical complexity among all observed foot techniques and the transfer of the area for achieving body points (Vidranski, T. 2011). The presence of the variable DzCDzCJ DCDCD (tsako tsuki - tsako tsuki jodan) is noticed, which for this factor is not important. Each individual variable of different intensity is related to the resulting factor, ie. the grouping of variables unequally represents the obtained factor. Therefore, the variable that carries the most information about it is distinguished (Perić, D.), as is the case with the latent dimension obtained.

The obtained results of the research carried out by Kostovski, Z., et all. (2013), refer to the measurement of the performance of the applied variable and, above all, the validity, sensitivity and reliability factor of the same, indicate that the test «Mawashi Geri» is characterized by a high degree of sensitivity and satisfaction of the reliability coefficients. Also, the test is simple to apply and easy to explain. The test estimates the motor dimension defined as the karate frequency of the lower limbs. According to the above, the test is recommended in the training process and the selection of karate athletes in the test battery for estimating the specific karate frequency of the lower limbs (until the construction of a new test).

## CONCLUSION

The survey was conducted on a deliberate sample of 32 respondents, 16 karate players and 16 karate competitors, male, from the Republic of Macedonia. For the realization of this research, a total of 15 variables of situational motor tests were applied (Kostovski, Ž., Et all.2014 and Zaborski, B. 2012), divided in 5 spaces. The research yields results that lead to the following conclusions:

1. Three significant latent dimensions of specific motoric stereotypes (situational karate tests) among the competitors:

- F1 - factor of a relatively complex structure of segmental movements in a sagittal plane with circular movements in three planes
- F2 - factor of circular techniques with leg
- F3 - factor of karate attack with two hands techniques

2. Five significant latent dimensions of specific motoric stereotypes (situational karate tests) among the representatives:

- F1 - factor of combined and complex attack
- F2 - a complex factor of continuous attack
- F3 - factor of segmental single attacks
- F4 - a factor of double attack by hand and leg.
- F5 - single leg attack factor

The analysis of the obtained factor structure from this research leads to the conclusion that it is logical and expected. The resulting larger number of extracted latent dimensions in the respondents' representative points to the fact that they practice a greater number of techniques and combinations in their training process, which on the other hand leads to the adoption of a larger number of points in karate battles. This would be one of the conditions under which the second group of respondents (representatives) stand out from the first (contestants).

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# ACUTE EFFECTS OF PHYSIOLOGICAL FATIGUE INDICATORS ON THE MOTOR REACTION SPEED AMONG THE KARATE PLAYERS AT DIFFERENT LEVEL OF COMPETITION

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**Abstract:** This study was conducted on a sample of 40 senior and junior male and female karate fighters, chronological ages 18 to 27 from the Tuzla Canton, who are part of the regular training and competition process. The aim of this paper is to determine the differences in the motor reaction speed among the karate players with the same specializations but at different levels of competition, in conditions of fatigue induced by intense physical work in combination with complex visual signalization, which determines certain karate techniques. The study was conducted with the application of sophisticated technologies used in sport that enable the collection of data. The light stimuli was generated by the usage of the RIR 102 reaction meter and the quantitative valorization of the investigated parameters was carried out by a sophisticated kinematic analysis of the videos collected using two high-speed Casio Exilim EX-F1 digital cameras synchronized with the data from the Polar Team heart monitoring system. By processing and analyzing data, it was concluded that fatigue induced by situational conditions such as performing a series of strikes that simultaneously generate muscular, cognitive and sensory strain, produces negative effects on reaction time of the karate players. The intensity of limiting factors grows gradually in function of time, but is manifested differently in relation to the international and state level of competition.

**Keywords:** acute effects, motor speed reaction, physiological fatigue indicators, karate.

## INTRODUCTION

The development of karate as a sport requires innovative technologies and a modern approach to the conceptualization of training and competition models as

# AKUTNI EFEKTI FIZIOLOŠKIH INDIKATORA ZAMORA NA BRZINU MOTORNE REAKCIJE KOD KARATISTA RAZLIČITOG TAKMIČARSKOG NIVOA

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**Abstract:** Ova studija sprovedena je na uzorku od 40 seniorskih i juniorskih karate boraca muškog i ženskog spola hronološke dobi od 18 do 27 godina iz Tuzlanskog kantona koji su u redovnom trenažnom i takmičarskom procesu. Cilj rada je da se utvrde razlike u brzini motorne reakcije kod karatista iste specijalizacije ali različitog takmičarskog nivoa u uslovima zamora koji je inducirani intenzivnim fizičkim radom u kombinaciji sa kompleksnom vizuelnom signalizacijom koja determinira određene karate tehnike, a uz primjenu sofisticiranih tehnologija u sportu koje omogućavaju prikupljanje podataka. Generiranje svjetlosnih stimulusa izvršeno je pomoću Reakcionog metra RIR 102, a kvantitativna valorizacija istraživanih parametara vršena je sofisticiranom kinematičkom analizom video zapisa prikupljenih pomoću dvije high speed digitalne kamere Casio Exilim EX-F1 koje su sinhronizovane sa podacima srčanog monitoringa Polar tim sistema. Obradom i analizom podataka utvrđeno je da zamor inducirani situacionim uslovima izvođenjem serije udaraca koje simultano generiraju mišićno, kognitivno i senzorno opterećenje, proizvodi negativne efekte na vrijeme reagovanja kod karatista. Intenzitet limitirajućih faktora sukcesivno raste u funkciji vremena ali se različito manifestuje u odnosu na međunarodni i državni takmičarski nivo.

**Ključne riječi:** akutni efekti, vrijeme motorne reakcije, fiziološki indikatori zamora.

## UVOD

Razvoj karatea kao sporta zahtijeva inovirane tehnologije i savremeni pristup konceptualizacije trenažnih i takmičarskih obrazaca te dijagnostičkih postupaka usmje-

well as the diagnostic procedures aimed at analysis of anthropological dimensions structure, their relations and specific impacts on sporting events (Milošević, R. Mudrć, & M. Mudrić, 2012). Successful resolution of complex tasks of sports fight in karate depends on great number of factors, mostly related to abilities relating to time of reaction and anticipation as the key aspects of perception abilities (Mori, Ohtani, & Imanaka, 2002). The ability of an athlete to process relevant information quickly and accurately facilitates him to make adequate decisions and gives him more time to organize and prepare the motor apparatus for action (Mudrić, 2015). The first phase in the formation of movement is the sensory and pre-motor phase, i.e., latent time passed since the onset of the nerve impulse to the excitation of motor units. The occurrence of the nerve impulse is often associated with the external stimuli of the auditory and visual nature. *The latent motor reaction time* is determined by the physiological mechanisms for the transmission of nerve impulses, the creation of the action nerve potential, the realization of neuromuscular synapse, and the excitation of myofilaments in the structure of the muscle fiber. The manifestation of movement or motion, which is determined by complex contractile processes, is a *manifested motor reaction time* (Mikić, 2000). Sports competitions take place under severe stress conditions, due to high physical and mental strain, as well as the expectations and pressure to perform sports activity at a high level. Under such conditions, an athlete is required to process the relevant information quickly and accurately in order to reduce time for decision-making. Considering that *strains of maximum and sub-maximal intensity* prevail in karate fights (Kuleš, 1998), the focus of this study is on the *onset of fatigue* and its impact on the motor reaction time of karate players in complex situational conditions.

During the strain, metabolic processes are underway with a whole series of highly complex biochemical reactions (Jakovljev, 1979). At the core of the fatigue is the temporarily disturbed internal balance of the organism (homeostasis), whose main consequence is reduced work capacity, i.e., sports performance. During the fatigue diagnosis, the most common practice is to start from *the objective physiological symptoms of fatigue*, which represent qualitative changes in the reaction of certain organic systems to the applied strain (Blagajac, 2014). The heart rate is in high correlation with the level of physical activity, and therefore is used in practice as an optimal physiological load indicator (Papišta, 2013). With the development of modern technology, new opportunities and conditions for testing neuromuscular abilities of athletes have opened up, with the goal to bring the

renih na analizu strukture antropoloških dimenzija, njihovih relacija i specifičnih uticaja na sportske manifestacije (Milošević, R. Mudrć i M. Mudrić, 2012). Uspješno rješavanje složenih zadatka sportske borbe u karateu zavisi od velikog broja faktora, a najčešće se povezuje sa sposobnostima koje se odnose na *vrijeme reagovanja i anticipaciju* kao ključne aspekte perceptibnih sposobnosti (Mori, Ohtani i Imanaka, 2002). Sposobnost sportiste da brzo i tačno obradi relevantne informacije olakšavaju mu donošenje adekvatnih odluka i više vremena za organizaciju i pripremu motornog aparata za djelovanje (Mudrić, 2015).

Prvu fazu u formirajućem pokretu čini senzorna i premotorna faza tj. latentno vrijeme proteklo od pojave nervnog impulsa do eksitacije motornih jedinica. Pojava nervnog impulsa često je u konkretnim okolnostima povezana sa spoljašnjim nadražajem auditivne i vizuelne prirode. *Latentno vrijeme motorne reakcije*, determinisano je fiziološkim mehanizmima za transmisiju nervnih impulsa, stvaranje akcionog nervnog potencijala, ostvarenje neuromuskularne sinapse i pobuđivanje miofilamenata u strukturi mišićnog vlakna. Sama manifestacija pokreta ili kretanja, koja je determinirana složenim kontraktilnim procesima, predstavlja *manifestno vrijeme motorne reakcije* (Mikić, 2000). Takmičenja u sportu odvijaju se u izraženim stresnim uslovima, kako zbog visokih fizičkih i psihičkih naprezanja, tako i zbog očekivanja i pritiska da se sportska aktivnost vrši na visokom nivou. U takvim uslovima, od sportista se zahtijeva da brzo i precizno obrađuju relevantne informacije i skraćuju vrijeme za donošenje odluka. S obzirom da u karate borbama uglavnom prevladavaju *opterećenja maksimalnog i submaksimalnog intenziteta* (Kuleš, 1998) fokus ovog istraživanja usmjeren je na *pojavu zamora* te njegovom uticaju na vrijeme motorne reakcije karatista u složenim situacionim uslovima.

U toku napora odvijaju se metabolički procesi sa čitavim nizom vrlo složenih biohemiskih reakcija (Jakovljev, 1979). U osnovi zamora nalazi se privremeno narušena unutrašnja ravnoteža organizma (homeostaza) čija je osnovna posljedica smanjena radna sposobnost tj. sportska performansa. Pri dijagnosticiranju zamora najčešće se u praksi polazi od *objektivnih fizioloških simptoma zamora* koji predstavljaju kvalitativne promene reakcije pojedinih organskih sistema na primjenjena opterećenja (Blagajac, 2014). Frekvencija srca se nalazi u visokoj korelaciji sa nivoom tjelesne aktivnosti, te se zbog toga u praksi koristi kao optimalan fiziološki indikator opterećenja (Papišta, 2013). Razvojem savremene tehnologije danas su se otvorile nove mogućnosti i uslovi za ispitivanje neuromišićnih sposobnosti sportista sa ciljem

test conditions closer to realistic competitive situations. In order to carry out detailed biomechanical analysis of moving structures in sports activities, *kinematics* increasingly becomes an integral part of the efficient diagnostics technology, programming and control of the training process (Mejovšek, Hraski, Hofman, & Kuleš, 1997). Kinematic analyses of moving structures ensure a very precise registration of the sizes and parameters of the athletes' movement during the performance of any technical elements, especially those that cannot be registered with the naked eye, but have to be performed under the laboratory conditions. Under such conditions it is possible to register spatial-temporal movements of any anatomical points on the body or individual parts of the athlete's body, their speed and acceleration, etc. (Malacko & Rađo, 2004)

## RESEARCH METODOLOGY

### *Sample of respondents*

For the purposes of this research, a sample of 40 senior and junior male and female karate fighters, chronological ages 18 to 27 from the Tuzla Canton, who are part of the regular training and competition process, was selected. Karate players are of the same specialization and level of training, but differentiate according to the results achieved, which was the basic criterion for the selection and classification of athletes on 20 international level competition participants (Group A) and 20 state level competition participants (Group B)

### *Sample of variables*

Taking in account the problems and the aim of this research, the selection of relevant karate techniques was made: kisame tsuki jodan (KTJ), gyaku tsuki chudan (GTC), mawashi geri jodan (MGJ), mawashi geri chudan (MGC). **The total** (BR), **latent** (LBR), and **manifest** (MBR) velocity of the motor reaction of the analyzed karate techniques were detected in defined areas of physiological load: **I zone** (40–55% HR<sub>max</sub>), **II zone** (56–70% HR<sub>max</sub>), **III zone** (71–85% HR<sub>max</sub>), **IV zone** (86–100% HR<sub>max</sub>).

### *Description of the research*

The testing and measurement of the complex motor reaction speed in relation to visual stimulus in international and state competition karate players was carried out at the diagnostic center of the Faculty of Physical Education and Sport at the University of Tuzla that provides optimal spatial, technical and human resources required for a professional approach to this research. The RIR 102 reaction meter was used to generate light signals that transmitted

da se uslovi testiranja što je moguće više približe realnim takmičarskim situacijama. U cilju sprovodenja detaljnih biomehaničkih analiza kretnih struktura u sportskim aktivnostima **kinematika** sve više postaje sastavni dio tehnologije efikasne dijagnostike, programiranja i kontrole trenažnog procesa (Mejovšek, Hraski, Hofman i Kuleš, 1997). Kinematičke analize kretnih struktura omogućavaju veoma preciznu registraciju veličina i parametara kretanja sportista prilikom izvođenja bilo kojih tehničkih elemenata, pri čemu su posebno interesantni oni koji se ne mogu registrirati okom, već se moraju obaviti u labotorijskim uslovima. U takvim uslovima moguće je registrirati prostorno-vremenske pomake bilo koje anatomskе tačke na tijelu ili pojedinih dijelova tijela sportista, njihove brzine i ubrzanja itd. (Malacko i Rađo, 2004).

## METODOLOGIJA ISTRAŽIVANJA

### *Uzorak ispitanika*

Za potrebe ovog istraživanja odabrana je uzorak od 40 seniorskih i juniorskih karate boraca muškog i ženskog spola hronološke dobi od 18 do 27 godina iz Tuzlanskog kantona koji su u redovnom trenažnom i takmičarskom procesu. Karatisti su iste specijalizacije i nivoa obučenosti ali se diferenciraju s obzirom na ostvarene rezultate što je i predstavljalo osnovni kriterijum za selekciju i klasifikaciju sportista na 20 ispitanika međunarodnog takmičarskog nivoa (Grupa A) i 20 ispitanika državnog takmičarskog nivoa (Grupa B).

### *Uzorak varijabli*

Imajući u vidu problematiku i cilj ovog istraživanja izvršen je odabir relevantnih karate tehnika: **kizame tsuki jodan** (KTJ), **gyaku tsuki chudan** (GTC), **mawashi geri jodan** (MGJ), **mawashi geri chudan** (MGC). **Ukupna** (BR), **latentna** (LBR) i **manifestna** (MBR) brzina motorne reakcije analiziranih karate tehnika detektovane su u definiranim zonama fiziološkog opterećenja: **I-zona** (40–55% HR<sub>max</sub>), **II-zona** (56–70% HR<sub>max</sub>), **III-zona** (71–85% HR<sub>max</sub>), **IV-zona** (86–100% HR<sub>max</sub>).

### *Opis istraživanja*

Testiranje i mjerjenje složene brzine motorne reakcije u odnosu na vizuelne stimuluse kod karatista međunarodnog i državnog takmičarskog nivoa izvršeno je u dijagnostičkom centru Fakulteta za tjelesni odgoj i sport Univerziteta u Tuzli koji pruža optimalne prostorne, tehničke i kadrovske resurse koje zahtijeva profesionalni pristup ovom istraživanju. Reakciometra RIR 102 korišten je za generiranje svjetlosnih signala koji

over four mobile LED projectors to the frontal and lateral areas of the head and torso of the training doll. The reaction meter is programmed so that the measurement process is automatically carried out. The measuring cycle consisted of 28 iterations of signaling units that are activated for a period of 3 seconds, with different resting intervals. Each partial unit is activated 7 times during a single measurement cycle in random order, with the sequence of activation being automatically changed in each subsequent cycle. The total workload was 170 seconds. The respondent had the task of taking the basic combat stance (*Kumite dachi*) at the individual effective distance from the training doll, and considering the projected visual signals, which were emitted to certain segments of the training doll, reacting at the maximum speed with the performance of a certain karate technique. Projecting the signal to the frontal part of the head a *kisame tsuki jodan* strike was performed, a *gyaku tsuki chudan* was performed to the frontal part of the torso, *mawashi geri jodan* was performed by the projection of the light signal to the lateral part of the head, and when the signal was projected on the lateral part of the torso *mawashi geri chudan* was performed (Figure 1).



**Figure 1.** *Kumite dachi; kizame tsuki jodan; gyaku tsuki chudan; mawashi geri jodan; mawashi geri chudan*

**The quantitative valorization of the total, latent and manifested velocity** of the motor reaction of the investigated karate techniques was performed by a sophisticated **kinematic analysis** of the videos collected using two high-speed Casio Exilim EX-F1 digital cameras, which were positioned in the medial frontal plane. Kinematic processing was done using the software package Kinovea 0.8.15 (Video analysis software), and proce-

su se preko četiri mobilna LED projektori emitovali na frontalne i lateralne zone glave i trupa trenažne lutke. Reakciometar je programiran na način da se vrši automatsko vođenje mjernog procesa. Mjerni ciklus sastojao se od 28 iteracija signalnih jedinica koje se aktiviraju u trajanju od 3 sekunde sa različitim intervalima odmora. Svaka parcijalna jedinica aktivira se 7 puta u toku jednog mjernog ciklusa i to slučajnim redoslijedom, pri čemu se redoslijed aktivacije automatizovano mijenja u svakom narednom ciklusu. Ukupni ekstenzitet rada iznosio je 170 sekundi. Ispitanik je imao zadatak da zauzme osnovni borbeni stav (*Kumite dachi*) na individualnoj efektivnoj distanci od trenažne lutke te s obzirom na projektovane vizuelne signale, koji su emitovani na određene segmente trenažne lutke, maksimalnom brzinom reaguje izvođenjem određene karate tehnike. Projektovanjem signala na frontalni dio glave izvođen je udarac *kizame tsuki jodan*, na frontalni dio trupa izvođen je *gyaku tsuki chudan*, *mawashi geri jodan* izvođen je projekcijom svjetlosnog signala na lateralni dio glave, a kada je signal projiciran na lateralni dio trupa izvođen je *mawashi geri chudan* (Slika 1.).

**Slika 1.** *Kumite dachi; kizame tsuki jodan; gyaku tsuki chudan; mawashi geri jodan; mawashi geri chudan*

**Kvantitativna valorizacija ukupne, latentne i manifestne** brzine motorne reakcije istraživanih karate tehnika izvršena je sofisticiranom **kinematičkom analizom** video zapisa prikupljenih pomoću dvije high speed digitalne kamere Casio Exilim EX-F1, koje su se pozicionirale u sagitlanoj u frontalnoj ravni. Kinematička obrada izvršena je pomoću softverskog paketa Kinovea 0.8.15 (Video analysis software), a obrada i prikazivanje po-

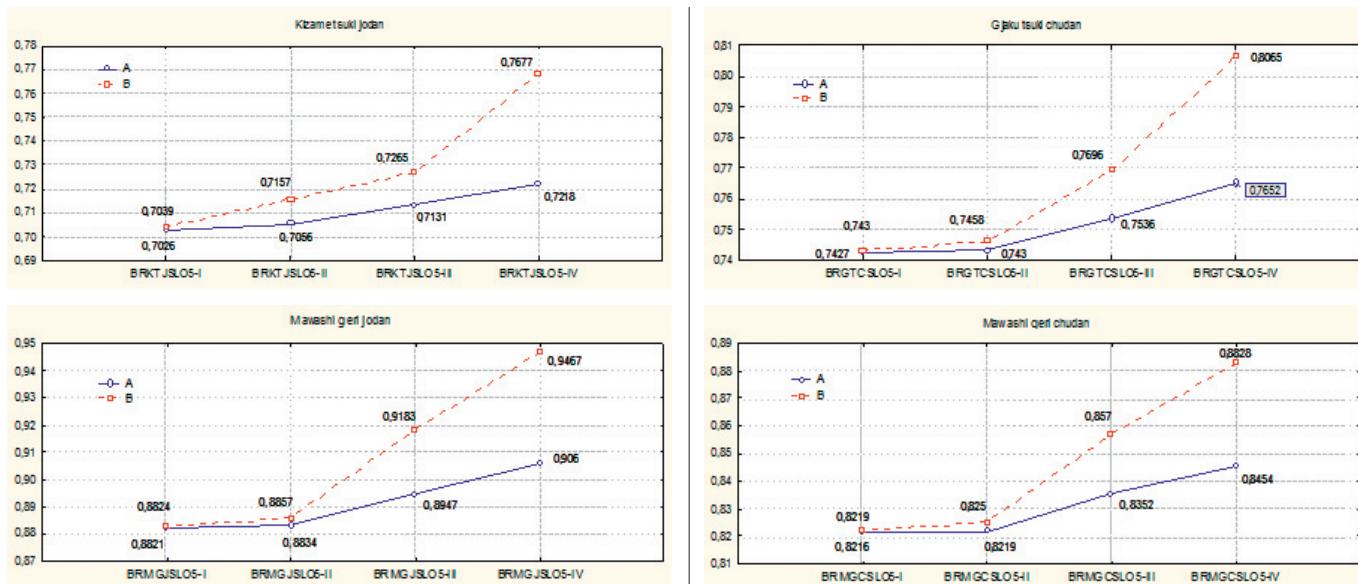
ssing and displaying data using the SPSS 20 statistical package. Polar Team system was used for the heart rate monitoring and the analysis of the registered data was performed with the Polar Precision Performance 4SW software package. The classification of the investigated parameters of the motor reaction was done by time synchronization of heart monitoring and video recordings.

## RESULTS AND DISCUSSION

Analysis of variance and covariance (Table 1.) using the General Linear Model (GLM) algorithm, taking into account the characteristics of the error variation homogeneity according to the Levene's Test of Equality of Variances, determined the quantitative differences between total, latent and manifested velocity between groups within the I-zone and the effect differences within the II, III and IV zones with the neutralization of the I-zone, with graphical illustration of total speed of motor reaction (Graph 1).

**Table 1.** Analysis of variance and covariance

Pairwise Comparisons - Covariate I-zone													
Variable		Mean - Group		Mean Difference (A-B)	Sig.	Variable		Mean - Group		Mean Difference (A-B)	Sig.		
		A	B					A	B				
KTJ	I - zone	BR	0.7026	0.7039	-.001	.862	GTC	I - zone	BR	0.7427	0.7430	.000	.962
		LBR	0.2809	0.2806	.000	.939			LBR	0.2816	0.2817	.000	.990
		MBR	0.4220	0.4230	-.001	.778			MBR	0.4611	0.4614	.000	.933
	II - zone	BR	0.7056	0.7157	-.009	.186		II - zone	BR	0.7430	0.7458	-.003	.258
		LBR	0.2816	0.2816	-.005	.211			LBR	0.2808	0.2815	-.001	.116
		MBR	0.424	0.4290	-.004	.166			MBR	0.4621	0.4644	-.002	.312
	III - zone	BR	0.7131	0.7265	-.012	.026		III - zone	BR	0.7536	0.7696	-.016	.007
		LBR	0.2813	0.2993	-.018	.000			LBR	0.2815	0.3027	-.021	.000
		MBR	0.4318	0.4340	-.001	.251			MBR	0.4721	0.4724	.000	.744
	IV - zone	BR	0.7218	0.7677	-.044	.000		IV - zone	BR	0.7652	0.8065	-.041	.000
		LBR	0.2821	0.3220	-.040	.000			LBR	0.2820	0.3246	-.042	.000
		MBR	0.4421	0.4457	-.003	.312			MBR	0.482	0.4832	.001	.378
MGJ	I - zone	BR	0.8821	0.8824	.000	.963	MGC	I - zone	BR	0.8216	0.8219	.000	.966
		LBR	0.2813	0.2814	.000	.969			LBR	0.2807	0.2809	.000	.969
		MBR	0.6008	0.6010	.000	.956			MBR	0.5409	0.5410	.000	.963
	II - zone	BR	0.8834	0.8857	-.002	.315		II - zone	BR	0.8219	0.8250	-.003	.464
		LBR	0.2851	0.2834	-.002	.412			LBR	0.2808	0.2828	-.002	.355
		MBR	0.6019	0.6022	.000	.672			MBR	0.5411	0.5422	-.001	.522
	III - zone	BR	0.8947	0.9183	-.023	.000		III - zone	BR	0.8352	0.8570	-.021	.000
		LBR	0.2818	0.3044	-.022	.000			LBR	0.2811	0.3020	-.021	.000
		MBR	0.6129	0.6139	-.001	.256			MBR	0.5542	0.5550	-.001	.416
	IV - zone	BR	0.9060	0.9467	-.040	.000		IV - zone	BR	0.8454	0.8828	-.037	.000
		LBR	0.2823	0.3224	-.040	.000			LBR	0.2822	0.3226	-.040	.000
		MBR	0.6237	0.6243	.000	.436			MBR	0.5632	0.5641	-.001	.398



**Graph 1.** Total speed of motor reaction technique *kizame tsuki jodan*, *gyaku tsuki chudan* *mawashi geri jodan* *mawashi geri chudan*

Analysis of the quantitative indicators show that the values of total, latent and manifested motor reaction stagnate with minimal changes between the I and II zones, while in the III and IV zone, a linear increase of different intensity is noted, depending on the investigated level of competition. The latent response time of the analyzed karate techniques in the load zone I among the surveyed groups is on average around  $282 \pm 4$  ms, and no significant differences have been recorded in the variance analysis between the international and state levels of competitions. At the international level of competitions, latent values do not significantly change in the II, III and IV areas of physiological load. At the state level of competition, the latent values stagnate with minimal changes in the zone II, while in the III and IV zones the average linear increase of  $40 \pm 4$  ms is registered. Bearing in mind the statistical indicators, the analysis of covariance did not record significant differences in effects within the load zone II, while in the III and IV zones the statistically significant differences were registered in the effects of physiological fatigue on the latent time of the motor reaction. The manifest response time in the load zone I does not differ significantly between the groups, and in the case of *kizame tsuki jodan* strike, the average is  $422 \pm 1$  ms, *gyaku tsuki chudan*  $461 \pm 1$  ms, *mawashi geri jodan*  $600 \pm 1$  ms, and the average manifested response time when performing *mawashi geri chudan* is  $540 \pm 1$  ms. In the load zone II, the manifested time increases minimally, while in the III and IV zones the average linear

**Grafikon 1.** Ukupna brzina motorne reakcije tehnike *kizame tsuki jodan*, *gyaku tsuki chudan* *mawashi geri jodan* *mawashi geri chudan*

Analizom kvantitativnih pokazatelja možemo zapaziti da vrijednosti ukupne, latente i manifestne brzine motorne reakcije uz minimalne promjene stagniraju između I i II zone opterećenja, dok u III i IV zoni bilježe linerni porast različitih intenziteta u zavisnosti od istraživanog takmičarskog nivoa. Latentno vrijememo reagovanja analiziranih karate tehnika u I zoni opterećenja kod istraživanih grupa u prosjeku iznosi oko  $282 \pm 4$  ms, te analizom varijanse nisu evidentirane signifikantne razlike između međunarodnog i državnog takmičarskog nivoa. Na međunarodnom takmičarskom nivou latentne vrijednosti se bitno ne mijenjaju u II, III i IV zoni fiziološkog opterećenja. Na državnom takmičarskom nivou latentne vrijednosti stagniraju uz minimalne promjene u II zoni, dok u III i IV zoni bilježe prosječni linerni porast od  $40 \pm 4$  ms. Imajući u vidu statističke pokazatelje analizom kovarijanse nisu evidentirane signifikantne razlike u efektima u okviru II zone opterećenja, dok su se u III i IV zoni isprofilirale statistički značajne razlike u efektima fiziološkog zamora na latentno vrijememo motorne reakcije. Manifestno vrijememo reagovanja u I zoni opterećenja značajno se ne razlikuje između grupa te kod udarca *kizame tsuki jodan* u prosjeku iznosi  $422 \pm 1$  ms, *gyaku tsuki chudan*  $461 \pm 1$  ms, *mawashi geri jodan*  $600 \pm 1$  ms, a prosječno manifestno vrijememo reagovanja kod udarca *mawashi geri chudan* iznosi  $540 \pm 1$  ms. U II zoni opterećenja manifestno vrijememo minimalno raste dok se u III i IV zoni bilježi prosječni linearni porast od  $22 \pm 3$  ms na međunarodnom i državnom takmičarskom nivou. S obzirom da

increase of  $22\pm3$ ms is recorded at the international and state levels of competitions. Since the dynamics of these changes is homogeneously conducted at the level of the investigated groups, no statistically significant differences in the effects of physiological fatigue indicators on the manifestation of the motor reaction have been recorded in the covariance analysis in the load zones II, III and IV. In relation to latent and manifested indicators, the total motor reaction time in the load zone I does not differ significantly between the analyzed groups. Is at an average of  $702\pm1$ ms during the *kisame tsuki jodan* strike,  $742\pm1$ ms *gyaku tsuki chudan*,  $882\pm1$ ms *mawashi geri jodan*, and the average total reaction time for the *mawashi geri chudan* kick is  $821\pm1$ ms. Bearing in mind the above-mentioned facts in the investigated karate techniques, the analysis of the covariance did not show significant differences in effects of the load zone II, while in the III and IV zones statistically significant differences in the effects of physiological fatigue on the total motor reaction time were recorded.

The results showed that fatigue induced by situational conditions by performing a series of strikes in combination with complex visual signaling that determines certain karate techniques negatively reflects on the time of the motor reaction of the investigated karate techniques. The intensity of limiting factors gradually grows over time, but is manifested differently in relation to the international and state levels of competitions. At the *international level of competition*, the *total motor response time* in conditions of progressive fatigue detected by physiological indicators increases exclusively at the expense of increase of the *manifested motor reaction component*. While at the *state level of competition*, in addition to the increase of the mentioned component, an increase in the *latent motor reaction component* is generated, which ultimately reflects on the quantitatively higher but qualitatively lower values of the overall speed of the motor reaction compared to the international level of competition

The results of this study confirmed the results in the work of Zemkova, Miklović, and Hamar (2009) which concluded that fatigue was induced by hard exercise connected with increased time of reaction, as well as in the work of Ilić et al. (2017) which showed that progressive physical load produced greater negative effects on manifested speed of punch by karate fighter on state completion level compared to karate fighter on world competition level. Minimum differences in the speed of kick are consequence of reduced height of a kick by state level karate fighter, which leads to a fact that world level

se dinamika navedenih promjena homogeno odvija na nivou istraživanih grupa, analizom kovarijanse u okviru II, III i IV zone opterećenja nisu evidentirane statistički značajne razlike u efektima fizioloških indikatora zamora na manifestno vrijeme motorne reakcije. U relaciji sa latentnim i manifestnim pokazateljima ukupno vrijeme motornog reagovanja u I zoni opterećenja se značajno ne razlikuje između analiziranih grupa te kod udarca *kisame tsuki jodan* u prosjeku iznosi  $702\pm1$ ms, *gyaku tsuki chudan*  $742\pm1$ ms, *mawashi geri jodan*  $882\pm1$ ms, a prosječno ukupno vrijeme reagovanja kod udarca *mawashi geri chudan* iznosi  $821\pm1$ ms. Imajući u vidu navedene činjenice kod istraživanih karate tehnika analizom kovarijanse nisu evidentirane signifikantne razlike u efektima u II zoni opterećenja, dok su se u okviru III i IV zone isprofilirale statistički značajne razlike u efektima fiziološkog zamora na ukupno vrijeme motorne reakcije.

Rezultati su pokazali da se zamor induciran situacionim uslovima izvođenjem serije udaraca u kombinaciji sa kompleksnom vizuelnom signalizacijom koja determinira određene karate tehnike negativno reflektuje na vrijeme motorne reakcije istraživanih karate tehnika. Intenzitet limitirajućih faktora sukcesivno raste u funkciji vremena ali se različito manifestuje u odnosu na međunarodni i državni takmičarski nivo. Na *međunarodnom takmičarskom nivou ukupno vrijeme motorne reakcije* se u uslovima progresivnog zamora detektovnog fiziološkim indikatorima povećava isključivo na račun povećanja *manifestne komponente motorne reakcije* dok se na *državnom takmičarskom nivou* pored povećanja navedene komponente generira i povećanje *latentne komponente motorne reakcije* što se u konačnici reflektuje i na kvantitativno veće ali kvalitativno slabije vrijednosti ukupne brzine motorne reakcije u odnosu na međunarodni takmičarski nivo.

Rezultatima ove studije potvrđeni su rezultati u radu Zemkova, Miklović i Hamar (2009) koji su zaključili da je zamor induciran napornim vježbanjem povezan sa povećanjem vremena reagovanja te rezultati u radu Ilić i sar. (2017) koji su pokazali da progresivno fiziološko opterećenje proizvodi znatno veće negativne efekte na manifestnu brzinu udarca rukama kod karatista državnog takmičarskog nivoa u odnosu na karatistu svjetskog takmičarskog nivoa. Minimalne razlike u brzini udarca nogom posljedica su smanjene visine udarca kod karatista državnog takmičarskog nivoa što ukazuje na činjenicu da karatista svjetskog takmičarskog nivoa s obzirom na ostvarenu visinu udaraca ostvaruje znatno veću manifestnu brzinu.

Jovanović (1988) je u svom radu utvrdio da vrijeme izbornog reagovanja u rješavanju tipičnih zadataka sport-

karate fighter in relation to height of a kick accomplishes greater manifested speed of a kick.

Jovanović (1988) established in his work that the time of reaction of typical task of sports fight by karate master is approx 520ms in relation to a group of lower level fighters whose time was 533ms, which is in relation to this study. Milošević et al. (2012) conducted analysis of execution of right lag front kick in optimal physical conditions without kicking any surface, where they registered 240ms as time of kick realization. Mentioned measurement describes manifested component of reaction which is lower compared to manifested analysis of measurements of karate techniques in this study. This can be explained by simple situational conditions in comparison to complex situational conditions utilized by karate fighters in this study. Comparison of manifested time of front kick between local and world level karate fighters conducted in work Pozo, Bastien, and Dierick (2011) which concluded that the time of execution of front kick is lot lower for world level fighters compared to national standard.

Latent speed of motor reaction in complex condition has been tested by Mudrić (2015) in his doctoral dissertation, where he compared reactions of defensive actions in optimal physical conditions between karate fighters of various levels of training and specialization. Results showed that elite karate fighters react significantly faster compared to beginners, and minimally faster and statistically negligible compared to kata fighters, which is in relation with results accomplished in frame of zone I and II of this study. This has also been confirmed in work of Mori et al. (2002), where better results were accomplished by karate fighters of higher level.

Having in mind functional classification of fatigue we can conclude that manifested time of motor reaction is determined by peripheral motor fatigue, while the latent time of motor reaction is determined by complex interaction peripheral sensory I central fatigue. The mentioned aspects of fatigue are product of certain biochemical and neuron physical changes which are taking place in muscles, central and peripheral neurons which are limiting contractual processes of aktino-miozin filaments and functional relation of CNS with receptors and effectors (Davis & Bailey, 1997). Fatigue of inter neuron and neuron muscular transmission in conditions of intense physical workload is result of depletion of transmitting substances in synoptic endings, gradual accumulation of abnormal quantities of ions inside postsynaptic neurons and muscle fibers, as well as progressive deactivation of greater number postsynaptic membrane receptors, which manifests itself as a result

ske borbe kod karate majstora iznosi oko 520ms u odnosu na grupu ispitanika sa nižim zvanjima koji su ostvarili vrijeme od 533ms, što je u relaciji sa rezultatima ove studije. Milošević i sar. (2012) su na vrhunskom takmičaru izvršili kinematičku analizu izvođenja desnog mae gerija iz lijevog stava u optimalnim fiziološkim uslovima, bez udaranja u bilo kakvu površinu, gdje su registrovali vrijeme realizacije udarca od 240ms. Navedeni parametar opisuje manifestu komponentu reagovanja koja je znatno niža u poređenju sa manifestnim vrijednostima analiziranih karate tehnika u ovoj studiji, a navedeno se može opravdati prostim situacionim uslovima u odnosu na složene situacione uslove u kojima su testirani karatisti u ovoj studiji. Poređenje manifesnog vremena izvođenja karate udarca mae-geri između domaćih i međunarodnih takmičara u karateu izvršeno je u radu Pozo, Bastien i Dierick (2011) koji su konstatovali da je vrijeme izvođenja udarca znatno kraće za karatiste međunarodnog u odnosu na nacionalni standard.

Latentnu brzinu motorne reakcije u složenim uslovima testirao je Mudrić (2015) u svojoj doktorskoj disertaciji, gdje je poredio reagovanja odbrambenih akcija u optimalnim fiziološkim uslovima između karatista različitog nivoa obučenosti i specijalizacije. Rezultati su pokazali da elitni karate borci signifikantno brže reaguju u odnosu na početnike te minimalno brže i statistički beznačajno u odnosu na kataše, što je u relaciji sa rezultatima dobivenim u okviru I i II zone opterećenja ove studije. Navedeno je potvrđeno i u radu Mori i sar. (2002), gdje su statistički bolje rezultate ostvarili karatisti većeg takmičarskog nivoa.

Imajući u vidu funkcionalnu klasifikaciju zamora možemo konstatovati da je ***manifestno vrijeme motorne reakcije*** determinisano ***periferno-motornim zamorom***, dok je ***latentno vrijeme motorne reakcije*** determinisano kompleksnom interakcijom ***periferno-senzornog i centralnog zamora***. Navedeni aspekti zamora proizvod su određenih biohemiskih i neurofizioloških promjena koje se odvijaju na nivou mišića, centralnih i perifernih neurona koji limitiraju kontraktilne procese aktinsko-miozinskih filamenata te funkcionalne veze CNS-a sa receptorima i efektorima (Davis i Bailey, 1997). Zamor interneuronske i neuromuskularne transmisije u uslovima intenzivnog fizičkog i kognitivnog opterećenja rezultat je iscrpljivanja depoa transmитerskih supstanci u sinaptičkim zavrsecima, postepenog nakupljanja nenormalno velike količine jona u unutrašnjosti postsinaptičkih neurona i mišićnih vlakana, te progresivne inaktivacije sve većeg broja postsinaptičkih membranskih receptora koja se javlja kao odgovor (senzorni feedback) organizma kada po-

of body during exaggerated activity. This mechanism is taking place while lowering number of receptor protein on postsynaptic membrane, releasing transmitters which inhibit postsynaptic membrane or releasing substances which are blocking work of transmitters on postsynaptic membrane (Guyton & Hall, 2017).

## CONCLUSION

We can conclude that fatigue induced by intense physical work in combination with complex visual signaling, which simultaneously generates muscular, cognitive and sensory strain, produces a negative effect on the reaction speed in karate players. It should be noted that, in relation to the international level of competition, where peripheral motor fatigue is manifested, at the state level of competition, in addition to the aforementioned fatigue, there is also a central and sensory fatigue that limits the effective processing of information and decision-making, which is reflected on the analyzed sports performances. This suggests that the perceptual-cognitive component is an essential factor that determines the sports results in karate fights.

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stoji prekomjerna aktivnost. Ovaj mehanizam odvija se umanjivanjem broja receptorskih proteina na postsinaptičkoj membrani, ispuštanjem transmitera koji inhibišu postsinaptičku membranu ili ispuštanjem supstanci koje blokiraju dejstvo transmitera na postsinaptičku membranu (Guyton i Hall, 2017).

## ZAKLJUČAK

Možemo zaključiti da zamor induciran intenzivnim fizičkim radom u kombinaciji sa kompleksnom vizuelnom signalizacijom, koji simultano generiraju mišićno, kognitivno i senzorno opterećenje, proizvodi negativan efekat na brzinu reagovanja kod karatista. Treba istaći da se u odnosu na međunarodni takmičarski nivo gdje se uglavnom manifestuje periferni motorni zamor, na državnom takmičarskom nivou pored navedenog zamora manifestuje i centralni i senzorni zamor koji limitiraju efikasno procesuiranje informacija i donošenje odluka što se reflektuje na analizirane sportske performanse. Navedeno upućuje na zaključak da je perceptivno-kognitivna komponenta esencijalni faktor koji deteminira sportski rezultat u karate borbama.

# VALIDATION OF THE SCALE INTENDED FOR THE ASSESSMENT OF THE QUALITY OF LIFE OF PERSONS WITH LUMBAL SYNDROME<sup>1</sup>

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**Abstract:** In order to determine the metric characteristics of the scale intended for the assessment of the quality of life of persons with lumbar syndrome (PQL-LS) on a sample of 202 subjects ( $M = 93$ ;  $F = 109$ ), three procedures for checking its metric characteristics were applied: factor analysis (Principal Components Analysis) with the Direct Oblimin method, in order to identify the latent structure of the perception of the quality of life of the respondents; Scale Reliability Analysis based on Cronbach's alpha coefficient; and a validation check based on the coefficient of internal correlation of the scale (Spearman's correlation of rank - rho). The results show that the scale has good metric characteristics and that it has a multi-item character (twenty-seven indicators). The internal accordance of the scale is in the high reference range of the Cronbach's alpha coefficient (0.947). The values of correlation coefficient of subscale scores: physical health, mental health, social relations and environment show a high degree of correlation with the overall mean value of the entire scale, which confirms the validity of the analyzed domains (subscale) and the scale as a whole (at the level of significance  $r < 0.001$ ). All 27 variables yielded the corresponding weight of the single extracted component ( $KMO = 0.901$ ;  $Sig. = 0.000$ ), which determined that the scale had adequate validity. Based on the identified good metric characteristics, this scale can be recommended for use as a unique/autonomous multi-item scale designed to assess the quality of life of adults with lumbar syndrome.

**Key words:** quality of life, lumbar syndrome, scale, validation

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# VALIDACIJA SKALE NAMENJENE PROCENI KVALITETA ŽIVOTA OSOBA SA LUMBALNIM SINDROMOM<sup>1</sup>

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**Apstrakt:** U cilju utvrđivanja metrijskih karakteristika skale namenjene proceni kvaliteta života osoba sa lumbalnim sindromom (PKŽ-LS) na uzorku od 202 ispitanika ( $M=93$ ;  $Z=109$ ), primenjena su tri postupka provere njenih metrijskih karakteristika: faktorska analiza (analiza glavnih komponenti – Principal Components Analysis) sa metodom kose rotacije (Direct Oblimin), radi identifikacije latentne strukture percepcije kvaliteta života ispitanika; proverom unutrašnje saglasnosti (Scale Reliability Analysis) zasnovane na Kronbahovom alfa koeficijentu); i proverom validnosti zasnovane na koeficijentu unutrašnje korelacije skale (Spirmanova korelacija ranga – ro). Rezultati pokazuju da skala ima dobre metrijske karakteristike i da je odlikuje multiajtemska karakteristika (dvadeset sedam indikatora). Unutrašnja saglasnost skale je u visokom referentnom opsegu Kronbahovog alfa koeficijenta (0,947). Vrednosti koeficijenta korelacije skorova subskala: telesno zdravlje, psihičko zdravlje, socijalni odnosi i okolina pokazuju visoku povezanost sa ukupnom srednjom vrednošću cele skale, što potvrđuje validnost analiziranih domena (subskala) i skale u celini (na nivou značajnosti  $r < 0,001$ ). Svi 27 varijabli dalo je odgovarajući faktorsku težinu jedinoj ekstrahovanoj komponenti ( $KMO=0,901$ ;  $Sig. = 0,000$ ) čime je utvrđeno da skala ima odgovarajuću validnost. Na osnovu identifikovanih dobrih metrijskih karakteristika ova skala se može preporučiti za primenu kao jedinstvena/samostalna multiajtemska skala namenjena proceni percepcije kvaliteta života odraslih osoba sa lumbalnim sindromom.

**Ključne reči:** kvalitet života, lumbalni sindrom, skala, validacija.

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## INTRODUCTION

When considering various issues of the quality of life of a modern man, the determinant that becomes the center of attention is his/hers overall well-being. It is influenced by many factors, from objective indicators, to subjective perception in the evaluation of physical, material, emotional and social well-being, personal development, etc. Thus, the concept of quality of life can be viewed through two, mutually correlative, aspects. The first is subjectivity, as a determinant of understanding from the perspective of individuals, while the other is related to multidimensionality, as a factor in the psychometric tradition of measuring health status that assimilates the assessment of several different dimensions of the individual's life (Nešić, 2016).

Therefore, the quality of life can be described as an essential determinant of individual existence of a man, his/hers social connections, life and work preferences, biological and reproductive prosperity, etc. Therefore, it is necessary for the quality of life to be regarded as a multidimensional construct under the complex influence of the physical health of an individual, his/hers psychological state, level of independence, social relations, personal beliefs and attitudes toward important aspects of the individual environment.

The World Health Organization represents the quality of life as a personal perception of one's own life position, in the context of a cultural and value system in which an individual lives and in relation to his/hers goals, expectations, standards and interests (WHOQOL group, 1998). Therefore, the assessment of the quality of life can generally be considered from two aspects: (1) subjective, as an individual's self-assessment, and (2) objective, as an observer's assessment - expert judgment. So, depending on who is evaluating, in complex research, sometimes occurrences and divergent grades are possible (Stojković et al., 2010). Pain in the lumbar spine is one of the most common health problems of a modern man, so it is considered one of the dominant causes of temporary inability to work (Mačak-Hadžiamerović, Čustović-Hadžimuratović & Mujezinović, 2009).

In support of this are the data of individual epidemiological studies (Božić, 2017) that show that in the area of Vojvodina the frequency of lumbar pain is most pronounced amongst the population between the age of 50 and 59. Also, it is certain that this problem as a cause of incapacity to work occurs in more than 25% of the working age population that is younger than 45 years of age. Similar studies performed abroad show that in 60-85% of the population of a country, at least once during their life-

## UVOD

Kada se razmatraju različita pitanja kvaliteta života savremenog čoveka u središte pažnje se, svakako, postavlja determinanta da je to njegovo sveukupno blagostanje. Na njega utiču brojni faktori, od objektivnih pokazatelja, pa do subjektivne percepcije u vrednovanju telesnog, materijalnog, emocionalnog i socijalnog blagostanja, ličnog razvoja, itd. Dakle, koncept kvaliteta života može se posmatrati kroz dva, međusobno korelativna aspekta. Prvi je subjektivnost, kao determinanta razumevanja iz perspektive pojedinca, dok se drugi vezuje za multidimenzionalnost, kao faktor psihometrijske tradicije merenja zdravstvenog statusa koji apostrofira procenu više različitih dimenzija života pojedinca (Nešić, 2016). Stoga se o kvalitetu života može govoriti kao bitnoj odrednici individualne egzistencijalizacije čoveka, njegovog društvenog povezivanja, životnih i radnih preferencija, biološko-reproaktivne celishodnosti, itd.

Prema tome, kvalitet života je neophodno posmatrati kao višedimenzionalni konstrukt koji se nalazi pod kompleksnim uticajem fizičkog zdravlja pojedinca, njegovog psihološkog stanja, nivoa nezavisnosti, socijalnih odnosa, ličnih verovanja i odnosa prema važnim aspektima individualnog okruženja. Svetska zdravstvena organizacija kvalitet života predstavlja kao lično opažanje sopstvene životne pozicije, u kontekstu kulturnog i vrednosnog sistema u kome pojedinac živi i u odnosu prema svojim ciljevima, očekivanjima, standardima i interesima (WHOQOL group, 1998). Zbog toga se procena kvaliteta života, u principu, može razmatrati iz dva ugla: (1) subjektivnog, kao individualna ocena (samoprocena) pojedinca i, (2) objektivnog, kao ocena posmatrača-ekspertska procena. Tako da, u zavisnosti od toga ko vrši procenu, kod kompleksnih istraživanja, moguća je nekada pojava i divergentnih ocena (Stojković i sar., 2010).

Bol u lumbalnom delu kičme predstavlja jednu od najčešćih zdravstvenih tegoba savremenog čoveka, tako da se smatra jednim od dominantnih uzroka privremene nesposobnosti za rad (Mačak-Hadžiamerović, Čustović-Hadžimuratović & Mujezinović, 2009). U prilog ovome govore podaci pojedinih epidemioloških studija (Božić, 2017) koje su utvrstile da je na području Vojvodine učestalost lumbalnog bola najizraženija u delu populacije između 50. i 59. godine života. Takođe, izvesno je da se ovaj problem kao uzročnik nesposobnosti za rad javlja u više od 25% radno sposobne populacije koja je mlađa od 45 godina. Slične studije rađene u inostranstvu pokazuju da se kod 60-85% populacije stanovništva jedne zemlje bar jednom tokom života javi lumbalni bol, a da

time, lumbar pain occurs, with recurrence in at least 50% of patients who are undergoing medical treatment (Middleton & Fish, 2009; Barkhordari, Halvani & Barkhordari, 2013). In that sense, there is almost always a consensus in the professional circles that the lumbar syndrome, due to its negative effects on physical and mental health, represents a major socio-economic problem for every society (Karahan & Bayraktar, 2004).

The exact source of lumbar pain is difficult to identify. It is manifested as unspecified back pain, and it represents a relatively big problem for setting the exact diagnosis. It can arise as a result of dysfunction of various tissues including muscles, soft connective tissue, ligaments, cartilage, and blood vessels (Božić, 2017: 11). In any case, lumbar pain can be observed in the general context of defining pain as an unpleasant sensory or emotional experience that is associated with actual or potential tissue damage (Maxwell, 2012). It is most commonly localized in the loin-shaped part of the spinal column (below the arterial arc to the lower part of the gluteal region), and is expressed in the form of "twitching" (tightening) and reflecting along the nerves (Yilmaz & Dedeli, 2012).

Causes which lead to the occurrence of pain in the lumbar part of the spine (lumbar syndrome) are very heterogeneous (Božić, 2017). In accordance with the etiological factors, they can be grouped according to the following factors: (1) caused by congenital or acquired diseases, (2) due to biomechanical disorders of the spinal column, (3) as a result of injuries, (4) caused by diseases of other organs in which the disease is reflected in the lower part of the spine (Popović, 2003). Primary prevention of lumbar syndrome is definitely focused on appropriate regular physical exercise (Henewer ET all, 2011). In this context, special attention should be paid to the muscles of the back that act as support for the spinal column and play the role of maintaining its stability. Insufficient back muscle strength (especially m. erector spinae and m. multifidus) can lead to lumbar pain, causing frequent repeated painful conditions (Lee et all, 2012).

## METHOD

Within the empirical non-experimental transversal study, which concerned the identification of some aspects of the quality of life of persons with lumbar syndrome, a scale for the self-assessment of quality of life was applied. The sample of the research entities consisted of a total of 202 subjects ( $M = 93$ ;  $F = 109$ ), persons with lumbar syndrome, who were, at the time of the survey, undergoing a physiotherapist treatment at the Physical Medicine and Rehabilitation Ordinations in four Vojvodina

se recidivi pojavljuju kod najmanje 50% pacijenata koji su podvrgnuti i medicinskim tretmanima (Middleton & Fish, 2009; Barkhordari, Halvani & Barkhordari, 2013). U tom smislu gotovo da postoji konsenzus u stručnim krugovima oko toga da lumbalni sindrom, zbog svojih negativnih efekata na fizičko i mentalno zdravlje, predstavlja veliki socio-ekonomski problem za svako društvo (Karahan & Bayraktar, 2004).

Tačan izvor pojave lumbalnog bola je teško identifikovati. Manifestuje se kao nespecifičan bol u leđima, te predstavlja relativno veliki problem za postavljanje tačne dijagnoze. Može nastati kao posledica disfunkcije različitih tkiva uključujući mišiće, meko vezivno tkivo, ligamente, hrskavicu i krvne sudove (Božić, 2017: 11). U svakom slučaju, lumbalni bol se može posmatrati u opštem kontekstu definisanja bola kao neprijatnog čulnog ili emocionalnog iskustva koje je povezano sa stvarnim ili potencijalnim oštećenjem tkiva (Maxwell, 2012). Najčešće je lokalizovan u slabinskom delu kičmenog stuba (ispod rebarnog luka do donjeg dela glutealne regije), a ispoljava se u vidu "trnjenja" i reflektuje duž nerava (Yilmaz & Dedeli, 2012). Uzroci koji dovode do pojave bola u lumbalnom delu kičmenog stuba (lumbalnog sindroma) su vrlo heterogene prirode (Božić, 2017). U skladu sa etiološkim faktorima mogu se grupisati prema sledećim činiocima: (1) uzrokovani kongenitalnim ili stečenim bolestima, (2) usled biomehaničkih poremećaja kičmenog stuba, (3) kao posledica povreda, (4) uzrokovani bolestima drugih organa kod kojih se bolest reflektuje u slabinski deo kičme (Popović, 2003).0

Primarna prevencija lumbalnog sindroma je definativno usmerena ka odgovarajućem redovnom fizičkom vežbanju (Henewer et all, 2011). Posebna pažnja se, u ovom kontekstu, treba posvetiti mišićima leđa koji deluju kao podrška kičmenom stubu i ostvaruju ulogu održavanja njegove stabilnosti. Nedovoljna snaga leđnih mišića (posebno m. erector spinae i m. multifidus) mogu dovesti do pojave lumbalnog bola, odnosno uzrok su čestih ponovljenih bolnih stanja (Lee et all, 2012).

## METOD

U okviru empirijske neeksperimentalne transverzalne studije, koja se odnosila na identifikaciju nekih aspekata kvaliteta života osoba sa lumbalnim sindromom, primenjena je skala za samoprocenu kvaliteta života.

Uzorak entiteta istraživanja sačinjavalo je ukupno 202 ispitanika ( $M=93$ ;  $Z=109$ ), osoba sa lumbalnim sindromom, koje su se u vreme anketiranja nalazile na fiziatrijskom tretmanu u Ordinacijama fizikalne medicine i rehabilitacije u četiri vojvodanska grada (Novi Sad, Su-

towns (Novi Sad, Subotica, Kanjiža and Bačka Palanka). The average age of the respondents was 47.5 years. The research data was collected through a survey using a questionnaire whose design was based on a modified WHOQOL-BREF version of the World Health Organization Quality of Life Questionnaire (BREF) in Serbian language, designed for self-assessment of quality of life. This essentially shortened version of the WHOQOL-100 questionnaire (De Vries & Van Heck, 1997) treats quality of life as a multidimensional space.

The starting point for the creation of this questionnaire in this study was the character of the respondents (persons with lumbar syndrome), and the basic version of WHOQOL-BREF was used in some earlier studies (Martinis, 2005), as well as the modified version of AQL-S (Nešić, 2016), redesigned by adjusting the formulations of a single number of items.

The quality of life profile in the applied questionnaire has been identified through the self-assessment scale, i.e. the perception of the quality of life of people with lumbar syndrome (PQL-LS), which includes four areas (domain) - physical health, mental health, social relations and the environment. A part of the questioner that defines the system of dependent variables has the form of a ten item Likert scale (the scale of the intensity of the indicators from 1 to 10) with a total of 29 items. The domains of quality of life concerned: physical health (8 items), mental health (7 items), social relations (5 items) and the environment (9 items). The timeframe for the questions asked (indicators) was "in the past two weeks".

Metrics of the applied scale was tested using three procedures: (1) factor analysis (Principal Components Analysis) with the Direct Oblimin method, in order to identify the latent structure of the perception of the quality of life of the respondents; (2) checking its internal compliance (Scale Reliability Analysis based on Cronbach's alpha coefficient); (3) validation based on the coefficient of internal correlation of the scale (Spearman's correlation of rank - rho). The selection of these procedures was conditioned, first and foremost, by the nature of the research and the applied research instrument. As in this case it is a type of instrument whose metric characteristics are checked through several similar studies, as a logical choice of the data analysis method, whose orientation towards the validation of the redesigned scale of self-assessment, has been devised by the PCA approach.

According to Tabachnick and Fidell, (Tabachnick & Fidell, 2007: 635) it is a far superior solution when it comes to the usual empirical compression of a data set in relation to the CFA (common factor analyzes) procedure.

botica, Kanjiža i Bačka Palanka). Prosečna starost ispitanika iznosila je 47,5 godina.

Istraživački podaci su prikupljeni anketnim putem, uz korišćenje upitnika čiji se konstrukt zasnivao na modifikovanoj verziji WHOQOL-BREF upitnika/skale na srpskom jeziku (*World Health Organization Quality of Life Questionnaire – BREF*) namenjenog samoproceni kvaliteta života. Ova, u suštini, skraćena verzija upitnika WHOQOL-100 (De Vries & Van Heck, 1997) kvalitet života tretira kao multidimenzionalni prostor. Kao polazna osnova za kreiranje upitnika u ovom istraživanju pošlo se od karaktera ispitanika (osobe sa lumbalnim sindromom), te je osnovna verzija WHOQOL-BREF primenjena u nekim ranijim studijama (Martinis, 2005), kao i modifikovana verzija PKŽ-S (Nešić, 2016), redizajnirana prilagođavanjem formulacija jednog broja ajtema.

Profil kvaliteta života je u primjenjenom upitniku identifikovan kroz skalu samoprocene, odnosno *percepcije kvaliteta života osoba sa lumbalnim sindromom* (PKŽ-LS), gde su obuhvaćena četiri prostora (domena) - telesno zdravlje, psihičko zdravlje, socijalni odnosi i okruženje. Deo upitnika kojim je definisan sistem zavisnih varijabli ima je oblik desetostepene Likertove skale (raspon intenziteta vrednovanja indikatora od 1 do 10) sa ukupno 29 ajtema. Domeni kvaliteta života su se odnosili na: telesno zdravlje (8 ajtema), psihičko zdravlje (7 ajtema), socijalni odnosi (5 ajtema) i okruženje (9 ajtema). Vremenska odrednica za postavljena pitanja (indikatore) bila je "u poslednje dve nedelje".

Metrika primjenjene skale testirana je primenom tri postupka: (1) faktorskom analizom (analiza glavnih komponenti – *Principal Components Analysis*) sa metodom kose rotacije (*Direct Oblimin*), radi identifikacije latentne strukture percepcije kvaliteta života ispitanika; (2) proverom njene unutrašnje saglasnosti (*Scale Reliability Analysis* koja je zasnovana na Kronbahovom alfa koeficijentu); (3) proverom validnosti zasnovane na koeficijentu unutrašnje korelacije skale (*Spirmanova korelacija ranga – ro*). Izbor navedenih procedura bio je uslovjen, u prvom redu, karakterom istraživanja i primjenjenim istraživačkim instrumentom. Kako je u ovom slučaju reč o tipu instrumenta čije su metrijske karakteristike proveravane kroz više sličnih istraživanja, to se kao logičan odabir metode analize podataka, čije je usmerenje ka validaciji redizajnirane skale samoprocene, namentnuo PCA pristup. On je, prema Tabačniku i Fidelu (Tabachnick & Fidell, 2007: 635) znatno superiornije rešenje kada je reč o uobičajenom empirijskom sažimanju skupa podataka, u odnosu na CFA postupak (*common factor analysis*). Takođe i preporučeni aspekti

Also, the recommended aspects of each instrument scale test (Pallant, 2009) have directed us to selecting a statistical procedure for determining the reliability of a particular sample, applying the Scale Reliability Analysis based on the Cronbach's alpha coefficient. Likewise, in this case it is a statistical data representing the ordinal sizes (scales), and to determine the coefficient of inertial correlation, in addition to the Crohnback's alpha coefficient (as a procedure for determining internal accordance) Spearman's correlation of rank (Chen & Popovich, 2002) was imposed as a correct procedure.

## RESULTS

The instrument for assessment of perception of the quality of life was constructed as a ten-step scale, which provides an individual assessment of the quality of life of people with lumbar syndrome (Perception of Quality of Life - Lumbar Syndrome). The initial questionnaire consisted of a total of 29 items, modeled on the PQL-S scale (Nešić, 2016), and according to the WHOQOL-BREF basic version model (WHOQOL Group, 1998; Skevington, Lotfy & O'Connell, 2004). The domains in the function of quality of life identification included four subspaces (within a single scale): physical health, mental health, social relations and living environment.

The validation of the scale was preceded by several test analyzes. Using the Factor Analysis Procedure (PCA) Item analysis identified two that with their coefficient of correlation (less than 0.3) do not meet the recommended acceptability criteria for items in the structure of an isolated factor (Tabachnick & Fidell, 2007; Pallant, 2009). As for items whose omission in the context of the indicator base does not disturb the construct and logic of the scale as a whole (QPZ10 and QPZ13), as well as the logical coverage of the corresponding subscale (mental health), the continuation of the analysis and validation of the applied scale took place in the coverage of the remaining 27 items. The subscale construct of this solution had the following distribution of quality of life indicators: physical health (8), mental health (5), social relations (5), and environment (9).

The reliability of the scale, which is based on its internal accordance, was analyzed using the Cronbach's alpha coefficient. The obtained results clearly indicate the appropriate internal accordance (Cronbach's alpha coefficient = 0.947), which significantly exceeds the recommended theoretical value of 0.7 (De Vellis, 2003) (Table 1).

provere svakog instrumenta tipa skale (Pallant, 2009) usmerili su nas na izbor statističke procedure za utvrđivanje pouzdanosti na konkretnom uzorku ka primeni *Scale Reliability Analysis* zasnovane na Kronbahovom alfa koeficijentu. Isto tako, kako se u ovom slučaju radi o statističkim podacima koji predstavljaju ordinalne veličine (skale), kao korektna procedura za utvrđivanje koeficijenta unutrašnje korelacije, pored kronbahovog alfa koeficijenta (kao procedure za utvrđivanje unutrašnje saglasnosti), nametnula se Spirmanova korelacija ranga (Chen & Popovich, 2002).

## REZULTATI

Instrument za procenu percepcije kvaliteta života konstruisan je kao desetostepena skala kojom se vrši individualna procena indikatora kvaliteta života osoba sa lumbalnim sindromom (*Percepcija Kvaliteta Života – Lumbalni Sindrom*). Incijalni upitnik se sastojao od ukupno 29 tvrđnji, po uzoru na skalu PKŽ-S (Nešić, 2016), odnosno prema modelu osnovne verzije WHOQOL-BREF upitnika (WHOQOL Group, 1998; Skevington, Lotfy & O'Connell, 2004). Domenima koji su u funkciji identifikacije kvaliteta bila su obuhvaćena četiri subprostora (u okviru jedinstvene skale): telesno zdravlje, psihičko zdravlje, socijalni odnosi i životno okruženje.

Postupku validacije skale prethodilo je nekoliko probnih analiza. Primenom procedure faktorske analize (PCA) ajtem analizom identifikovana su dva koja svojim koeficijentom korelacije (manji od 0,3) ne zadovoljavaju preporučene kriterijume prihvatljivosti ajtema u strukturi izolovanog faktora (Tabachnick & Fidell, 2007; Pallant, 2009). Kako je reč o ajtemima čije izostavljanje u kontekstu indikatorske osnove ne narušava konstrukt i logiku skale u celini (QPZ10 i QPZ13), kao ni logički obuhvat pripadajuće subskale (psihičko zdravlje), to se nastavak analize i validacije primenjene skale odvija u obuhvatu preostalih 27 ajtema. Subskalni konstrukt ovakvog rešenja je imao sledeću distribuiranost indikatora kvaliteta života: telesno zdravlje (8), psihičko zdravlje (5), socijalni odnosi (5), okruženje (9).

Pouzdanost skale, koja se zasniva na njenoj unutrašnjoj saglasnosti, analizirana je pomoću Kronbahovog alfa koeficijenta. Dobijeni rezultati jasno ukazuju na odgovarajuću unutrašnju saglasnost (Kronbahov alfa koeficijent = 0,947) koji je značajno premašuje preporučenu teorijsku vrednost od 0,7 (De Vellis, 2003) (Tabela 1).

**Table 1.** Elements of internal accordance PQL-LS scale**Tabela 1.** Elementi unutrašnje saglasnosti PKŽ-LS skale

Broj / №	Indikator / Indicator	Skalarni prosek / Scalar average	Uticaj uklanjanja stavke na alfa koeficijent / Cronbach's Alpha if Item Deleted
1	TZ1 Nivo dnevnih fizičkih aktivnosti / Level of daily physical activity	5.58	.942
2	TZ2 Redovnost bavljenja sportsko-rekreativnim aktivnostima / Regularity of sports-recreational activities	4.00	.943
3	TZ3 Telesna kondicija / Body condition	5.00	.942
4	TZ4 Zdravlje u celini / Health in general	6.11	.941
5	TZ5 Bolovi i nelagodnost u telu / Pain and discomfort in the body	5.00	.944
6	TZ6 Spavanje i odmor / Sleep and rest	6.06	.941
7	TZ7 Kvalitet i redovnost dnevnih obroka / Quality and regularity of daily meals	7.01	.943
8	TZ8 Opšti radni kapacitet / General working capacity	6.65	.941
9	PZ9 Predstava o svom telesnom izgledu / The image of your physical appearance	6.62	.942
10	PZ11 Učestalost pozitivnih osećanja / The frequency of positive feelings	6.54	.942
11	PZ12 Samopouzdanje / Self-confidence	6.98	.940
12	PZ14 Lična uverenja / Personal beliefs	7.80	.942
13	PZ15 Pamćenje i koncentracija / Memory and concentration	7.67	.942
14	SO16 Lično (unutrašnje) stanje / Personal (internal) condition	7.11	.940
15	SO17 Društveni odnosi i podrška okoline / Social relations and environmental support	7.23	.940
16	SO18 Seksualna aktivnost / Sexual activity	6.12	.942
17	SO19 Odnosi sa vršnjacima/prijateljima / Relationships with peers/friends	7.60	.941
18	SO20 Kontakti na društvenim mrežama / Contacts on social networks	5.70	.943
19	O21 Izvori finansija/finansijska stabilnost / Sources of finance/financial stability	6.45	.940
20	O22 Osećaj slobode, fizičke bezbednosti i lične sigurnosti / A sense of freedom, physical security and personal security	7.29	.941
21	O23 Kvalitet i dostupnost zdravstvene i socijalne zaštite / Quality and accessibility of health and social care	6.12	.943
22	O24 Radno mesto / Workplace	6.15	.942
23	O25 Porodično okruženje / Family environment	8.06	.942
24	O26 Mogućnosti za sticanje novih znanja i veština u našoj zemlji / Opportunities for acquiring new knowledge and skills in our country	5.94	.942
25	O27 Mogućnosti za upražnjanje rekreacije i sporta u mestu stanovanja / Possibilities for practicing recreation and sports in the place of residence	6.02	.942
26	O28 Kvalitet životne sredine (zagadenje, buka, klima) / Environmental quality (pollution, noise, climate)	5.48	.945
27	O29 Kvalitet saobraćaja i prevoza u mestu stanovanja / The quality of traffic and transport in the town of residence	5.39	.946
Kronbahov alfa koeficijent: / Cronbach's alpha coefficient:			.947

Also, within the four subscales, their high internal accordance was established (Table 2). Although there is no full agreement on the minimum acceptable alpha coefficient, a number of authors (Hair et al., 1998; Huh et al., 2006) believe that this is a value of 0.6. In the context of the metric characteristics of the subscales in our research, this methodological attitude was accepted.

Takođe je i unutar četiri subskale utvrđena njihova visoka unutrašnja saglasnost (Tabela 2). Mada ne postoji potpuna saglasnost oko minimalne prihvatljive vrednosti za alfa koeficijent, jedan broj autora (Hair et al. 1998; Huh et al. 2006) smatra da je to vrednost 0,6. U kontekstu metrijskih karakteristika subskala u našem istraživanju prihvaćen je ovakav metodološki stav.

**Table 2.** Elements of internal accordance subscales

Subskala / Subscale	Pitanje / Question	Uticaj uklanjanja stavke na alfa koeficijent / The effect of removing an object on an alpha coefficient	Kronbahov alfa koeficijent / Cronbach's alpha coefficient
1) Telesno zdravlje / Physical health	1	,862	,882
	2	,865	
	3	,853	
	4	,859	
	5	,882	
	6	,869	
	7	,877	
	8	,862	
2) Psihičko zdravlje / Mental health	9	,811	,825
	10	,781	
	11	,747	
	12	,784	
	13	,821	
3) Socijalni odnosi / Social relations	14	,805	,868
	15	,814	
	16	,813	
	17	,817	
	18	,848	
4) Okruženje / Environment	19	,818	,855
	20	,822	
	21	,831	
	22	,829	
	23	,828	
	24	,838	
	25	,830	
	26	,849	
	27	,852	
Kronbahov alfa koeficijent: / Cronbach's alpha coefficient:			,947

The validation of the scale was performed by the method of identifying the coefficient of internal correlation (Spearman's correlation of rank) (Table 3). The values of the coefficient of correlation of the scores of individual domains (subsubscales: physical health, psychological health, social relations, environment) show a high correlation with the total mean value of the entire scale, which confirms the validity of the analyzed domains (subsubscales) and the scale as a whole (level of significance -  $r < 0.001$ ).

**Table 3.** Values of coefficient of correlation of subscales with the score of overall PQL-LS scale

Provera validnosti skale izvršena je postupkom identifikacije koeficijenta unutrašnje korelacije (Spirmanova korelacija ranga) (Tabela 3). Vrednosti koeficijenta korelacije skorova pojedinačnih domena (subskale: telesno zdravlje, psihičko zdravlje, socijalni odnosi, okolina) pokazuju visoku povezanost sa ukupnom srednjom vrednošću cele skale, što potvrđuje validnost analiziranih domena (subskala) i skale u celini (na nivou značajnosti  $r < 0,001$ ).

**Tabela 3.** Vrednosti koeficijenta korelacije subskala sa skrom ukupne PKŽ-LS skale

Subskale	PKŽ-LS / PQL-LS	
	Spirmanov koef. / Spearman's correlation	Sig.
1) Telesno zdravlje / Physical health	.823	.000
2) Psihičko zdravlje / Mental health	.870	.000
3) Socijalni odnosi / Social relations	.868	.000
4) Okruženje / Environment	.866	.000
Statistička značajnost korelacijske na nivou / level of significance $p = 0,001$		

In this way, the established high metric values of the PQL-LS scale create a good basis and the capacity for its research applicability. In addition, the context of the identified scalar averages, based on the self-assessment of all indicators of the quality of life, points to the prominence of respondents' responses towards the positive end of the scale ( $Sv = 6,36$ ) (Table 4). Such results enabled further analysis of its metric characteristics through the determination of factuality.

**Table 4.** Scalar processes of self-assessment of the quality of life by persons with lumbar syndrom

Na ovaj način utvrđene visoke metrijske vrednosti PKŽ-LS skale stvaraju dobru osnovu i kapacitet za njenu istraživačku primenljivost. Uz to i kontekst identifikovanih skalarnih proseka, zasnovanih na samoproceni svih indikatora kvaliteta života, ukazuju na prominentnost odgovora ispitanika koji su usmereni ka pozitivnom kraju skale ( $Sv = 6,36$ ) (Tabela 4). Ovakvi rezultati su omogućili dalju analizu njenih metrijskih karakteristika kroz utvrđivanje faktorijabilnosti.

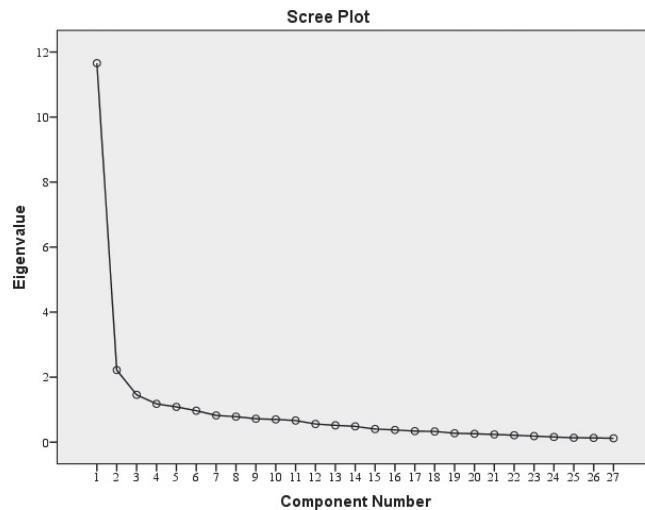
**Tabela 4.** Skalarni proseci samoprocene kvaliteta života osooba sa lumbalnim sindromom

RB / №		Telesno zdravlje / Physical health:	Sv
1	TZ1	Nivo dnevnih fizičkih aktivnosti / Level of daily physical activity	5.58
2	TZ2	Redovnost bavljenja sportsko-rekreativnim aktivnostima / Regularity of sports-recreational activities	4.00
3	TZ3	Telesna kondicija / Body condition	5.00
4	TZ4	Zdravlje u celini / Health in general	6.11
5	TZ5	Bolovi i nelagodnost u telu / Pain and discomfort in the body	5.00
6	TZ6	Spavanje i odmor / Sleep and rest	6.06
7	TZ7	Kvalitet i redovnost dnevnih obroka / Quality and regularity of daily meals	7.01
8	TZ8	Opšti radni kapacitet / General working capacity	6.65
<b>Ukupno TZ / Total PH:</b>			<b>5.68</b>
Psihičko zdravlje / Mental Health:			Sv
9	PZ9	Predstava o sopstvenom telesnom izgledu / The image of your physical appearance	6.62
10	PZ11	Učestalost pozitivnih osećanja / The frequency of positive feelings	6.54
11	PZ12	Lično samopouzdanje / Self-confidence	6.98
12	PZ14	Lična uverenja / Personal beliefs	7.80
13	PZ15	Pamćenje i koncentracija / Memory and concentration	7.67
<b>Ukupno PZ / Total MH:</b>			<b>7.12</b>
Socijalni odnosi / Social relations:			Sv
14	SO16	Lično (unutrašnje) stanje / Personal (internal) condition	7.11
15	SO17	Društveni odnose i podrška okoline / Social relations and environmental support	7.23
16	SO18	Seksualna aktivnost / Sexual activity	6.12
17	SO19	Odnosi sa vršnjacima/prijateljima / Relationships with peers/friends	7.60
18	SO20	Kontakti na društvenim mrežama / Contacts on social networks	5.70
<b>Ukupno SO / Total SR:</b>			<b>6.75</b>
Okruženje / Environment:			Sv
19	O21	Izvori finansija/finansijska stabilnost / Sources of finance/financial stability	6.45
20	O22	Osećaj slobode, fizičke bezbednosti i lične sigurnosti / A sense of freedom, physical security and personal security	7.29
21	O23	Kvalitet i dostupnost zdravstvene i socijalne zaštite / Quality and accessibility of health and social care	6.12
22	O24	Radno mesto / Workplace	6.15
23	O25	Porodično okruženje / Family environment	8.06
24	O26	Mogućnosti za sticanje novih znanja i veština u našoj zemlji / Opportunities for acquiring new knowledge and skills in our country	5.94
25	O27	Mogućnosti za upražnjavanje rekreacije i sporta u mestu stanovanja / Possibilities for practicing recreation and sports in the place of residence	6.02
26	O28	Kvalitet životne sredine (zagadenje, buka, klima) / Environmental quality (pollution, noise, climate)	5.48
27	O29	Kvalitet saobraćaja i prevoza u mestu stanovanja / The quality of traffic and transport in the town of residence	5.39
<b>Ukupno O / Total E:</b>			<b>6.32</b>
<b>Ukupna Sv – PKŽ-LS / Total Sv – PQL-LS:</b>			<b>6.36</b>

In order to further assess the validity of PQL-LS, the process of factor analysis was applied. All 27 scale items were subjected to an analysis of the main components (PCA), preceded by an assessment of the adequacy of data for factor analysis. By examining the correlation matrix, a lot of coefficients of value of 0,3 and more were recorded. In accordance with the Kaiser-Meyer-Olkin (Sampling Adequacy) criterion, which defines the necessary recommended value of 0.6 (Kaiser, 1970, 1974), in this case it was exceeded at a statistically viable level (0.901). Also, Bartlett's test of sphericity (Bartlett, 1954) reached a statistical significance ( $Sig. = ,000$ ) indicating high factuality of the correlation matrix.

The analysis of the main components obtained after the Oblimin rotation revealed the presence of five components with characteristic values (Eigenvalues) over one, which explain 43.17%, 8.27%, 5.37%, 4.29% and 4.07% variance. However, the obtained fracture diagram (Scree plot) showed a clear fracture point already behind the first component (Figure 1).

**Figure 1.** Scree Plot scale PQL-LS



**Slika 1.** Tačka preloma (Scree Plot) skale PKŽ-LS

Based on Kattel's criterion (Kattel, 1966), it was decided to retain only one component. This was also supported by the results of a parallel analysis with one component whose characteristic values exceed the corresponding threshold values obtained using an equally large matrix of random numbers (27 variables x 202 subjects). This one-component solution explained the acceptable part of the total variance (43.17%), which is in line with the recommended procedures for interpreting the results of factor analysis (Pallant, 2009).

U cilju nastavka procene validnost PKŽ-LS primenjen je postupak faktorske analize. Svi 27 ajtema skale podvrgnuto je analizi glavnih komponenti (PCA), čemu je prethodila ocena prikladnosti podataka za faktorsku analizu. Pregledom korelace matrice evidentirano je veoma mnogo koeficijenata vrednosti 0,3 i više. U skladu sa Kajzer-Majer-Olkinovom kriterijumom (*Kaiser-Meyer-Olkin Measure of Sampling Adequacy*) koji definiše neophodnu preporučen u vrednost od 0,6 (Kaiser, 1970, 1974) u ovom slučaju je bila premašena na statistički visokom nivou (0,901). Takođe je i Bartletov test sferičnosti (*Bartlett's test of sphericity*) (Bartlett, 1954) dostigao statističku značajnost ( $Sig.= ,000$ ) što ukazuje na visoku faktorabilnost korelace matrice.

Analiza glavnih komponenti dobijenih nakon Oblimin rotacije, otkrila je prisustvo pet komponenti sa karakterističnim vrednostima (Eigenvalues) preko jedan, koje objašnjavaju 43,17%, 8,27%, 5,37%, 4,29% i 4,07% varijanse. Međutim, dobijeni dijagram preloma (Scree plot) pokazao je postojanje jasne tačke preloma već iza prve komponente (Slika 1).

Na osnovu Katelovog kriterijuma (Kattel, 1966) odlučeno je da se zadrži samo jedna komponenta. To su podržali i rezultati paralelne analize sa jednom komponentom čije karakteristične vrednosti premašuju odgovarajuće vrednosti praga dobijene pomoću jednak velike matrice slučajnih brojeva (27 varijabli x 202 ispitanika). Ovakvo jednofaktorsko rešenje (*single component*) objasnilo je prihvatljiv deo ukupne varijanse (43,17%), što je u skladu i sa preporučenim procedurama tumačenja rezultata faktorske analize (Pallant, 2009).

All 27 variables gave the corresponding weight of the single extracted component (Table 5) to determine that the PQL-LS scale has a correct validity.

**Table 5. Descriptiv statistic the PQL-LS scale for isolated factor**

RB / No.	Ajtemi skale / Aitems	Matrica strukture / Structure matrix	Komunaliteti / Communalities
1	TZ1	.636	.405
2	TZ2	.584	.341
3	TZ3	.638	.407
4	TZ4	.757	.573
5	TZ5	.416	.173
6	TZ6	.690	.476
7	TZ7	.574	.329
8	TZ8	.713	.509
9	PZ9	.648	.420
10	PZ11	.674	.455
11	PZ12	.788	.620
12	PZ14	.696	.484
13	PZ15	.612	.374
14	SO16	.821	.674
15	SO17	.809	.655
16	SO18	.679	.461
17	SO19	.715	.512
18	SO20	.589	.347
19	O21	.780	.609
20	O22	.744	.554
21	O23	.532	.283
22	O24	.665	.442
23	O25	.670	.449
24	O26	.641	.412
25	O27	.667	.445
26	O28	.340	.116
27	O29	.366	.134

KMO Measure of Sampling Adequacy = 0,901 / KMO Measure of Sampling Adequacy = 0,901  
Bartlett's Test of Sphericity = 3550,034 Sig. = ,000 / Bartlett's Test of Sphericity = 3550,034 Sig. = ,000

Also, the results of the internal characteristics of the subscales (within the PQL-LS scale) showed good factuality, which clearly speaks of the metric correctness of this instrument (Table 6).

Svih 27 varijabli dalo je odgovarajuću faktorsku težinu jedinoj ekstrahovanoj komponenti (Tabela 5) čime je utvrđeno da PKŽ-LS skala ima korektnu validnost.

**Tabela 5. Deskriptivni pokazatelji PAŽS skale izolovanog faktora**

Takođe su i rezultati unutrašnjih karakteristika susekskala (unutar PKŽ-LS skale) pokazale dobru faktorabilnost, što jasno govori o metrijskoj korektnosti ovog instrumenta (Tabela 6).

**Table 6.** Descriptive indicators of factoriability within the subscales (POL-LS)

RB / No.	Subskala / Subscale	KMO & Bartletts'	% varianse / % variancje	Ajtemi / Ajtems	Matrica strukture / Structure matrix	Komunaliteti / Communalities
1				TZ1	.0786	.618
2				TZ2	.773	.597
3				TZ3	.855	.732
4	Telesno zdravlje / <i>Physical health</i>	KMO = 0,852 BTS = 834,368 Sig.=0,000	55.45	TZ4	.809	.654
5				TZ5	.522	.273
6				TZ6	.721	.520
7				TZ7	.653	.427
8				TZ8	.784	.615
9				PZ9	.704	.495
10				PZ11	.798	.637
11	Psihičko zdravlje / <i>Mental health</i>	KMO = 0,809 BTS = 369,718 Sig.=0,000	59.17	PZ12	.870	.757
12				PZ14	.793	.629
13				PZ15	.664	.440
14				SO16	.867	.751
15				SO17	.835	.697
16	Socijalni odnosi / <i>Social relations</i>	KMO = 0,844 BTS = 474,477 Sig.=0,000	65.55	SO18	.812	.659
17				SO19	.811	.658
18				SO20	.720	.519
19				O21	.822	.676
20				O22	.827	.684
21				O23	.695	.483
22				O24	.731	.535
23	Okruženje / <i>Environment</i>	KMO = 0,836 BTS = 734,710 Sig.=0,000	47.87	O25	.748	.560
24				O26	.645	.416
25				O27	.700	.490
26				O28	.468	.219
27				O29	.497	.247

Based on the identified good metric characteristics, this scale can be recommended for use as a unique/autonomous multi-item scale designed to assess the perception of the quality of life of adults with lumbar syndrome (general quality of life factor).

## DISCUSSION

An assessment of the quality of life is an area that has an expressed dispersivity, i.e. different aspects from which it can be observed. Thus, for example, nutritionists convey a healthy and proper diet as the dominant factor in the quality of life, environmentalists put the preservation of the environment at the forefront, sociologists favor the issue of group dynamics in social relations, economists give preference to economic factors, psychologists study the quality of life from the individual's position, kinesiologists dominantly speak and insist on the importance of physical activity in raising the quality of life, etc. For these and similar reasons, recent research practice has created numerous instruments to assess the quality of life construct.

The assessment of the quality of life, which relates to the area of human health, is comprised of a group of research instruments comprising three subspaces (Martinis,

**Tabela 6.** Deskriptivni pokazatelji faktorabilnosti unutar slobodne skale (PKŽ-LS)

Na osnovu identifikovanih dobrih metrijskih karakteristika ova skala se može preporučiti za primenu kao jedinstvena/samostalna multijtemska skala namenjena proceni percepcije kvaliteta života odraslih osoba sa lumbalnim sindromom (generalni faktor kvaliteta života).

DISKUSIJA

Procena kvaliteta života je područje koje ima izraženu disperzivnost, odnosno različite aspekte sa kojih se može posmatrati. Tako, na primer, nutricionisti apostrofiraju zdravu i pravilnu ishranu kao dominantan činilac kvaliteta života, ekolozi u prvi plan stavlju očuvanost životne sredine, sociolozi favorizuju pitanje grupne dinamike u društvenim odnosima, ekonomisti prednost daju ekonomskim faktorima, psiholozi proučavaju kvalitet života sa pozicija pojedinca, kineziolozi dominantno govore i insistiraju na značaju fizičke aktivnosti u podizanju kvaliteta života, itd. Iz ovih i sl. ičnih razloga novija istraživačka praksa je kreirala brojne instrumente kojima se procenjuje konstrukt kvaliteta života.

Procena kvaliteta života, koji se povezuje sa prostorom čovekovog zdravlja, obuhvaćena je grupom istraživačkog instrumentarija koji razmatra tri subprostora

2005): (1) multidimensional questionnaires that cover a number of areas of quality of life and are applied, as in the population with various diseases, as well as in healthy people; (2) instruments related to specific illnesses developed for use in patients with similar health problems and which include domains of quality of life that are relevant to the individual disease; (3) a group of instruments aimed at measuring individual domains of quality of life (physical health, physical functioning, mental health, etc.).

Thus, the assessment of the quality of life is a complex area that sets many "pitfalls" for researchers, that is, poses a dilemma - how to measure a certain context of quality of life. One of the possible "exits" for researchers related to the field of kinesiology may be based on the current position of the World Health Organization (WHO, 1996), which defines quality of life as the perception of the role of an individual in the context of culture and value patterns in which he/she lives and in relation to individual goals, expectations, standards and aspirations.

As far as the context of a subjective evaluation of the quality of life is concerned (within the broader understanding of the social environment in which an individual exists), questionnaires have been constructed to create the conditions for responding to complex questions about the interaction of psychological, physical and social variables with the individual's health. One of these is WHOQOL-100 questionnaire (estimates 6 domains of quality of life: physical and mental health, independence, social relations, environment and personal beliefs), or its reduced version of WHOQOL-BREF, which evaluates four areas of quality of life (physical health, psychological health, social relations and environment).

Questionnaires are suitable for use, both in the afflicted population and in the healthy population. Metric characteristics, both the basic versions of the questionnaire, and their different shapes and degrees of modification, were confirmed in several studies (De Vries & Van Heck, 1997; Skevington, Lotfy, O'Connell, 2004; Martinis, 2005; Ač-Nikolić, Čanković, Dragnić & Radić, 2010; Karahasanović, Ostojić, & Jukić, 2013; Jašić & Kaluđerović, 2015; Nešić, 2016).

## CONCLUSION

The presented study documented a construct of metric characteristics of a questionnaire designed to assess the quality of life in adults with lumbar syndrome. Based on previous research, the baseline for the selection and design of the assessment scale, and within the research study in the area of AP Vojvodina, a scale was designed for (self) assessment of the quality of life in persons with

(Martinis, 2005): (1) višedimenzionalni upitnici kojima se zahvata veći broj područja kvaliteta života i primjenjuju se, kako kod populacije sa različitim oboljenjima, tako i kod zdravih osoba; (2) instrumenti vezani za konkretna oboljenja, razvijeni za korišćenje kod pacijenata sa sličnim zdravstvenim tegobama i obuhvataju domene kvaliteta života koji su značajni za pojedino oboljenje; (3) grupacija instrumenata usmerena ka merenju pojedinačnih domena kvaliteta života (telesnog zdravlja, fizičkog funkcioniranja, psihičkog zdravlja, i sl.)

Dakle, procena kvaliteta života predstavlja kompleksno područje koje postavlja mnoge "zamke" za istraživače, odnosno postavlja dilemu – kako meriti određeni kontekst kvaliteta života. Jedan od mogućih "izlaza" za istraživače koji su povezani sa područjem kineziologije, može biti oslođen na još uvek aktuelan stav Svetske zdravstvene organizacije (WHO, 1996) kojim se kvalitet života definiše kao percepcija uloge pojedinca u kontekstu kulture i vrednosnih obrazaca u kojima živi i, u odnosu na individualne ciljeve, očekivanja, standarde i težnje. Kako se ovde radi o kontekstu subjektivne evaluacije kvaliteta života (u okviru šireg poimanja socijalnog okruženja u kojem pojedinac egzistira) konstruisani su upitnici kojima se nastojalo stvoriti uslove za davanje odgovora na kompleksna pitanja o međusobnom uticaju psiholoških, fizičkih i socijalnih varijabli na zdravlje pojedinca. Jedan od takvih je i WHOQOL-100 upitnik (procenjuje 6 domena kvaliteta života: telesno i psihičko zdravlje, nezavisnost, socijalne odnose, okolinu i lična uverenja), odnosno njegova redukovana verzija WHOQOL-BREF kojom se procenjuju četiri prostora kvaliteta života (telesno zdravlje, psihičko zdravlje, socijalni odnosi i okruženje). Upitnici su podesni za primenu, kako kod obolelih osoba, tako i kod zdrave populacije. Metrijske karakteristike, kako osnovnih verzija upitnika, tako i njihovih različitih oblika i stepena modifikacije, potvrđene su u više istraživanja (De Vries & Van Heck, 1997; Skevington, Lotfy, O'Connell, 2004; Martinis, 2005; Ač-Nikolić, Čanković, Dragnić & Radić, 2010; Karahasanović, Ostojić, & Jukić, 2013; Jašić & Kaluđerović, 2015; Nešić, 2016).

## ZAKLJUČAK

Prezentovana studija dokumentovala je konstrukt metrijskih karakteristika jednog upitnika namenjenog proceni kvaliteta života kod odraslih osoba sa lumbalnim sindromom. Na temelju ranijih istraživanja, kao polazne osnove za izbor i dizajn skale procene, a u okviru istraživačke studije na području AP Vojvodine, konstruisana je skala namenjena (samo)proceni kvaliteta života kod osoba sa lumbalnim sindromom (PKŽ-LS). Primenjeni upitnik/

lumbar syndrome (PKŽ-LS).

The applied questionnaire/scale is based on the WHOQOL-BREF instrument and is determined by the coverage of four domains of quality of life (subscales): physical health - 8 items, mental health - 5 items, social relations - 5 items, environment - 9 items.

The instrument is dimensioned in the form of a ten-step numerical scale, where the intensity of one (1) represents the lowest, and ten (10) highest levels of satisfaction in each indicator of quality of life that make up its construct. Such a metric solution enables the results of (self) assessment of quality of life, based on the range of scalar averages, to obtain qualitative features: (1-2) poor quality of life, (3-4) satisfactory quality of life, (5-6) good quality of life, (7-8) very good quality of life, (9-10) excellent quality of life.

The use of the Scale Reliability Analysis process has determined the high value of the Cronbach's Alpha Coefficient (Cronbach's Alpha = 0,947) for the scale as a whole. Also, in the context of the internal accordance of the defined subscales, the acceptable values of this coefficient were obtained: the physical health domain (0,882), the mental health domain (0,825), the social relations domain (0,868) and the environment domain (0,855), which confirms the good reliability of the PQL-LS scale.

The validity of the scale was analyzed by the method of determining its internal correlation, using the Spearman's Correlation Rank (Spearman's rho). The values that show a high degree of internal correlation of individual domain scores with the total scalar value of the PQL-LS scale (physical health - 0,823; psychological health - 0,870; social relations - 0,868; environment - 0,866) with statistical significance of correlation at the level  $p = 0,001$   $\text{Sig.} = 0,000$ .

In order to determine the latent structure of the factors that determine the perception of the quality of life of adults with lumbar syndrome, factor analysis was applied. In this way, additional confirmation of the metric validity of the PQL-LS scales as a whole was performed. The obtained values of the Bartlett's sphericity test (Bartlett's Test of Sphericity = 3550,034) and the Kaizer-Meyer-Oklin sample of adequacy ( $KMO = 0,901$ ) indicate a high validity of the scale and the justification of the application of factor analysis, given that all 27 variables of the scale gave the corresponding factor weight of the single extracted component (general quality of life factor).

The application of the PQL-LS scale was shown on the example of a number of people with lumbar syndrome from the area of AP Vojvodina who was undergoing a physical treatment at the Physical Medicine and Rehabilitation Ordinations in four Vojvodina towns (Novi Sad, Subotica, Kanjiža and Bačka Palanka). The following surveys are

skala baziran je na instrumentu WHOQOL-BREF i determiniše ga obuhvat četiri domena kvaliteta života (subskale): telesno zdravlje – 8 ajtema, psihičko zdravlje – 5 ajtema, socijalni odnosi – 5 ajtema, okruženje – 9 ajtema.

Instrument je dimenzioniran u obliku desetostepene numeričke skale, gde je intenzitet jedan (1) predstavlja najniži, a deset (10) najviši stepen zadovoljstva u svakom indikatoru kvaliteta života koji čine njen konstrukt. Ovakvo metričko rešenje omogućava da rezultati (samo)procene kvaliteta života, na osnovu raspona skalarnih proseka, dobiju kvalitativna obeležja: (1-2) *loš kvalitet života*, (3-4) *zadovoljavajući kvalitet života*, (5-6) *dobar kvalitet života*, (7-8) *veoma dobar kvalitet života*, (9-10) *odličan kvalitet života*.

Primenom postupka kojim se vrši identifikacija unutrašnje saglasnosti skale (*Scale Reliability Analysis*) utvrđena je visoka vrednost Kronbahovog alfa koeficijenta (*Cronbach's Alpha* = 0,947) za skalu u celini. Takođe i u kontekstu unutrašnje saglasnosti definisanih subskala dobijene su prihvatljive vrednosti ovog koeficijenta: domen *telesno zdravlje* (0,882), domen *psihičko zdravlje* (0,825), domen *socijalni odnosi* (0,868) i domen *okruženje* (0,855), što potvrđuje dobru pouzdanost PŽS-LS skale.

Validnost skale je analizirana postupkom utvrđivanja njene unutrašnje korelacije, primenom Spearmanove korelacijske ranga (*Spearman's rho*). Identifikovane su vrednosti koje pokazuju visok stepen unutrašnje korelacijske skorova pojedinačnih domena sa ukupnom skalarnom vrednošću PŽS-LS skale (telesno zdravlje – 0,823; psihičko zdravlje – 0,870; socijalni odnosi – 0,868; okruženje – 0,866) uz statističku značajnost korelacijske skore na nivou  $p = 0,001$  ( $\text{Sig.} = 0,000$ ).

Radi utvrđivanja latentne strukture faktora koji determinišu percepciju kvaliteta života odraslih osoba sa lumbalnim sindromom primenjena je faktorska analiza. Na ovaj način je, ujedno, izvršeno dodatno potrdjivanje metričke valjanosti PKŽ-LS skale u celini. Dobijene vrednosti Bartletovog testa sferičnosti (*Bartlett's Test of Sphericity* = 3550,034) i Kajzer-Majer-Oklinovog pokazatelja adekvatnosti uzorka ( $KMO = 0,901$ ) ukazuju na visoku validnost skale i opravdanost primene faktorske analize, obzirom da je svih 27 varijabli skale dalo odgovarajuću faktorsku težinu jedinoj ekstrahovanoj komponenti (generalni faktor kvaliteta života).

Primena PKŽ-LS skale prikazana je na primeru jednog broja osoba sa lumbalnim sindromom sa područja AP Vojvodine koje su se u vreme anketiranja nalazile na fizijatrijskom tretmanu u Ordinacijama fizikalne medicine i rehabilitacije u četiri vojvodanska grada (Novi Sad, Subotica, Kanjiža i Bačka Palanka). Od narednih istraživanja se очekuje da prikazani upitnik/skalu provere na sličnoj

expected to check the displayed questionnaire/scale on a similar population, but in a wider geographical scope. Starting from the good metric characteristics obtained in this study, with respect to and certain limitations of this instrument, it is realistic to expect the PQL-LS questionnaire to be considered applicable in further research practice.

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populaciji, ali u širem geografskom obuhvatu. Polazeći od dobrih metrijskih karakteristika dobijenih u ovoj studiji, uz uvažavanje i određenih ograničenja ovog instrumenta, realno je očekivati da se PKŽ-LS upitnik pokaže primenljivim u daljoj istraživačkoj praksi.

# ANALYSIS OF QUANTITATIVE CHANGE OF MOTOR CHILD INDICATORS OF SECONDARY SCHOOL STUDENTS UNDER THE INFLUENCE OF REGULAR PHYSICAL EDUCATION

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**Abstract:** The research was conducted on a sample of 166 students of „Secondary Technical School Travnik”, first and second malegrade who regularly attended elementary education during the 2016/2017 school year. A total of 15 variables were used in the research to assess the level of motor skills (three variables for assessing the motor skills of basketball, volleyball, handball, volleyball and athletics). The main aim of the research was to determine the quantitative changes of the motor skills of secondary school students through the longitudinal study in one school year duration under the influence of the program contents of regular physical education. Quantitative changes in motor skills and analysis of differences between initial and final measurements were determined by analysis of changes under the difference model and SSDIF analysis (Bonacin, 2004). By projecting measurement data, a hypothetical measurement matrix is defined, and by explicating the set of linear displacements on the association matrix, a structural vector is described describing quantitative changes, taking into account the relations of initial variables. The results of the SSDIF analysis indicate that a one-year curriculum of physical education has caused statistically significant changes in motor skills at the global level ( $p = 0.000$ ). According to the results of the quantitative global changes, they are not particularly significant and extend across a whole set of analyzed variables. The greater the number of variables that contribute to these quantitative changes, but the contributions of some variables to the discriminating function are relatively small, which means that the effects produced are mild, without dramatic changes, and virtually all variables contribute positively.

**Keywords:** quantitative changes, motor skills, physical education

# ANALIZA KVANTITATIVNIH PROMJENA POKAZATELJA MOTORIČKIH ZNANJA UČENIKA SREDNJE ŠKOLE POD UTICAJEM REDOVNE NASTAVE TJELESNOG ODGOJA

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**Apstrakt:** Istraživanje je provedeno na uzorku ispitanika koji je obuhvatilo 166 učenika „Mješovite srednje tehničke škole“ I. i II. razreda muškog spola iz Travnika koji su u toku školske 2016/2017 godine redovno pohađali nastavu tjelesnog odgoja. U istraživanju je primijenjeno ukupno 15 varjabli za procjenu nivoa usvojenosti motoričkih znanja (po tri varijable za procjenu motoričkih znanja košarkače, odbojke, rukometu, nogometu i atletike). Osnovni cilj istraživanja bio je da se longitudinalnom studijom u trajanju jedne školske godine utvrde kvantitativne promjene motoričkih znanja učenika srednje škole pod uticajem programskih sadržaja redovne nastave tjelesnog odgoja. Kvantitativne promjene motoričkih znanja i analiza razlika između inicijalnog i finalnog mjerjenja utvrđeni su analizom promjena pod modelom razlika i SSDIF analizom (Bonacin, 2004). Projekcijom podataka mjerjenja definisana je hipotetska matrica mjerjenja, a eksplikacijom skupa linearnih pomaka na matricu asocijacije dolazi do struktornog vektora koji opisuje kvantitativne promjene, uvažavajući relacije inicijalnih varijabli. Rezultati SSDIF analize ukazuju da je jednogodišnji nastavni program tjelesnog odgoja izazao statistički značajne promjene motoričkih znanja na globalnom nivou ( $p = 0.000$ ). Prema dobijenim rezultatima kvantitativne globalne promjene su nesumnjivo značajne i protežu se preko cijelog skupa analiziranih varijabli. Veći je broj varijabli koje doprinose tim kvantitativnim promjenama, ali su doprinosi pojedinih varijabli diskriminativnoj funkciji relativno mali, što znači da su nastali efekti blagi, bez dramatičnih promjena i u njima pozitivno učestvuju gotovo sve varijable.

**Ključne riječi:** kvantitativne promjene, motorička znanja, tjelesni odgoj

## INTRODUCTION

Physical and health education as an integral part of the educational process in schools has the basic task of applying appropriate kinesiology operators to positive transformation processes in all dimensions that make up the student's personality structure. Today, it is increasingly emphasized that the transformation of anthropological status and improvement of the health status of students is the primary objective of the teaching of physical and health education, and that sports activities are a means of achieving this goal (Milanović et al., 2011, 2015). In the aim of improving the physical abilities and health status of students, there is a need for their testing and establishment of reference parameters (Sekulić, 2007). For this purpose, on the ground of Europe,

Eurotest Battery Test (EUROFIT) stands out, consisting of simple and relatively inexpensive tests, which can be run within regular classes of physical education or supplementary exercises, as well as in medical institutions. Although primarily designed for testing children - students aged 6 to 18, it can be successfully applied in older categories. The effects of physical and health education are primarily reflected in the positive influence on the growth and development of young, on the one hand, and on the increase of motor skills, on the other hand (Višnjić et al., 2004; Neljak, 2015).

The high level of development of motor skills is a good precondition for gaining and adopting new motor skills (moving structures) during the process of teaching physical education. Determining the level of adoption of motor skills within the teaching units has a certain significance in pedagogical and sports practice, both for the rationalization of the application of methodological procedures and for the better planning and programming of teaching contents. In addition, it is also a control of the effects of applying different methods and forms of work in the transformation of methodical knowledge. The study of the effects of the exercise process on the human body is one of the most important subjects of interest in kinesiology science in general (Findak, 2000, Bonacin, 2006). Programmed physical and health education should enable students to meet basic human needs such as the biological need for movement and play and the need for security, order, affiliation, self-esteem and self-actualization. The question is whether the regular physical and health education subject (and other extra-curricular activities) responds to changed living conditions and work in modern society, and how to use the comparative advantages of physical exercise in modern conditions (Findak, Metikoš, Mraković, 1999). In this

## UVOD

Tjelesni i zdravstveni odgoj (TIZO) kao integralni dio vaspitno - obrazovnog procesa u školama ima osnovni zadatak da primjenom odgovarajućih kinezioloških operatora utiče na pozitivne transformacione procese u svim dimenzijama koje čine strukturu ličnosti učenika. Danas se sve više ističe da je transformacija antropološkog statusa i poboljšanje zdravstvenog statusa učenika primarni cilj nastave Tjelesnog i zdravstvenog odgoja, a da su sportske aktivnosti sredstvo za postizanje tog cilja (Milanović i sur. 20011; 2015.). U cilju praćenja razvoja tjelesnih sposobnosti i zdravstvenog statusa učenika u školi pojavila se potreba za njihovim testiranjem i uspostavljanjem referentnih parametara (Sekulić, 2007). U tu svrhu, na tlu Evrope, pa tako i na našim prostorima, izdvojila se Eurofit baterija testova (EUROFIT), sastavljena od jednostavnih i relativno jeftinih testova, koji se mogu izvoditi u okviru redovnih časova tjelesnog odgoja ili dopunskog vežbanja, kao i u medicinskim ustanovama. Iako je prvenstveno dizajnirana za testiranje djece – učenika uzrasta od 6 do 18 godina, uspješno se može primjenjivati i kod starijih uzrasnih kategorija. Efekti nastave tjelesnog i zdravstvenog odgoja ogledaju se prvenstveno u pozitivnom uticaju na rast i razvoj mладог организма, s jedne, i povećanja motoričkih sposobnosti, s druge strane (Višnjić i sur., 2004; Neljak, 2015). Visok nivo razvijenosti motoričkih sposobnosti predstavlja dobar preduslov za sticanje i usvajanje novih motoričkih znanja (kretnih struktura) tokom procesa nastave tjelesnog odgoja. Utvrđivanje nivoa usvojenosti motoričkih znanja u okviru nastavnih cjelina ima određeni značaj u nastavno-pedagoškoj i sportskoj praksi, kako za racionalizaciju primjene metodskih postupaka, tako i za kvalitetnije planiranje i programiranje nastavnih sadržaja koje treba obučavati i usvajati u nastavnom procesu. Pored toga to je ujedno i kontrola uticaja efekata primjene različitih metoda i oblika rada u transformaciji metodičkog znanja. Proučavanje efekata procesa vježbanja na ljudski organizam jedan je od najznačajnijih predmeta interesa kineziološke nauke uopšte (Findak, 2000., Bonacin, 2006). Programirani nastavni sadržaji TIZO treba da omoguće učenicima i svakoj mlađoj osobi zadovoljavanje osnovnih ljudskih potreba kao što su, biološka potreba za kretanjem i igrom te potreba za sigurnošću, redom i poretkom, pripadanjem, samopoštovanjem i samoaktualizacijom. Postavlja se pitanje kako putem redovne nastave TIZO (i drugih izvannastavnih i izvanškolskih aktivnosti), odgovoriti na promijenjene uvjete života i rada u suvremenom društvu, i kako iskoristiti komparativne prednosti tjelesnog vježbanja u civiliziranim uslovima života (Findak, Metikoš, Mraković, 1999.).

sense, systematic and continuous work throughout the school year must be the basic requirement that is placed in front of the students at the school and in front of the professor of physical and health education.

The basic objective of this research is aimed at determining quantitative changes of the motor skills of secondary school students under the influence of current program contents of physical and health education.

## METHODS OF WORK

### *Sample of respondents*

The survey was conducted on a sample of 166 male respondents of the "Secondary technical school Travnik" who regularly attended physical and health education in the school year 2016 / 2017. A comprehensive sample of 166 students is not based on any criteria that could be in correlation with manifest anthropological dimensions. The only criterion for students to be eligible is to be continuous in the teaching process and be completely healthy (all students who are in the period of measurement sick were omitted from the sample). The research will be conducted in regular classes in the subject physical and health education.

### *Pattern of variables*

Pattern of variables for assessing the adoption of motor skills (basketball, handball, volleyball, football and athletics).

Pattern of variables for assessing the level of adoption of motor skills in basketball

For assessing the level of the motor skills of basketball, these tests were used to determine the knowledge of the basic elements of technique: throwing and catching a ball on the wall, for 30", running the ball in the slalom and inserting the ball into the basket for 30".

1. Throwing and catching a ball on the wall for 30 " ..... (SMKBLZ)
2. Running the ball in slalom ..... SMKVLS
3. Inserting ball into basket for 30" ..... SMKBLK)

Pattern of variables for assessing the level of adoption of motor skills in handball

For assessing the level of the motor skills of handball, these tests were used to determine the knowledge of the basic elements of technique: performing seven meter throw, throwing and catching ball on the wall for 30" and running the ball in slalom.

1. Performing seven meter throw ..... SMRSED)
2. Throwing and catching the ball on the wall for 30" ..... (SMRBLZ)
3. Leading the ball in slalom ..... SMRVLS)

U tom smislu sistematski i neprekidan rad tokom cijele školske godine mora biti osnovni zahtjev koji se postavlja pred učenike u školi i pred profesore (nastavnike) TIZO.

Upravo je i osnovni cilj ovog istraživanja usmjeren na utvrđivanje kvantitativnih promjena motoričkih znanja učenika srednje škole pod uticajem aktuelnih programskih sadržaja redovne nastave tjelesnog i zdravstvenog odgoja.

## METODE RADA

### *Uzorak ispitanika*

Istraživanje je sprovedeno na uzorku oko 166 ispitanika - učenika „Mješovite srednje tehničke škole“ muškog spola iz Travnika koji su u školskoj 2016/2017-oj godini redovno pohađali nastavu tjelesnog i zdravstvenog odgoja. Ukupan uzorak od 166 učenika nije zasnovan ni na kakvim kriterijima koji bi mogli biti u korelaciji sa manifestnim antropološkim dimenzijama. Jedini kriterij po kojem će učenici steći pravo da budu dio uzorka je da budu neprekidno u nastavnom procesu i potpuno zdravi (svi učenici koji u periodu mjerena i testiranja budu bolesni, a budu dolazili na nastavu, bit će izostavljeni iz uzorka).

### *Uzorak varijabli*

Uzorak varijabli za procjenu usvojenosti motoričkih znanja (košarke, rukomet, odbojke, nogomet i atletike)

Uzorak varijabli za procjenu nivoa usvojenosti motoričkih znanja košarke

Za procjenu nivoa motoričkih znanja košarke primjenjeni su testovi pomoću kojih se utvrdilo poznavanje osnovnih elemenata tehnike: bacanje i hvatanja lopte o zid za 30", vođenje lopte u slalomu i ubacivanje lopte u koš za 30".

1. Bacanje i hvatanje lopte o zid za 30" ..... (SMKBLZ)
2. Vođenje lopte u slalomu ..... (SMKVLS)
3. Ubacivanje lopte u koš za 30" ..... (SMKBLK)

Varijable za procjenu nivoa usvojenosti motoričkih znanja rukometa

Za procjenu nivoa motoričkih znanja rukometa primjenjeni su testovi pomoću kojih se utvrdilo poznavanje osnovnih elemenata tehnike rukometa: izvođenje sedmerca, bacanje i hvatanje lopte o zid za 30" i vođenje lopte u slalomu.

1. Izvođenje sedmerca ..... (SMRSED)
2. Bacanje i hvatanje lopte o zid za 30" ..... (SMRBLZ)
3. Vođenje lopte u slalomu ..... (SMRVLS)

Varijable za procjenu nivoa usvojenosti motoričkih znanja odbojke

### Pattern of variables for assessing the level of adoption of motor skills in volleyball

For assessing the level of the motor skills of volleyball, these tests were used to determine the knowledge of the basic elements of technique: shooting over the net from the base line, rejection the ball with forearm (hammer) in the 30 " and lower " school "service.

1. Shooting over the net from the base line .....(SMOGCI)
2. Rejection the ball with forearm (hammer) in the 30" .....(SMOČEK)
3. Lower "school" service ..... SMOSRV)

### Pattern of variables for assessing the level of adoption of motor skills in football:

For assessing the level of the motor skills of football, these tests were used to determine the knowledge of the basic elements of technique: Power of striking the ball, leading the ball in slalom, juggling the ball

1. Power of striking the ball ..... SMNSNO)
2. Leading the ball in slalom ..... SMNVLS)
3. Juggling the ball ..... SMNŽON)

### Pattern of variables for assessing the level of adoption of motor skills in athletics:

For assessing the level of the motor skills of athletics, these tests were used to determine the knowledge of the basic elements of technique: long jump, sprint 100m and sprint at 400m.

1. long jump ..... SMASDZ)
2. sprint 100 m ..... SMA100)
3. sprint 400 m ..... SMA400)

## RESULTS AND DISCUSSION

### *Results of SSDIF analysis of quantitative changes in situational and motor skills*

Table 1 shows the results of the SSDIF analysis of quantitative changes in situational and motor skills (induction motions) generated by the teaching of elementary education in one school year. Based on the results presented, it can be seen that quantitative changes at global level are statistically significant,  $p = 0.000$ .

According to the results of the quantitative global changes, they are not doubtful and extend across the entire set of analyzed characteristics of the respondents. The greater the number of variables that contribute to these quantitative changes, but the contributions of some variables to the discriminating function are relatively small. This means that global quantitative effects have been caused by the influence of teaching content, but these effects are mild, with no dramatic changes, and virtually all variables contribute positively to them.

Za procjenu nivoa usvojenosti motoričkih znanja odbjekti primjenjeni su testovi pomoću kojih se utvrdilo poznavanje osnovnih elemenata tehnike odbjekti: gađanje cilja preko mreže iz osnovnog stava, odbijanje lopte podlakticama (čekić) u krugu za 30" i donji „školski“ servis.

1. Gađanje cilja preko mreže iz osnovnog stava(SMOGCI)
2. Odbijanje podlakticama (čekić) u krugu za 30" .....(SMOČEK)
3. Donji „školski“ servis.....(SMOSRV)

Varijable za procjenu nivoa usvojenosti motoričkih znanja nogometu

Za procjenu nivoa usvojenosti motoričkih znanja nogometu primjenjeni su testovi kojima se utvrdilo poznavanje osnovnih elemenata tehnike nogometu: vođenje lopte u slalomu, žongliranje loptom i snaga udarca po lopti nogom.

1. Snaga udarca po lopti nogom .....(SMNSNO)
2. Vođenje lopte u slalomu .....(SMNVLS)
3. Žongliranje loptom.....(SMNŽON)

Varijable za procjenu nivoa usvojenosti motoričkih znanja atletike

Za procjenu nivoa usvojenosti motoričkih znanja atletike primjenjeni su testovi kojima se utvrdilo nivo motoričkih znanja iz nastavne cjeline atletike: skok u dalj iz zaleta, trčanje na 100m i trčanje na 400m.

1. Skok u dalj iz zaleta.....(SMASDZ)
2. Trčanje na 100 m .....(SMA100)
3. Trčanje na 400 m .....(SMA400)

## REZULTATI I DISKUSIJA

### *Rezultati SSDIF analize kvantitativnih promjena situaciono - motoričkih znanja*

U tabeli 1 prikazani su rezultati SSDIF analize kvantitativnih promjena situaciono - motoričkih sposobnosti (motoričkih znanja) nastalih pod uticajem nastavnih sadržaja tjelesnog odgoja u trajanju od jedne školske godine. Na osnovu prikazanih rezultata može se vidjeti da su kvantitativne promjene na globalnom nivou statistički značajne,  $p=0.000$ .

Prema dobijenim rezultatima kvantitativne globalne promjene su nesumnjivo značajne i protežu se preko cijelog skupa analiziranih karakteristika ispitanika. Veći je broj varijabli koje doprinose tim kvantitativnim promjenama, ali su doprinosi pojedinih varijabli diskriminativnoj funkciji relativno mali. Ovo znači da su pod uticajem nastavnih sadržaja izazvani globalni kvantitativni efekti, ali ti efekti su blagi, bez dramatičnih promjena i u njima pozitivno učestvuju gotovo sve varijable.

**Table 1.** Results of SSDIF analysis

Varijable / Variables	A	D	S	R
SMKBLZ	0.8449	30.859	20.081	0.3522
SMKVLS	-0.3604	-21.684	-15.951	-0.2797
SMKBLK	12.567	22.510	22.462	0.3939
SMRSED	0.2337	11.860	11.173	0.1959
SMRBLZ	11.964	25.479	24.382	0.4276
SMRVLS	-0.3454	-20.890	-11.698	-0.2052
SMOGCI	13.351	11.167	21.040	0.3690
SMOČEK	16.320	-14.832	18.566	0.3256
SMOSRV	11.140	26.576	19.949	0.3499
SMNSNO	0.4008	88.677	22.281	0.3908
SMNVLS	-0.6590	-27.300	-17.975	-0.3152
SMNŽON	13.939	0.6906	15.278	0.2679
SMASDZ	163.677	0.4390	29.926	0.5248
SMA100	-0.8161	-81.539	-27.413	-0.4808
SMA400	-12.381	-0.0495	-10.139	-0.1778
M			=	32.5129
H			=	5397.1343
F			=	329.2797
DF1			=	15
DF2			=	151
P			=	<b>0.0000</b>

**Legend:** A-Differentiate Methytic Centers, D-discriminatory factors, S-standardized ortogonal projections, R-structure discrimination factor, M-Mahalanobis distance between center of vector of initial and final measurement, H-Hotelling's T test, Ff-test variance analysis, DF1 and DF2 - degrees of freedom, P - the level of significance or error that claims that there have been significant changes

Table 2 shows the partial tests of differences hypothesis. Based on the results in a given table, it can be seen that the content of physical education during one school year produced statistically significant partial quantitative changes in all applied variables of motor skills (situational-motor spasticity).

**Table 2.** Partial tests of differences hypothesis

**Legend:** F -F-test, P-significance level

**Tabela 1.** Rezultati SSDIF analize

Varijable / Variables	F	P
SMKBLZ	669.3970	0.0000
SMKVLS	422.3516	0.0000
SMKBLK	837.5401	0.0000
SMRSED	207.2101	0.0000
SMRBLZ	986.8081	0.0000
SMRVLS	227.1649	0.0000
SMOGCI	734.8811	0.0000
SMOČEK	572.2009	0.0000
SMOSRV	660.6379	0.0000
SMNSNO	824.1002	0.0000
SMNVLS	536.3744	0.0000
SMNŽON	387.4939	0.0000
SMASDZ	1486.6819	0.0000
SMA100	1247.4630	0.0000
SMA400	170.6626	0.0000

**Legenda:** A-razlike aritmetičkih sredina, D-diskriminativni koeficijenti, S-standardizovane ortogonalne projekcije, R-struktura diskriminacije faktora, M-Mahalanobisova udaljenost između centroida vektora inicijalnog i finalnog mjerjenja, H-Hotellingov T test, F-f-test analize varijance, DF1 i DF2 – stupnjevi slobode, P - razina značajnosti, odnosno pogreška kojom se tvrdi da je došlo do značajnih promjena

U tabeli 2 prikazani su parcijalni testovi hipoteza o razlikama. Na osnovu rezultata u dатој табели може се видjetи да је nastavni sadржај тјесног одgoja у toku jedne školske godine proizveo statistički značajne parcijalne kvantitativne promjene kod svih primijenjenih varijabli motoričkih znanja (situaciono-motoričkih sposobnosti).

**Tabela 2.** Parcijalni testovi hipoteza o razlikama

**Legenda:** F – F-test, P – nivo značajnosti

### ***The focus of quantitative changes of situational motor skills***

In the further analysis process, global directions have been developed in which the above mentioned developments in the use of motor skills have been developed. Table 3 presents the results of the SSDIF analysis-engineer knowledge-driven routing promax measurement difference circuit, which gives us information on the before mentioned global quantitative changes. Based on the results presented in Table 5, it can be seen that the changes took place in six global directions.

The first line describes the manipulation of the object (ball), the explosive power, and the speed of running since it mostly defines manipulative variables for basketball and handball (SMKBLZ 0.5663 and SMRBLZ 0.4770), long jump (SMASDZ -0.5228) and sprint 100 m (SMA100 0.6769).

The second line describes variables for the assessment of motor skills from the teaching content of the spectrum since it most defines the variables for assessing the adoption of volleyball instructional contents (SMOGCI 0.7117, SMOSRV 0.8782, and SMOČEK 0.3575).

The cross-directional (factor) juggling the ball and sprint 400 m because it defines the variables of the ball scoring and running speeds at 400 m (SMNŽON 0.8036 and SMA400 -0.7769). This is where the endurance has come to fruition, because it is the ability to successfully handle the ball.

The fourth factor describes the precision of running seven in the hand, as it defines a variable to evaluate the performing seven meter throw (SMRSED 0.7866).

The fifth factor describes the speed of running a ball in slalom and rejecting the ball with forearm (hammer) it defines the variable to assess the (SMKVLS 0.4812, SMRVLS 0.7943, SMNVLS 0.6848 and SMOČEK -0.4224). Here the speed reached keeping the ball in the slalom.

The sixth line (factor) best describes variables SMKBLZ 0.7880 and SMOGCI 0.4344).

The acquired factors describe the complete area of motor knowledge, which is very important information, because it points to the fact that the programmed and systematic realization of the educational content of physical education leads to the optimization of the control of the specific movement structure and enables the development of general motor skills in its entirety.

### ***Usmjerenošć kvantitativnih promjena situaciono-motoričkih znanja***

U daljem postupku analize prikazani su globalni pravci u kojima su se razvijale navedene promjene usvojenosti motoričkih znanja. U tabeli 3 prezentovani su rezultati SSDIF analize motoričkih znanja- koso rotirani promax sklop razlika mjerena koja nam daje informacije o usmjerenošći navedenih globalnih kvantitativnih promjena. Na osnovu prezentovanih rezultata u tabeli 5 može se vidjeti da su se promjene odvijale u šest globalnih pravaca.

Prvi pravac (faktor) opisuje manipulisanje objektom (loptom), eksplozivna snaga i brzina trčanja, jer ga najviše definišu varijable za procjenu manipulisanja košarkaškom i rukometnom loptom (SMKBLZ 0.5663 I SMRBLZ 0.4770), skok u dalj iz zaleta (SMASDZ -0.5228) i brzina trčanjana 100 m (SMA100 0.6769).

Drugi pravac (faktor) opisuju varijable za procjenu motoričkih znanja iz nastavnog sadržaja odbojke, jer ga najviše definišu varijable za procjenu usvojenosti nastavnih sadržaja odbojke (SMOGCI 0.7117, SMOSRV 0.8782, i SMOČEK 0.3575).

Treći pravac (faktor) opisuje baratanje lopte nogom i trčanja na 400 m, jer ga definišu varijable za procjenu baratanja loptom i brzine trčanja na 400 m (SMNŽON 0.8036 i SMA400 -0.7769). Ovdje je do izražaja došla izdržljivost, jer je to sposobnost koja je naophodna u uspješnom baratanju loptom.

Četvrти pravac (faktor) opisuje preciznost izvođenja sedmerca u rukometu, jer ga definiše varijabla za procjenu pracznosti pogađanja gola (SMRSED 0.7866).

Peti pravac (faktor) opisuje brzinu vođenja lopte u slalomu i odbijanje lopte „čekićem“, jer ga definišu varijable za procjenu brzine vođenja lopte u slalomu (SMKVLS 0.4812, SMRVLS 0.7943, SMNVLS 0.6848 i SMOČEK -0.4224).

Šesti pravac (faktor) najbolje opisuju varijable SMKBLZ 0.7880 i SMOGCI 0.4344).

Dobijeni faktori opisuju kompletan prostor motoričkih znanja što je vrlo važna informacija, jer upućuje na činjenicu da programirana i sistematska realizacija nastavnih sadržaja tjelesnog odgoja dovodi do optimizacije upravljačkog sklopa specifičnih struktura kretanja (motoričkih znanja).

**Table 3.** Compact Promax Measurement Differentiation Module

Varijable / Variables	PX1	PX2	PX3	PX4	PX5	PX6
SMKBLZ	0.5635	-0.0758	0.2299	0.1596	-0.2665	0.0118
SMKVL	-0.0451	-0.3980	0.0009	-0.1442	0.4812	0.3312
SMKBLK	0.1340	0.1116	-0.0990	-0.0934	-0.2172	0.7780
SMRSED	0.1076	-0.2386	-0.0747	0.7866	0.0627	0.0739
SMRBLZ	0.4770	0.3085	0.2869	0.2232	0.1316	0.0739
SMRVLS	-0.1166	0.1782	-0.0200	0.2054	0.7943	-0.0351
SMOGCI	0.1021	0.7127	0.0239	-0.1952	0.0845	0.4344
SMOČEK	-0.1635	0.3575	-0.0671	0.3230	-0.4224	0.1698
SMOSRV	-0.0582	0.8782	-0.0727	-0.0653	0.1138	-0.0392
SMNSNO	0.0147	0.0619	-0.0639	0.7766	0.0613	-0.1545
SMNVLS	0.0703	0.0678	0.0130	-0.0027	0.6848	-0.2496
SMNŽON	0.0960	-0.0790	0.8036	0.0592	0.0194	0.0136
SMASDZ	-0.5228	-0.0440	0.1306	0.2624	0.0485	0.5130
SMA100	0.6769	-0.0595	-0.2959	0.0092	0.0559	0.0731
SMA400	0.2056	-0.0008	-0.7769	0.2283	0.0289	0.0804

**Legend:** PX1, PX2, PX3, PX4, PX5, PX6 - rotated promax factors

Table 4 shows the correlation of isolated promax factors. From the table it can be noticed that no statistically significant relationship between the promax factor was achieved.

**Table 4.** Promax factor correlations (PX1, PX2, PX3, PX4, PX5, PX6 = promax factors)

Faktori / Factors	PX1	PX2	PX3	PX4	PX5	PX6
PX1	1.0000	0.0410	0.0217	0.0398	-0.1400	-0.0023
PX2	0.0410	1.0000	0.1018	0.2051	-0.2454	0.0514
PX3	0.0217	0.1018	1.0000	0.1959	-0.1761	0.0659
PX4	0.0398	0.2051	0.1959	1.0000	-0.2851	0.1148
PX5	-0.1400	-0.2454	-0.1761	-0.2851	1.0000	0.0054
PX6	-0.0023	0.0514	0.0659	0.1148	0.0054	1.0000

**Legend:** PX1, PX2, PX3, PX4, PX5, PX6 - rotated promax factors

#### Analysis of translation and dilatation of situational - motor skills

Table 5 shows the results of the analysis of translation and dilatation of the level of motor skills. Based on the analysis of the results shown in the given table it can be seen that the linear changes in the final measurement were much greater than the initial measurement. The biggest shifts occurred at long jump (SMASDZ 1.04), throwing and catching the ball on the wall for 30" (SMRBLZ 1.09), shooting over the net from the base line (SMOGCI 1.25), rejection the ball with forearm (hammer) in the 30". (SMOČEK 1.04), the lower "school"

**Tabela 3.** Koso rotirani promax sklop razlika mjerena

Varijable / Variables	PX1	PX2	PX3	PX4	PX5	PX6
Legenda: PX1, PX2, PX3, PX4, PX5, PX6 - koso rotirani promax faktori						

U tabeli 4 prikazana je povezanost izolovanih promax faktora. Iz tabele je uočljivo da nisu ostvarene statistički značajne veze između promax faktora.

**Tabela 4.** Korelacije promax faktora (PX1, PX2, PX3, PX4, PX5, PX6 = promax faktori)

Faktori / Factors	PX1	PX2	PX3	PX4	PX5	PX6
Legenda: PX1, PX2, PX3, PX4, PX5, PX6 – koso rotirani promax faktori						

#### Analiza translacije i dilatacije situaciono - motoričkih znanja

U tabeli 5 prikazani su rezultati analize translacije i dilatacije nivoa motoričkih znanja. Na osnovu analize rezultata prikazanih u dатој tabeli može se uočiti da su linearni pomaci u finalnom mjerenu bili mnogo veći u odnosu na inicijalno mjerjenje. Najveći pomaci desili su se kod varijable skok u dalj iz zaleta (SMASDZ 1.04), bacanje rukometne lopte o zid za 30 sec. (SMRBLZ 1.09), gađanje cilja preko mreže iz osnovnog stava (SMOGCI 1.25), odbijanje podlakticama („čekić“) u krugu za 30 sec. (SMOČEK 1.04), donji „školski“ servis (SMOSRV

service (SMOSRV 1.18), sprint at 100 m (SMA100 0.94) and sprint at 400 m (SMA400 0.98).

When dilation is concerned, it can be seen that the areas of action are narrowing. Students adhere to the demands of the teaching process in a unique way, ie. they adopt a unique technique. This implies a unique approach to learning of motor skills and in this way the students responded positively to the expected requirements.

**Table 5.** Analysis of translation and dilatation of situational-motor abilities

Varijable / Variables	MEAN-1	MEAN-2	DELTA	TL	VAR-1	VAR-2	DT
SMKBLZ	14.7354	15.5802	0.8449	1.0573	3.4535	3.2283	0.9668
SMKVLZ	8.2151	7.8547	-0.3604	0.9561	1.4486	1.2675	0.9354
SMKBLK	11.9078	13.1646	1.2567	1.1055	9.1382	8.3826	0.9578
SMRSED	2.8134	3.0471	0.2337	1.0831	0.2635	0.2044	0.8808
SMRBLZ	13.0546	14.2510	1.1964	1.0916	1.8774	1.6915	0.9492
SMRVLS	8.0648	7.7193	-0.3454	0.9572	0.5761	0.5596	0.9856
SMOGCI	5.3357	6.6708	1.3351	1.2502	2.3791	2.1217	0.9443
SMOČEK	37.4142	39.0463	1.6320	1.0436	23.1655	20.9066	0.9500
SMOSRV	6.0486	7.1627	1.1140	1.1842	2.5031	2.4151	0.9823
SMNSNO	1.9857	2.3865	0.4008	1.2018	0.2256	0.1675	0.8617
SMNVLS	13.6727	13.0137	-0.6590	0.9518	2.0841	1.7783	0.9237
SMNŽON	12.1527	13.5466	1.3939	1.1147	2.0479	1.5816	0.8788
SMASDZ	347.4698	363.8375	16.3677	1.0471	2763.1603	2817.8541	1.0098
SMA100	14.3648	13.5487	-0.8161	0.9432	2.4064	2.2887	0.9752
SMA400	79.3919	78.1539	-1.2381	0.9844	99.2085	97.2481	0.9901

**Legend:** Mean-1,2 = arithmetic meanings in 1st and 2nd measurements, DELTA = difference, TL = translation coefficient, VAR-1,2 = variance in 1st and 2nd measurements, DT = dilation coefficient

The processing of the obtained results is aimed at obtaining reliable information on partial and global quantitative changes that occurred in the exploration space during a school year under the influence of teaching contents of physical and health education. The results obtained from this research indicate that the one-year content of the physical and health education in secondary school students has caused some quantitative changes. Changes are comparable both at a global and partial level. The question is justified. Did the regular teaching of physical education also lead to qualitative (structural) and doctrinal changes? It is very important to know if there will be a structurally varied stimulus program that it is able to change the relationships between variables. These changes are different, uneven. What should be conceived of a work program that is emerging to challenge it. If the work is performed in the maximum intensity zone we encounter, then it would

1.18), trčanje na 100 m (SMA100 0.94) i nešto manje trčanje na 400 m (SMA400 0.98).

Kada je dilatacija u pitanju može se vidjeti da se prostori djelovanja sužavaju. Učenici usvajaju zahtjeve nastavnog procesa na jedinstven način, tj. usvajaju jedinstvenu tehniku. Ovo upućuje na jedinstven pristup učenju motoričkih znanja i učenici su na takav način rada pozitivno reagovali i prihvatali predviđene zahtjeve.

**Tabela 5.** Analiza translacije i dilatacije situaciono-motoričkih sposobnosti

**Legenda:** Mean-1,2 = aritmetičke sredine u 1. i 2. mjerenu, DELTA = razlika, TL = koeficijent translacije, VAR-1,2 = varijanca u 1. i 2. mjerenu, DT = koeficijent dilatacije

Obrada dobijenih rezultata usmjerena je tako da se dobiju pouzdane informacije o parcijalnim i globalnim kvantitativnim promjenama do kojih je došlo u istraživanom prostoru (motorička znanja) u toku jedne školske godine pod uticajem nastavnih sadržaja tjelesnog odgoja. Dobijeni rezultati ovog istraživanja ukazuju da je jednogodišnji nastavni sadržaj tjelesnog i zdravstvenog odgoja kod učenika srednje škole nasumnjivo izazvao kvantitativne promjene. Promjene su vidljive i na globalnom i parcijalnom nivou. Opravdano se postavlja pitanje. Da li je pod uticajem redovne nastave tjelesnog odgoja došlo i do kvalitativnih (strukturalnih) i do kvantitativnih promjena? Ono što je vrlo važno znati, to je da bi uopšte došlo do strukturalnih promjena program nadražaja mora biti takav da je u stanju promijeniti odnose između dimenzija, tj. varijabli. Te promjene su različite, nejednake. Kakav treba koncipirati program rada koji je u stanju da

surely dominate quantitative changes in relation to structural. Due to the fact that school work on teaching content education, these activities are performed in a medium intensity area. However, the changes that have occurred are mild and not dramatic. Numerous studies in the field of physical and health education have shown that combinational classes of physical education and other organizational forms of activity (extracurricular, extra-school, school sports societies, various forms of supplementary and additional tuition) gave many and significant effects (Džibrić et al., Selmanović et al., 2008, Ferhatbegović et al., 2010, Bajrić et al. 2012a; 2012b., Badrić et al. 2015, 2016.). The research provides persuasive arguments that is necessary to provide, along with regular physical education, additional hours of physical exercise, which would first meet the needs of children for physical activity and prevent the various types of diseases that occur due to obesity and insufficient activity (Rađo, 2003, Jurak , 2007., Hodžić, 2008., Nikolić, 2008., Milenković, 2011.).

## CONCLUSION

The main objective of the research is to determine the quantitative changes in the level of the adopted theoretical knowledge of high school students under the influence of current program of physical and health education. The survey was conducted on a sample of 166 male students of "Secondary Technical School Travnik", I and II grade, who regularly attended classes during the school year 2016/2017. The survey was applied by three variables to assess the level of adoption of motor skills of basketball, handball, volleyball, football and athletics. The results of the research indicate that the current program contents of physical and health education course during one school year produced significant positive effects on improving the level of adoption of motor skills in basketball, handball, volleyball, football and athletics. The obtained results of the SSDIF analysis of the strength of the motor skills - the spin-routed promax circuit measurement measure tells us that the changes took place in six global directions (actors) that describe the complete range of motor skills, which is very important information because it suggests that programmed systematic realization of teaching contents of physical and health education leads to optimization of the control structure of the specific movement structure and allows for the development of the general motive abilities of ingenuity. Obviously, there has been an significant introduction of general motor resources in the motor skills group, which is a significant information, because opportunities for development and integration of basic skills and motor skills are very large in high school students.

to izazove. Kada bi se rad izvodio u zoni maksimalnog intenziteta koji susrećemo u sportu, onda bi sigurno dominirale kvantitativne promjene u odnosu na strukturalne. Obzirom da se u školi radi na edukaciji nastavnih sadržaja, to se takve aktivnosti izvode u zoni srednjeg intenziteta opterećenja. Međutim, nastale promjene su blage i nisu dramatične. Mnoga dosadašnja istraživanja u oblasti tjelesnog i zdravstvenog odgoja su pokazala da kombinacija redovne nastave tjelesnog odgoja i drugih organizacijskih oblika aktivnosti (vannastavne, vanškolske, školska sportska društva, razni oblici dopunske i dodatne nastave...) daju mnogo veće i značajnije efekte (Džibrić i sar. 2009., Selmanović i sur. 2008., Ferhatbegović i sar. 2010., Bajrić i sar. 2012a; 2012b., Badrić i sar. 2015; 2016.). Istraživanje daje uvjerljive argumente da je učenicima, uz redovnu nastavu tjelesnog odgoja, potrebno uvođenje dodatnih sati tjelesnog odgoja, koji bi prije svega zadovoljili potrebe djece za tjelesnom aktivnošću i bili prevencija različitim vrstama oboljenja koja se javljuju uslijed pretilosti i nedovoljne aktivnosti djece (Rađo, 2003., Jurak, 2007., Hodžić, 2008., Nikolić, 2008., Milenković, 2011.).

## ZAKLJUČAK

Osnovni cilj istraživanja usmjeren na utvrđivanje kvantitativnih promjena nivoa usvojenosti motoričkih znanja učenika srednje škole pod uticajem aktualnih programskih sadržaja redovne nastave tjelesnog i zdravstvenog odgoja. Istraživanje je provedeno na uzorku ispitanika koji je obuhvatilo 166 učenika „Mješovite srednje tehničke škole“ I. i II. razreda muškog spola iz Travnika koji su u toku školske 2016/2017 godine redovno pohađali nastavu tjelesnog odgoja. U istraživanju je primijenjeno po tri varijable za procjenu nivoa usvojenosti motoričkih znanja košarke, odbojke, rukometa, nogometa i atletike. Rezultati istraživanja ukazuju da su aktuelni programski sadržaji redovne nastave tjelesnog i zdravstvenog odgoja u toku jedne školske godine proizveli značajne pozitivne efekte na poboljšanje nivoa usvojenosti motoričkih znanja košarke, odbojke, nogometa, rukometa i atletike. Dobijeni rezultati SSDIF analize nivoa usvojenosti motoričkih znanja - koso rotitrani promax sklop razlika mjerena nas upućuju na zaključak da su se promjene odvijale u šest globalnih pravaca (faktora) koji opisuju kompletan prostor motoričkih znanja što je vrlo važna informacija.

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## HEALTH FITNESS – TRUTH OR MARKETING

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**Abstract:** Numerous scientific studies have shown that physical activity has a positive effect on the health of modern people. Exercise for health is one of the main contents on which the promotion of fitness is based. The fitness industry rapidly develops and creates more and more money. The term health fitness is often misused because of the increased profit. In practice, there are more and more programs that have the prefix health, but they are essentially classic marketing. The aim of this paper is to point out to the incorrect and uncritical interpretation of health fitness. There are three examples that illustrate the ability to manipulate people who do not understand what health fitness is. Lumbar syndrome (back pain), osteoporosis and action of so-called hormones of happiness were analyzed.

**Key words:** *health, fitness, lumbar syndrome, osteoporosis, osteopenia, physical activity, endorphin, serotonin.*

### INTRODUCTION

It is difficult to precisely determine a person's health. This fact is supported by WHO (2006) definition, where health is not only linked to the absence of illness, but to the condition of the total physical, mental, and social well-being. Certain later definitions (Taylor & Marandi, 2008; Bellieni & Buonocore, 2009; Huber et al., 2011) also indicate the complexity of the term health, whereby only certain aspects of it are emphasized (bodily functions, metabolic efficiency, absence of pain, the feeling of personal satisfaction, etc.). There is a large number of factors influencing a person's health which are divided into two large groups according to the WHO (2006) documents: endogenous (factors of heritage, genetics) and exogenous (economic factors, socio-cultural determinants, physio-biological environment, etc.). One of the most important exogenous factors of a modern person's health, as well as in scientific and quasi-scientific, program-propaganda, or even political texts - is physical ac-

## ZDRAVSTVENI FITNES – ISTINA ILI MARKETING

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**Apstrakt:** Brojne naučne studije su dokazale da fizička aktivnost ima pozitivan uticaj na zdravlje savremenog čoveka. Jedan od glavnih sadržaja na kojima se zasniva promocija fitnesa je vežbanje zbog zdravlja. Fitnes industrija se brzo razvija i obrće sve veći novac. Pojam zdravstveni fitnes se često zloupotrebljava zbog povećanja zarade. U praksi je sve više programa koji imaju prefiks zdravstveni, a suštinski su klasičan marketing. Cilj ovog rada je da ukaže na pogrešno i nekritično prihvatanje zdravstvenog fitnesa. Data su tri primera koji ilustruju mogućnost za manipulaciju osobama koje ne razumeju šta je zdravstveni fitnes. Analizirani su: lumbalni sindrom (bol u leđima), osteoporiza i dejstvo takozvanih hormona sreće.

**Ključne reči:** *zdravlje, fitnes, lumbalni sindrom, osteoporiza, osteopenija, fizička aktivnost, endorfín, serotonín.*

### UVOD

Zdravlje čoveka teško je precizno odrediti. To pokazuje i definicija WHO (2006) kojom se ono ne vezuje samo za odsustvo bolesti, već za stanje potpunog fizičkog, mentalnog i socijalnog blagostanja. Na kompleksnost pojma zdravlja ukazuju i neke kasnije definicije (Taylor & Marandi, 2008; Bellieni & Buonocore, 2009; Huber et al., 2011) kojima se u prvi plan ističu samo njegovi pojedini aspekti (telesne funkcije, metabolička efikasnost, odsustvo bola, osećaj lične satisfakcije itd). Na zdravlje ljudi utiče veliki broj faktora koji se u dokumentima WHO (2006) dele u dve velike grupe: endogene (faktori nasleda, genetike) i egzogene (ekonomski faktori, socio-kulturne determinante, fizičko-biološka sredina itd). Kao jedan od značajnijih egzogenih faktora zdravlja savremenog čoveka, kako u naučnim i kvazi naučnim, tako i u programsko-propagandnim, čak i političkim tekstovima je – fizička aktivnost. Njoj se

tivity. Frequently, the effects are non-critically attributed to it and are difficult to prove and explain.

An objective overview of the impact of physical activity on a person's health is predominantly hindered by non-scientific claims that are being used nowadays as marketing tools. They are used to conduct a non-ethical manipulation by insufficiently informed trainers in various fitness centers and "beauty" studios. This situation is made worse by the pharmacology industry that uses aggressive campaigns to promote various misconceptions in the form of supposed dietary supplements, "fat melters" and similar trick-products. The manufacturers do not need any scientific evidence regarding the real effects of those products, but only a confirmation of a referential state institution that the product is not harmful to health in order to place it into the market, which is overly saturated by uneducated consumers. Taking advantage of such situation (as the old saying goes: if it does not do harm, maybe it will do good), lots of people are getting rich by selling worthless products.

Modern sciences (medicine, kinesiology, psychology ...) have recognized the significance of physical activity to the modern person, who, due to speedy development of technology, leads a sedentary way of life and lacks free time, has encountered the problem marked as hypokinesia. There is a large number of scientific evidence regarding the importance of dosed physical activity. However, those are usually partial evidence of stochastic nature, with limited generalization. The importance of physical activity is most often linked with obesity control, correction of child posture, prevention of cardio-vascular diseases, diabetes, and metabolic dysfunctions. In not so rare cases, however, non-critical glorification of physical activity, particularly its uncontrolled application, was the cause of new health problems, even sudden death. Across the world, the term fitness is usually used for health-related exercise with the widest spectrum of activity. Due to large economic (market) potential, fitness has gained the features of an industry. Attracting as high number of exercisers and creating profit are the basic goals of fitness industry. It offers various programs and devices that are not always in accordance with the health needs and abilities of the exerciser. Medical promotion of such programs and devices is primarily used to tap into people's superficial motives, such as good looks. What is being promoted as good (fit) looks very often has nothing to do with health. By using the ignorance of exercisers, many fitness clubs, for example, promote lifting weights in a gym as a weight loss program, which clashes with the initial lessons about energetics of muscular activity. It has been scientifically proven long ago that a human

često nekritički pripisuju i efekti koje je teško dokazati i objasniti.

Objektivno sagledavanje uticaja fizičke aktivnosti na zdravlje ljudi najviše ometaju nenaučne tvrdnje koje se danas koriste kao marketniški alati. Pomoću njih se sprovodi neetična manipulacija nedovoljno informisanim vežbačima u različitim fitnes centrima i studijima „lepote“. Situaciju pogoršava i farmakološka industrija koja agresivnim kampanjama promoviše razne zablude u vidu navodnih dijetetskih preparata, „topljača masti“ i sličnih trik-proizvoda. Za njihov plasman na aktuelno tržište zasićeno needukovanim korisnicima, proizvođačima uopšte nisu potrebni naučni dokazi o stvarnim efektima tih preparata, već jedino potvrda neke referentne državne ustanove da proizvod nije štetan po zdravlje. Koristeći se takvom situacijom (kao i onom narodnom: ako ne škodi možda će da koristi) mnogi se bogate prodajom bezvrednih proizvoda.

Savremene nauke (medicina, kineziologija, psihologija...) prepoznale su značaj fizičke aktivnosti za savremenog čoveka koji je, zbog ubrzanog razvoja tehnike, sedentarnog načina života i manjka slobodnog vremena, ušao u problem označen kao hipokinezija. O značaju dozirane fizičke aktivnosti postoji veliki broj naučnih dokaza. Obično su to, međutim, parcijalni dokazi, stohastičkog karaktera, sa ograničenom generalizacijom. Značaj fizičke aktivnosti se najčešće dovodi u vezu sa kontrolom gojaznosti, korekcijom dečje posture, prevencijom kardio-vaskularnih bolesti, dijabetesa i metaboličkih disfunkcija. Nisu retki slučajevi, međutim, da su nekritično veličanje fizičke aktivnosti, naročito njena nekontrolisana primena, bili uzrok nastajanja novih zdravstvenih problema, čak i iznenadne smrti. Za zdravstveno vežbanje sa najširim spektrom delovanja u svetu se najviše koristi pojам fitnes. Zbog velikih ekonomskih (tržišnih) potencijala fitnes je poprimio obeležja industrije. Privlačenje što većeg broja vežbača i stvaranje profita osnovni su ciljevi fitnes industrije. Ona nudi raznovrsne programe i sprave koji nisu uvek usklađeni sa zdravstvenim potrebama i mogućnostima vežbača. Medijskom promocijom takvih programa i sprava prvenstveno se deluje na površne motive ljudi, poput dobrog izgleda. Kao dobar (fit) izgled često se promoviše ono što nema mnogo veze sa zdravljem. Koristeći se neznanjem vežbača mnogi fitness-klubovi, na primer, promovišu dizanje tegova u teretani kao program za mršavljenje, što je u suprotnosti sa početnim lekcijama o energetici mišićne aktivnosti. Odavno je naučno dokazano da ljudski mišić ne koristi masti kao gorivo u radu visokog intenziteta, te da se masti mogu pokrenuti samo u radu srednjeg i niskog intenziteta i

muscle does not use fats as fuel in high-intensity work, and that the fats can be initiated only in medium or low intensity activity, and only under the condition that such activity lasts longer than 24 minutes. Therefore, those are activities such as longer walks, bike riding, moderate jogging, or classic chores (vacuuming the apartment, grass mowing, watering the garden, going to the market, etc.).

Unfortunately, for most modern fitness programs, there is no exact scientific evidence regarding the energy zone in which they take place, nor the objective effects they create. Valorizing fitness programs, particularly those with the ambition of being proclaimed as health fitness, requires complex approach. Apart from precise diagnostics (ergonomic, kinematic and dynamic), it is very important to take into consideration the individual features of the exerciser (sex, age, level of training, type of body constitution, the condition of moving apparatus, the level of anaerobic threshold, values of heart frequency in  $RQ=0.7$  or  $RQ=1$ , tendency to be injured, level of positive and negative effective conditions, etc.). There are very few fitness centers or sports medicine clinics that have this information, and without them it is impossible to find the right measure to determine the level which turns fitness activity into either health or marketing means. This paper is written without any ambitions to offer a conclusive answers, but only to use several examples from practice to indicate the thin line separating health fitness from classic marketing manipulation.

#### **Example 1: Lumbar syndrome**

Lumbar syndrome is a collection of syndromes characterized by acute pain or chronically present pain in the lumbo-sacral part of the spinal column, with a possible cramping of paravertebral muscles and limited movability of the lumbar spine. It occurs equally in persons of both sexes and recidivation is easy to occur. It is one of the most frequent health problems and the most frequent cause of taking leave of absence from work. It is estimated that 80% of adults feel pain in the lumbar part of the spine at least once in their life, which recidivates in at least 50% of the cases (Manusov, 2012). The problem of back pain most frequently occurs in the most productive period of life, between the age of thirty and fifty, equally in both sexes. In the initial phase, this is only an acute spinal disc herniation accompanied by a prolapse of the nucleus pulposus of intervertebral disk into the zone of fibrous ring (Figure 1). In most people, it is accompanied by a decreased ability to work due to unpleasant pain and unnatural body posture (Figure 2). If the proper treatment is applied in time, most patients can recover from discus hernia and only in 5% of

samo pod uslovom da takav rad u kontinuitetu traje duže od 24 minuta. To su, dakle, aktivnosti poput dužih šetnji, vožnje bicikla, umerenog trčanja ili klasičnih kućnih poslova (usisavanje stana, košenje i zalivanje bašte, odlazak na pijac isl.).

Za većinu savremenih fitnes programa, na žalost, ne postoje egzaktni naučni dokazi o energetskoj zoni u kojoj se odvijaju, niti o objektivnim efektima koje ostvaruju. Valorizovanje fitnes programa, naročito onih koji imaju ambicije da budu proglašeni za zdravstveni fitnes, zahteva kompleksan pristup. Osim precizne dijagnostike (kako ergonomске, tako kinematičke i dinamičke), veoma je značajno uvažiti i individualna obeležja vežbača (pol, uzrast, nivo treniranosti, konstitucionalni tip, stanje aparata za kretanje, nivo anaerobnog praga, vrednosti frekvencije srca pri  $RQ=0.7$  ili  $RQ=1$ , sklonost ka povređivanju, nivo pozitivnih i negativnih afektivnih stanja itd.). Ovim informacijama danas raspošlaže malo koji fitnes centar ili ambulanta sportske medicine, a bez njih je nemoguće pronaći pravu meru za određivanje obima i intenziteta fitnes aktivnosti. Problem ovog teksta upravo je traganje za tom merom koja fitnes aktivnost pretvara ili u zdravstveno ili marketinško sredstvo. Napisan je bez ambicija da ponudi konačne odgovore, već da kroz nekoliko primera iz prakse ukaže na tu tanku granicu koja zdravstveni fitnes deli od klasične tržišne manipulacije.

#### **Primer 1: Lumbalni sindrom**

Lumbalni sindrom je skup simptoma koji se karakterišu akutnim bolovima ili hronično prisutnim bolom u lumbosakralnom delu kičmenog stuba, uz moguću pojavu grča paravertebralne muskulature i ograničenjem pokretljivosti lumbalne kičme. Podjednako je čest kod osoba oba pola i lako recidivira. To je jedan od najčešćih zdravstvenih problema i najčešći uzrok izostanka s posla. Procenjuje se da 80% odraslih ljudi bar jednom tokom života oseti bol u lumbalnom delu kičme, koji recidivira u najmanje 50% slučajeva (Manusov, 2012). Problem bola u ledima se najviše javlja u najproduktivnijem periodu života, između tridesete i pedesete godine, podjednako često kod oba pola. U početnoj fazi radi se samo o akutnoj diskus herniji koja je praćena prolapsom galerntnog jedra intervertebralnog diskusa u zonu fibroznog prstena (Slika 1). Kod većine je praćena smanjenjem sposobnosti za rad zbog neprijatnog bola i neprirodног položaja tela (Slika 2). Ukoliko se pravilan tretmann primeni na vreme, od diskus hernije se oporavi većina pacijenata i samo kod 5% slučajeva ovaj bol pređe u hroničnu bolest (Menezes Costa Lda

the cases this pain grows into a chronic illness (Menesez Costa Lda et al., 2012). In the chronic phase, the crack of the fibrous ring deepens and leads to discopathialumbalis, which in time leads to a constant pressure to the surrounding spinal nerves. This local lesion of the spinal nerves is expanded in time and leads to sciatica.

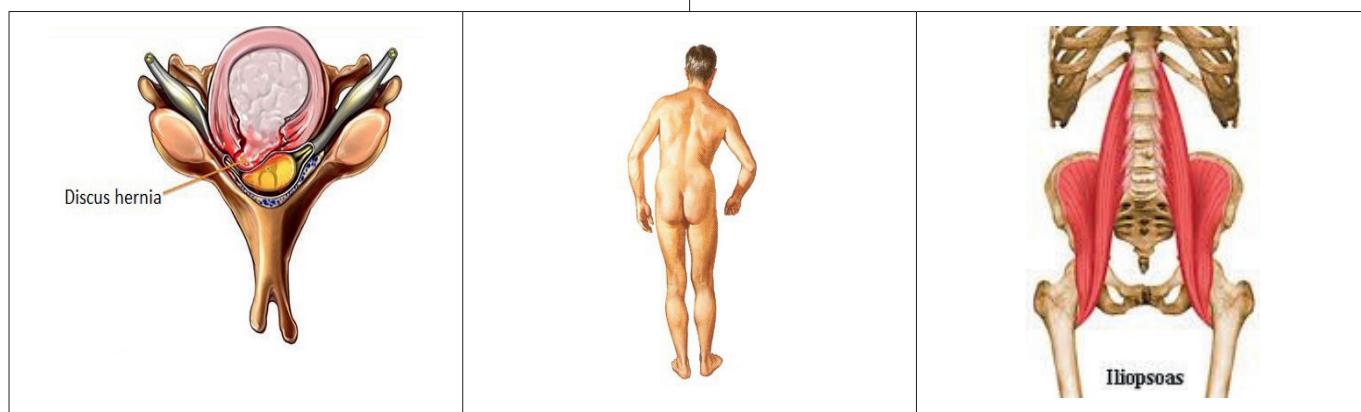
Most people who feel pain in the lumbar spine, usually after long periods of sitting and lifting heavy weights from a deep forward bend without flexing in the knee joint (typical mechanism of origin), see a doctor who recommends them to take physical treatment. Electricity, magnets and other similar physiotherapeutic treatments speed up the recovery process in many patients, but they never remove the main cause of lumbar syndrome, which is - lordosis in lumbar spine. This lordosis is caused by shortening of the main flexor in the hip joint, m. iliopsoas (Figure 3), which is constantly contracting due to all-day sitting, whether during work, driving a car, working at the computer or too long resting position (Hendrick, Milosavljevic & Hale, 2011). According to this, a permanent combat against the initial phase of lumbar syndrome (lordosis and spinal disc herniation) is not a passive physiotherapeutic treatment that only decreases the acute pain, but it includes working on removing the main cause, which is – systematic stretching of m. iliopsoas combined with everyday strengthening of stomach muscles (Qaseem, Wilt, McLean & Forciea, 2017).

The first spinal disc herniation is the last alarm for the patient and a sure sign that they must immediately start with everyday stretching of the flexor in the hip joint and strengthening of stomach muscles. As most people lead a sedentary way of life, it is only logical that there is a high predisposition in all persons for the contracture of m. iliopsoas, lumbar lordosis and finally lumbar syndrome. Ac-

et al., 2012). U hroničnoj fazi produbljuje se pukotina fibroznog prstena i nastupa diskopatija koja vremenom dovodi do konstantnog pritiska na okolne spinalne nerve. Ova lokalna lezija spinalnih nerava vremenom se proširuje i dovodi do ishialgije.

Većina ljudi koja oseti bol u lumbalnoj kičmi, obično nakon dugog sedenja i podizanja teškog tereta iz dubokog pretklona bez fleksije u zglobu kolena (tipičan mehanizam nastanka), odlazi kod lekara koji mu preporučuje fizikalnu terapiju. Struje, magneti i slični fizioterapeutски tretmani kod mnogih pacijenata ubrzaju proces oporavka, ali nikada ne uklone glavni uzrok nastanka lumbalnog sindroma, a to je – pojava lordoze u lumbalnoj kičmi. Ovu lordozu izaziva skraćenje glavnog pregibača u zglobu kuka, *m. iliopsoas-a* (Slika 3) koji je u stalnoj kontrakturi zbog celodnevног sedenja, bilo zbog posla, vožnje automobila, rada na računaru ili predugog odmarajućeg položaja Hendrick, Milosavljevic & Hale, 2011). Prema tome, trajna borba protiv početne faze lumbalnog sindroma (lordoze i diskus hernije) nije pasivni fizioterapeutski tretman kojim se samo umanjuje akutni bol, već rad na otklanjanju glavnog uzroka, a to je – sistematsko istezanje *m. iliopsos-a* kombinovano sa svakodnevnim jačanjem trbušne muskulature (Qaseem, Wilt, McLean & Forciea, 2017).

Prva diskus hernija je poslednji alarm za pacijenta i siguran znak da se odmah mora početi sa svakodnevnim istezanjem pregibača u zglobu kuka i jačanjem trbušne muskulature. Kako većina ljudi danas vodi sedentarni oblik života, logično je da kod svih postoji visoka predisponiranost za kontrakturu *m. iliopsoas-a*, lumbalnu lordozu i na kraju pojavu lumbalnog sindroma. Prema tome, kod svih takvih osoba



*Slika 1: Prolaps Nucleus pulposus-a kroz anulus fibrosus intervertebralnog diskusa*

*Figure 1: Prolapse of nucleus pulposus through anulusfibrosus of intervertebral disk*

*Slika 2: Tipičan položaj čoveka sa lumbalnim sindromom*

*Figure 2: Typical position of a man with lumbar syndrome*

*Slika 3: Pregibač u zglobu kuka*

*Figure 3: Flexor in the hip joint*

cording to this, with all such persons, health fitness must contain stretching exercises of flexors in hip joint and strengthening of the stomach wall. Such exercises can be done in any place (at home or at work) and they do not require going to a fitness center, much less a gym.

### ***Example 2: Experiment with exercises and osteopenia***

Osteoporosis is a systemic disease of the skeleton characterized by decreased mineral bone density (Bone mineral density – BMD) and harming of bone tissue microarchitecture (Jordan & Cooper, 2002; See Tai, Parsons, Rutherford & Lliffe, 2009). These changes cause lower bone density and increase the possibility of fracture (Bessette, 2008; NOF, 2012). Osteoporosis is widespread and is gaining epidemic proportions. Currently, there are over 200 million people suffering from osteoporosis, primarily females of older age. After the age of 40, bone mineral density progressively decreases for about 0.5% per year of life, particularly in women (Gomez-Cabello et al., 2012). The prevalence of osteoporosis grows from 4% in women of the age 50-59 to 52% in women over 80. There is a growing trend of osteoporosis fractures. During a person's life, the possibility of these fractures is 50% in women and 25% in men (NOF, 2016). Osteopenia is the initial phase of the physiological aging of the bone leading to osteoporosis. Around the age of 25 the bones achieve maximum density (peak bone mass). After that, the BMD stagnates, and after the menopause it begins to decrease as the resorption speeds up and surpasses bone formation. This leads to osteopenia and it usually occurs in perimenopause, when the BMD in women decreases by about 2%. In post-menopause, BMD decreases by 1-1.5% per year. In the eighth decade of life, women have about 30% lower BMD than in the third decade, thus significantly increasing the risk of fracture (ecker, Lappe, Davies & Heaney, 2000; Wayne, 2012).

The best way to combat early onset of osteopenia is prevention (NOF, 2016). There is a significant link between increased physical activity and BMD. It plays an important role in increasing bone mass in childhood and early adolescence (Obradović et al., 2009). After the age of 35, dosed physical activity significantly contributes to maintaining bone mass, and in older persons it slows its loss and decreases the risk of fracture (Compston et al., 2009). Bone quality achieved through exercise cannot be permanently maintained if the exercise is not regular (WHO, 2016). The evidence for that is bone mass reduction even in younger women occurring as a consequence of immobilization due to injury of the movement apparatus (Rautava, 2007). Sev-

zdravstveni fitnes mora da sadrži vežbe istezanja pre-gibača u zglobo kuka i jačanje trbušnog zida. Takve vežbe mogu da se izvode na svakom mestu (kod kuće i na poslu) i zbog njih se ne mora u fitnes centar, a kamo li u teretanu.

### ***Primer 2: Eksperiment sa vežbanjem i osteopenijom***

Osteoporoza je sistematsko oboljenje skeleta koje se karakteriše smanjenjem mineralne gustine kosti (*Bone mineral density* – BMD) i narušavanjem mikroarhitekture koštanog tkiva (Jordan & Cooper, 2002; See Tai, Parsons, Rutherford & Lliffe, 2009). Ove promene uzrokuju manju čvrstinu kosti i povećavaju mogućnost za prelom (Bessette, 2008; NOF, 2012). Osteoporoza je široko rasprostranjena i dobija dimenzije epidemije. Trenutno u svetu od osteoporoze boluje preko 200 miliona osoba, pretežno žene starije životne dobi. Nakon 40-e godine života mineralna gustina kostiju progresivno se smanjuje oko 0,5% po godini života, naročito kod žena (Gomez-Cabello et al., 2012). Prevalenca osteoporoze raste od 4% kod žena sa 50-59 godina do 52% kod žena preko 80 godina. Osteoporotske frakture imaju trend rasta. Tokom života mogućnost nastanka ovih fraktura kod žena iznosi 50%, a kod muškaraca 25% (NOF, 2016). Osteopenija je početna faza fiziološkog starenja kostiju koja sa godinama dovodi do osteoporoze. Oko 25-e godine kosti do-stižu maksimalnu gustinu (peak bone mass). Nakon toga BMD stagnira, a od menopauze počinje da se smanjuje jer se resorpcija ubrzava i prevazilazi koštano formiranje. Tako nastaje osteopenija i obično se javlja u perimenopazi kada BMD žena godišnje opada za oko 2%. U postmenopauzi BMD se smanjuje za 1-1,5% godišnje. U osmoj deceniji života žene imaju za oko 30% manji BMD nego u trećoj deceniji čime se značajno povećava rizik za prelom (Recker, Lappe, Davies & Heaney, 2000; Wayne, 2012).

Najbolji način borbe protiv preranog nastanka osteopenije je prevencija (NOF, 2016). Postoji značajna veza između povećane fizičke aktivnosti i BMD. Ona ima važnu ulogu u povećanju koštane mase tokom de-tinjstva i rane adolescencije (Obradović et al., 2009). Nakon 35-e godine dozirana fizička aktivnost značajno doprinosi održavanju koštane mase, a kod starijih osoba usporava njen gubitak i smanjuje rizik od preloma (Compston et al., 2009). Kvalitet kosti koji se postigao vežbanjem ne može trajno da se održava ukoliko vežbanje nije redovno (WHO, 2016). Dokaz za to je redukcija koštane mase čak i kod mlađih žena koja nastaje kao posledica imobilizacije zbog povreda aparata za kreta-

eral scientific papers indicate a positive influence of systematic physical activity to bone mass (Kohrt et al., 2004; Bošković et al., 2013; Roghani, 2013). On the other hand, physical inactivity (hypokinesia) has a negative impact on bone remodeling and increases resorption (Gupta, et al., 2014). Apart from a direct impact on the bones, hypokinesia lowers muscle power, which influences the lowering of abilities of the locomotor apparatus and increases the risk of falls and fractures (Ye, Wu, & Wu, 2013).

Taking as the starting point the findings of previous studies indicating a positive impact of physical activity on mitigating the consequences of osteopenia, an experiment has been conducted at the Faculty of Sports and Tourism in Novi Sad including 26 women in post-menopause of age between 46 and 58, in whom osteopenia has been diagnosed using DXA method. The sample was divided into 2 groups – experimental and control. In the experimental group a combined program of exercise had been applied, consisting of aerobic activities and strength exercises, while the control group did not do any exercise. The program had lasted for 7 weeks, with 3 trainings per week and a break day between them. The intensity of aerobic training was between 60% and 70% of heart reserve, and strength training intensity was between 60% and 85% of one repetitive maximum (1RM). Before and after the experiment the following has been recorded: the level of biochemical markers in serum (Beta-CTx, tP1NP and ALP isoenzyme), biochemical parameters of building, 1RM of leg extensors, maximum oxygen consumption (calcium, magnesium and T-proteine), bodily height, mass, and calculated Body-Mass-Index (BMI).

Before starting the experimental treatment, the groups were fully homogenous compared with all the measured variables. After the experiment, statistically significant changes have been determined only in the experimental group, and not for all variables, while no significant changes have been recorded in the control group (Tables 1 and 2). During the experiment, significant increase of muscle strength and VO<sub>2</sub> max occurred, with a decreased concentration of Beta-CTx (bone resorption marker) in calcium in the blood, while tP1NP remained unchanged. This indicates that the treatment had been stimulative enough only to improve metabolic and motor functions, and to slow down degradative processes in the bones, but not for construction of bone mass. There has been an unexpected decrease of calcium concentration in the blood, a nutrient significant for bone construction. Even though not statistically significant, there has been a decrease of superoxide dismutase (SOD), which is an important anti-oxidant. The decrease of the aforementioned seemed confusing at first glance. It ap-

nje (Rautava, 2007). Nekoliko naučnih radova ukazuju na pozitivan uticaj sistematske fizičke aktivnosti na masu kosti (Kohrt et al., 2004; Bošković et al., 2013; Roghani, 2013). Sa druge strane, fizička neaktivnost (hipokinezija) negativno utiče na remodelovanje kosti i povećava resorpciju (Gupta, et al., 2014). Osim direktnog uticaja na kosti, hipokinezija smanjuje mišićnu snagu što utiče na pad sposobnosti lokomotornog aparata i povećava rizik od padova i preloma (Ye, Wu, & Wu, 2013).

Polazeći od nalaza prethodnih studija koje ukazuju na pozitivan uticaj fizičke aktivnosti na ublažavanje posledica osteopenije, na Fakultetu za sport i turizam u Novom Sadu realizovan je eksperiment sa 26 žena u postmenopauzi, starosti između 46 i 58 godina kod kojih je DXA metodom konstatovana osteopenija. Uzorak je podeljen u dve grupe – eksperimentalnu i kontrolnu. U eksperimentalnoj grupi primenjen je kombinovani program vežbanja koji se sastojao od aerobnih aktivnosti i vežbi snage, dok kontrolna grupa nije vežbala. Program je trajao 7 sedmica, sa tri treninga nedeljno i danom pauze između njih. Intenzitet aerobnog treninga se kretao između 60% i 70% srčane rezerve, a intenzitet treningu snage između 60% i 85% jednog repetitivnog maksimuma (1RM). Pre i posle eksperimenta izmereni su: nivo biohemijskih markera u serumu (Beta-CTx, tP1NP i izoenzima ALP), biohemski parametri izgradnje (kalcijum, magnezijum, T-protein), 1RM ekstenzora nogu, maksimalna potrošnja kiseonika (VO<sub>2</sub>max), telesna visina i masa i izračunat Body-Mass-Index (BMI).

Grupe su su pre početka eksperimentalnog tretmana bile potpuno homogene u odnosu na sve izmerene varijable. Nakon eksperimenta statistički značajne promene utvrđene su samo u eksperimentalnoj grupi i to ne za sve varijable, dok u kontrolnoj grupi nije evidentirana ni jedna značajna promena (Tabele 1 i 2). Tokom trajanja eksperimenta došlo je do značajnog povećanja mišićne snage i VO<sub>2</sub> max, uz smanjenje koncentracije Beta-CTx (marker koštane resorpcije) i kalcijuma u krvi, dok su tP1NP (marker formiranja kosti) i ALP (parametar metabolizma i remodelovanja) ostali gotovo nepromjenjeni. To pokazuje da je tretman bio dovoljno stimulativan samo za poboljšanje metaboličkih i motoričkih funkcija, te za usporavanje degenerativnih procesa u kostima, ali ne i za izgradnju koštane mase. Nečekivano je došlo i do smanjenja koncentracije kalcijuma u krvi, nutritijenta značajnog za izgradnju kosti. Iako ne statistički značajno, smanjila se superoksiddismutaze (SOD), važan antioksidans. Ova smanjenja

peared that systematic exercise causes a negative response of the bone instead of creating progress. By using logical analysis, however, it was concluded that the decrease of calcium in the blood is the consequence of its transmission into the bones, where it is more necessary. The decrease of SOD has been explained through the conclusion that the training, particularly in beginners, has a stressful effect and increases the concentration of free radicals in the blood, and so, the SOD was most likely demonstrating its anti-oxidant effect during the experimental treatment.

The demonstrated results did not convincingly prove the efficiency of physical exercise in women with osteopenia, which could cast doubt on the justifiability of the application of health fitness. By a more thorough interpretation of the findings, however, some other principles significant for the promotion of health fitness stand out. Primarily it is noted how important knowledge of this matter is, meaning the significance of having specific education. Health fitness, particularly in working with sensitive groups, requires high expert knowledge. The other important observation, masked by non-critical and superficial acceptance of the results, is related to the length of time necessary to cause positive effects. This Novi Sad study has, without a doubt, demonstrated that, apart from the strength of the stimulus, it is necessary to take consideration also of its duration when it comes to health fitness. Sometimes 2-3 months are not enough to cause adaptive changes, which is the reason why many trainees frequently give up on the treatment and declare the fitness trainers as incompetent. Highly educated trainer, however, will provide good arguments for the trainee and lead them into patiently waiting for the first effects of their labor.

**Table 1:** Descriptive statistics of pre-test and post-test for experimental and control group

Variabla / Variables	Grupa / Group	Pretest / Pre-test		Pretest / Post-test	
		N	Mean	Std.Dev	Mean
Beta-CTX (pg/ml)	Eksperimentalna / Experimental	15	550.87	164.474	489.09
	Kontrolna / Control	11	489.09	175.662	438.00
tP1NP (mcg/L)	Eksperimentalna / Experimental	15	68.27	19.295	64.78
	Kontrolna / Control	11	55.12	14.167	52.29
ALP (U/L)	Eksperimentalna / Experimental	15	77.07	18.425	74.47
	Kontrolna / Control	11	72.55	26.909	74.73
Leg-Press (kp)	Eksperimentalna / Experimental	15	118.93	40.006	168.53
	Kontrolna / Control	11	119.70	40.255	118.10
VO <sub>2</sub> max (ml/kg/min)	Eksperimentalna / Experimental	15	29.77	4.831	32.76
	Kontrolna / Control	11	28.82	3.882	28.61
Kalcijum / Calcijum (mmol/L)	Eksperimentalna / Experimental	15	2.43	.076	2.33
	Kontrolna / Control	11	2.32	.071	2.33
SOD (U/L)	Eksperimentalna / Experimental	15	1422.93	159.057	1337.07
	Kontrolna / Control	11	1366.30	208.989	1480.10

su u prvi mah delovala zbumujuće. Izgledalo je kao da sistematsko vežbanje umesto napretka izaziva negativan odgovor kosti. Logičkom analizom, međutim, zaključeno je da je smanjenje kalcijuma u krvi posledica njegovog prelaska u kosti, tamo gde je potrebniji. Smanjenje SOD-a objašnjeno je time što trening, naročito kod početnika, deluje stresno i povećava koncentraciju slobodnih radikalala u krvi, pa je SOD verovatno intenzivnije ispoljavao svoje antioksidansno dejstvo tokom eksperimentalnog tretmana.

Prikazani rezultati nisu ubedljivo dokazali efikasnost fizičkog vežbanja kod žena sa osteopenijom, što bi moglo da dovede u sumnju opravdanost primene zdravstvenog fitnesa. Pažljivijim tumačenjem nalaza, međutim, nameću se još neki principi značajni za promociju zdravstvenog fitnesa. Pre svega zapaža se koliko je važno poznavanje ove materije, odnosno koliko je značajno posedovati specifičnu edukaciju. Zdravstveni fitnes, naročito u radu sa osetljivim grupama, zahteva visoko ekspertno znanje. Drugo važno zapažanje, zamaskirano nekritičnim i površnim prihvatanjem rezultata, odnosi se na dužinu vremena neophodnog za izazivanje pozitivnih efekata. Ova novosadska studija nedvosmisleno je pokazala da je, osim jačine stimulansa, u zdravstvenom fitnesu neophodno voditi računa i o njihovom trajanju. Nekada su 2-3 meseca nedovoljna za izazivanje adaptacionih promena zbog čega vežbači često odustaju od tretmana i fitnes trenere proglašavaju nekompetentnima. Vrhunski edukovan trener, međutim, vežbaču će dati dobru argumentaciju i navesti ga da strpljivo sačeka prve efekte svog rada.

**Tabela 1:** Prosečne vrednosti varijabli pre i posle eksperimentalnog tretmana

**Table 2: Statistics of Mixed between-within subjects ANOVA**

**Tabela 2: Rezultati dvofaktorske analize varijanse o uticaju specifičnosti grupe i eksperimentalnog tretmana na promene varijabli iz Tabele 1.**

Variable	Wilks' Lambda	F	Sig.	Partial Eta Squared
<b>Beta CTx</b>				
Kombinovani uticaj / Treatment^Group impact	.913	2.280	.144	.087
Uticaj tretmana / Treatment impact	.578	17.553	.000	.422*
Uticaj grupe / Group difference		.226	.639	.009
<b>tP1NP</b>				
Kombinovani uticaj / Treatment^Group impact	.999	.025	.876	.001
Uticaj tretmana / Treatment impact	.915	2.227	.149	.085
Uticaj grupe / Group difference		3.035	.094	.112
<b>ALP</b>				
Kombinovani uticaj / Treatment^Group impact	.930	1.807	.191	.070
Uticaj tretmana / Treatment impact	.999	.014	.907	.001
Uticaj grupe / Group difference		.058	.812	.002
<b>Leg-Press</b>				
Kombinovani uticaj / Treatment^Group impact	.329	49.028	.000	.671*
Uticaj tretmana / Treatment impact	.357	43.281	.000	.643*
Uticaj grupe / Group difference		54.993	.000	.817*
<b>VO<sub>2</sub> max</b>				
Kombinovani uticaj / Treatment^Group impact	.478	25.105	.000	.522*
Uticaj tretmana / Treatment impact	.548	18.947	.000	.452*
Uticaj grupe / Group difference		10.388	.013	.216*
<b>Kalcijum</b>				
Kombinovani uticaj / Treatment^Group impact	.695	6.964	.015	.240*
Uticaj tretmana / Treatment impact	.760	9.636	.005	.305*
Uticaj grupe / Group difference		5.859	.024	.210*
<b>SOD</b>				
Kombinovani uticaj / Treatment^Group impact	.854	3.751	.066	.146
Uticaj tretmana / Treatment impact	.997	.073	.789	.003
Uticaj grupe / Group difference		.734	.401	.032

\*Statistically significant difference

\*Statistički značajan uticaj

### **Example 3: Is there a happiness hormone?**

A notable example which provides a good illustration of the manipulations in the sphere of health fitness is the story of “happiness hormones” - endorphin and serotonin. Often, in literature (both expert and quasi-scientific), there are cases pointing out that exercising stimulates the secretion of these two hormones. This data is not inaccurate but it is wrongly interpreted. What exactly are endorphin and serotonin? They are biochemical compounds from the group of peptides, which act as enzymes and neurotransmitters. They are very similar to opiates and they are secreted by hypothalamus as its endocrine hormones (Nelson & Coc, 2005). They are most secreted during high-intensity physical strain, as discovered by a group of Scottish scientists in a laboratory in Aberdeen

### **Primer 3: Da li postoji hormon sreće?**

Upečatljiv primer koji dobro ilustruju manipulacije u sferi zdravstvenog fitnesa je priča o „hormonima sreće“ – endorfinu i serotoninu. Ne retko se u literaturi (kako stručnoj tako i kvazinaučnoj) ističe kako vežbanje podstiče lučenje ova dva hormona. To nije netačan podatak, ali je pogrešno njegovo tumačenje. Šta su egzaktno endorfín i serotonin? To su biohemijska jedinjanja iz grupe peptida, a deluju kao enzimi i neurotransmitteri. Vrlo su slični opijatima, a luči ih hipotalamus kao svoje endokrine hormone (Nelson & Coc, 2005). Najviše se luče tokom fizičkih naprezanja visokog intenziteta što je otkrila grupa škotskih naučnika iz laboratorije u Aberdinu (Stefano et al., 2012). Prvi su ih izolovali 1975. godine Džon Hjuz i Hans Kosterlic iz mozga

(Stefano et al., 2012). They were first isolated from a pig brain by John Hughes and Hans Kosterlitz in 1975, who explained them as amino-acids polymers linked by peptide connections. In most, five connections existed, which is why they were called penta-peptides. They acted as inhibitors of neurotransmitters, primarily between the spinal cord and peripheral nerves. Such effect caused a decrease of the sensation of pain in the muscles after heavy labor (Hughes, Smits, Kosterlitz, et al., 1975). Due to this effect, it was given the name enkephalin opioids (Kosterlitz & Hughes, 1977). At the same time, on the other side of the Atlantic, a group of American scientists had isolated the same biochemical compounds from the brain of a calf and confirmed their opiate effect (Simanov & Snyder, 1976). The title endorphin is attributed to Eric Simon, an American researcher, who had, independently from his predecessors, isolated opiate receptors from the vertebral human spine, to which he attributed the characteristic of endogenous morphine, meaning, internal narcotic produced by the human brain (Simon, 1974; Bonnet & Simon, 1982; Onoprishvili & Simon, 2007). Endorphin had the same effect as Hughes' and Kosterlitz' penta-peptides, meaning, it inhibited peripheral neurotransmitters. Later on, penta-peptide of similar effect was discovered in some groceries rich in amino-acid tryptophan and called serotonin (Stephano et al., 2012). Apart from the brain, where it is significant for sleep regulation, it can be found in the gastro-intestinal system (in the neuroendocrine cells) as well as in thrombocytes where it participates in the coagulation process. Unlike endorphin, which is produced exclusively by pituitary gland, serotonin can be ingested through food. There is also medicines containing serotonin. They cause euphoria and are used in treating depression.

Increased concentration of endorphins in the peripheral neurotransmitters is retained for about two hours causing the feeling of relaxedness in the muscles. If following the exercise nutrients high in serotonin are additionally consumed (chocolate, wine, fruit), this leads to additional decrease of nerve endings sensitivity, which causes the nice feeling usually felt after a good workout. Precisely due to this feeling, endorphin and serotonin have been (falsely) declared as happiness hormones. Many fanatic exercisers, after the limited feeling of these two opiate penta-peptides fades away, wish to regain the lost feeling of bodily relaxedness and immediately initiate into new physical activity (new fitness training). In time, they turn into training addicts, the same as any other opiate (narcotics) addicts. Endorphin addicts can be recognized on trim tracks, marathon races, in gyms and all the places where the body is daily exposed to more and more exhaustion. After a certain period of such immo-

svinje i objasnili kao polimere aminokiselina povezane peptidnim vezama. Kod većine njih je egzistiralo pet veza, zbog čega su ih nazvali pentapeptidi. Delovali su kao inhibitori neurotransmitera, prvenstveno između kičmene moždine i perifernih nerava. Takvo dejstvo izazivalo je umanjenje osećaja bola u mišićima nakon teškog rada (Hughes, Smith, Kosterlitz, et al., 1975). Zbog takvog dejstva dodelili su im i naziv enkefalinski opijati (Kosterlitz & Hughes, 1977). U isto vreme, ali sa druge strane Atlantika, grupa američkih istraživača je iz mozga teleta izolovala ista biohemijska jedinjenja i potvrdila njihovo opijatsko dejstvo (Simantov & Snyder, 1976). Naziv endorfin pripisuje se američkom istraživaču Ericu Sajmonu koji je, nezavisno od prethodnika, iz vertebralne kičme čoveka izolovao opijatne receptore kojima je pripisao svojstvo endogenog morfijuma, odnosno, unutrašnjeg narkotika koji proizvodi ljudski mozak (Simon, 1974; Bonnet & Simon, 1982; Onoprishvili & Simon, 2007). Endorfin je imao isto dejstvo kao Hjuzovi i Kosterlicovi pentapeptidi, odnosno, inhibirao je periferne neurotransmitere. Kasnije je, u nekim namirnicama bogatim aminokiselinom triptofanom otkriven pentapeptid sličnog dejstva i nazvan Serotonin (Stefano et al., 2012). Osim u mozgu, gde je značajan za regulaciju sna, ima ga dosta u gastrointestinalnom sistemu (u neuroenndokrinim ćelijama) i u trombocitima gde učestvuje u procesu koagulacije. Za razliku od endorfina kojeg stvara isključivo hipofiza, serotonin se može uneti i hranom. Postoje i medikamenti koji sadrže serotonin. Oni izazivaju euforiju i koriste se u lečenju depresije.

Povećana koncentracija endorfina u perifernim neurotransmiterima se zadržava oko dva sata izazivajući osećaj opuštenosti u mišićima. Ukoliko se nakon vežbanja dodatno kozumiraju namirnice koje sadrže serotonin (čogolada, vino, voće) dolazi do dotatnog smanjenja osetljivosti nervnih završetaka, što prouzrokuje ono lepo stanje koje se oseća nakon dobrog treninga. Upravo zbog tog osećanja, endorfin i serotonin su proglašeni (lažnim) hormonima sreće. Mnogi fanatični vežbači, nakon što iščili ograničeno dejstvo ova dva opijatna pentapeptida, žele da povrate izgubljeni osećaj telesne opuštenosti i odmah kreću u novu fizičku aktivnost (novi fitnes trening). Vremenom postaju zavisnici od treninga, kao i svaki zavisnik od opijata (narkotika). Endorfinski zavisnici prepoznaju se na trim stazama, maratonskim trkama, u teretanama i na svim mestima gde se telo iz dana u dan izlaže sve većem iscrpljivanju. Posle izvesnog perioda takvog neumerenog izlaganja fizičkom vežbanju, organizam ulazi u hronični zamor i

erate exposure to physical exercise, the body enters chronic fatigue and the state of general exhaustion. Frequently it leads to serious health problems (metabolic disorders, loss of sleep, physical tissue damages, injuries, etc.).

## CONCLUSION

Lumbar syndrome analysis, results of the experiment with osteopenia, and the story about fake happiness hormones (endorphin and serotonin) served the purpose of indicating the importance of one of the most important principles in health fitness – determining a measure. It is important to know that a universal measure and a universal recipe does not exist. Optimal volume, intensity and the kind of physical activity are extremely individual and each trainee must continuously search from them. In their search, education and introspection play the crucial role. Knowledge must be continually revised by developing a critical relationship towards all marketing manipulations heavily present in the modern fitness industry. Each change is in the function of time, so the trainees must wait patiently to see the effects of dosed physical activity. The effects of health fitness can occur only if the person is continually physically active throughout their life. 15 kilograms cannot be lost in 15 days, nor is there an exercise which “removes” fat precisely from the stomach; fat cannot be turned into muscles, nor are there “fat meltters” in a pharmacy. Only a person who truly understands biochemical and physiological processes at the core of human movement and muscle activity can feel the benefits of health fitness.

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stanje opšte iscrpljenosti. Često nastaju i ozbiljni zdravstveni problemi (poremećaji metabolizma, gubitak sna, fizička oštećenja tkiva, povrede itd.).

## ZAKLJUČAK

Analiza lumbalnog sindroma, rezultati eksperimenta sa osteopenijom i priča o lažnim hormonima sreće (endorfinu i serotoninu) imala je za cilj da ukaže na značaj jednog od najvažnijih principa u zdravstvenom fitnesu – traženje mere. Važno je znati da univerzalna mera i univerzalni recept ne postoji. Optimalan obim, intenzitet i vrsta fizičke aktivnosti su krajne individualne i za njima svaki vežbač mora neprekidno da traga. U tom traganju edukacija i introspekcija imaju presudnu ulogu. Znanja moraju konstantno da se obnavljaju, uz razvijanje kritičkog odnosa prema svim marketinškim manipulacijama kojima obiluje moderna fitnes industrija. Svaka promena je u funkciji vremena i zato se efekti dozirane fizičke aktivnosti moraju strpljivo čekati. Efekti zdravstvenog fitnesa se ostvaruju samo ukoliko je čovek fizički aktivan kontinuirano tokom čitavog života. Za 15 dana se ne može izgubiti 15 kilograma, niti postoji vežba kojom se masne naslage „skidaju“ baš sa stomaka; masti se ne mogu pretvoriti u mišiće, niti u apoteci postoje „topljači masti“... Samo onaj ko dobro razume biohemijske i fiziološke procese na kojima počivaju ljudsko kretanje i mišićna aktivnost, moći će da oseti benefite zdravstvenog fitnesa.

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# ANALYSIS IN DIFFERENCES OF SPEED SWIMMING CRAWL TECHNIQUE BETWEEN SWIMMERS AND WATER POLO PLAYERS

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**Abstract:** Research is spent on 50 respondents divided in two groups, of which first group was combined by 25 swimmers and second group was combined by 25 water polo players from water polo club „Dabar“ from Sarajevo, at age of 12-14 years. The main goal of research was to spot the differences between speed in swimming crawl technique disciplines of 25m, 50m and 100m between swimmers and water polo players of water polo club „Dabar“ from Sarajevo. It is analyzed the time swimmers will swim crawl technique every discipline separately: 25m (BK 25M), 50m (BK 50M) and 100m (BK 100M). For establishment of differences in speed swimming crawl technique on 25m, 50m and 100m between swimmers and water polo players we used T-test analise of results for independent samples. Based on T-test analise of results for independent samples we can conclude that there is statisticly big difference between swimmer and water polo players in speed during swimming all three criterion variables (BK 25M), (BK 50M), (BK 100M).

**Keywords:** speed, swimmers, water polo players, analyses of differences, T-test

## INTRODUCTION

Swimming and water polo are kinesiology activities that are part of water sports. Swimming is part of family of water and basic sports. Swimming is define as ability of keeping humans body on top of the water in horizontal position and moving in water with certain moves of hands and legs without using some help of other objects. We can say that swimming is part of cyclically sports in which by the way of performance of moves-technique and the style of swimming, dominate relatively simple moves, that moves are the same all the time and they

# ANALIZA RAZLIKA U BRZINI PLIVANJA KRAUL TEHNIKOM IZMEĐU PLIVAČA I VATERPOLISTA

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**Apstrakt:** Istraživanje je provedeno na ukupnom uzorku od 50 ispitanika podijeljenom u dvije grupe, od kojih je prvu grupu činilo 25 ispitanika-plivača i drugu grupu 25 ispitanika-vaterpolista Plivačko-vaterpolo kluba "Dabar" iz Sarajeva, uzrasne dobi 12 – 14 godina. Osnovni cilj istraživanja bio je utvrđivanje razlika u brzini plivanja kral tehnikom u disciplinama 25m, 50m i 100m između plivača i vaterpolista Plivačko-vaterpolo kluba "DABAR" iz Sarajeva. Analizirano je vrijeme za koje ispitanici plivaju kral tehnikom svaku dionicu posebno: 25m (BK25M), 50m (BK50M) i 100m (BK100M). Za utvrđivanje razlika u brzini plivanja kral tehnikom na dionicama 25m, 50m i 100m kral tehnikom između plivača i vaterpolista primjenjena je analiza rezultata T-testa za nezavisne uzorke. Na osnovu analize rezultata T-testa za nezavisne uzorke može se konstatovati da postoji statistički značajna razlika između plivača i vaterpolista u brzini plivanja u sve tri kriterijske varijable (BK 25M), (BK50M), (BK100M).

**Ključne riječi:** brzina, plivači, vaterpolisti, analiza razlika, T-test

## UVOD

Plivanje i vaterpolo su kineziološke aktivnosti koje spadaju u vodene sportove. Plivanje spada u porodicu vodenih i bazičnih sportova. Plivanje se definije kao sposobnost održavanja čovječjeg tijela na površini vode u horizontalnom položaju i kretanje u vodi pomoću određenih pokreta ruku i nogu bez upotrebe pomoćnih sredstava. Za plivanje se može se reći da spada u red cikličnih sportova u kojem prema načinu i obliku izvođenja pokreta - tehnikе te stila plivanja, dominiraju relativno jednostavni pokreti, koji su stalno isti i koji se periodično ponavljaju tokom plivanja

periodically repeat during the certain technique. This complex motoric structure require from swimmers high level of motoric abilities-coordination, or „good feelng of water“. When we speak about swimming speed, we need to say that she depends of many factors. Main factor that affect on swimming speed is the position of body in water, the reason is that position of body in water directly affect on increase frontal resistance that is created during swimming. Frontal resistance depends on:

- position of swimmers body in water- reducing of frontal surface of body in water and bringing the body in hydrodynamic position, we can reduce resistance of moving body through the water (Kolmogorov and sar, 1997),
- shape of body- motion of swimmer causes cumulation of pressure of water in front of him, result of this if frontal resistance, that appears on curved body parts, such as head, shoulders, hips, skin folds (Colwin, 1998),
- surface quality of swimmers body, as is proved that after removing hair from body swimmer in big measure incerase frontal resistance and on that way he gets better results (Sharp, Hackney, Cain and Ness, 1998),
- swimming speed, with swimming speed the resistance increases with quadrate(Colwin, 1998).

Newer research (Madic and sar.2007.) showes that achieving high results in swimming depends on these factors:

- regularly move maintance (sport technique),
- energy abilities of swimmers,
- contractile muscle performance,
- knuckle mobility,
- tactical abilities.

According to Wertheimer, V. and the.Zoretić, (2010) work of muscles on short distances depends on each swimming technique, swimming speed and most of all efficiency of anaerobic, lactate energy mechanism. Babin,B.(2012), recommend that we should use invidual form of work.

Water polo as collective sport is extracurricular complex sport which is different of other sports, the reason is that water polo is playing in different and specific habitat-in water. In water polo we use all kind of moves, cyclic and acyclic with very complex motoric and tactical requirements. High level of efficiency and sport rally requires the maximum knowledge of technical-tactical elements, high level of body competence (Dopsaj, 1993). If we observe water polo game we can notice that players mainly swim short distances with maximum odds and different techniques. With time limit of the game, and total swimed volume, from

određene tehnike. Ova složena motorička struktura traži od plivača visok nivo motoričke sposobnosti – koordinacije, te posebno naglašen kinestetički osjećaj kretanja kroz vodu, odnosno “dobar osjećaj vode.“ Kada se govori o brzini plivanja, potrebno je istaći da ona zavisi od mnogo faktora. Osnovni faktor koji primarno utiče na brzinu plivanja jeste položaj tijela u vodi, iz razloga što položaj tijela u vodi direktno utiče na povećanje čeonog otpora koji se stvara tokom kretanja plivača kroz vodu. Čeoni otpor zavisi od:

- položaja tijela plivača u vodi – smanjivanjem čeone površine tijela u vodi i dovođenjem tijela u hidrodinamički položaj ili povećanjem plovnosti, može se smanjiti otpor kretanja tijela kroz vodu (Kolmogorov i sar., 1997),
- oblika tijela – kretanje plivača uzrokuje gomilanje pritiska u vodi ispred njega, što za posljedicu ima čeoni otpor, koji se pojavljuje na zaobljenim dijelovima tijela, kao što su glava, ramena, kukovi, kožni nabori (Colwin, 1998),
- kvaliteta površine tijela plivača, kao što je dokazano da poslije uklanjanja dlaka sa tijela, plivač u znatnoj mjeri smanjuje čeoni otpor i na taj način postiže bolje rezultate (Sharp, Hackney, Cain i Ness, 1998),
- brzine plivanja, tako što s povećanjem brzine plivanja otpor povećava sa kvadratom (Colwin, 1998).

Novija istraživanja (Madić i sar. 2007.) ukazuju da postizanje visokih rezultata u plivanju zavisi i od sljedećih faktora:

- pravilnost izvođenja pokreta (sportske tehnike),
- energetske sposobnosti plivača,
- kontraktilnih svojstva mišića,
- zglobne pokretljivosti i
- taktičkih sposobnosti.

Prema Wertheimer, V. i D. Zoretić, (2010.) sam rad mišića na kratkim distancama zavisi od vrste plivačke tehnike, brzine plivanja te najviše od efikasnosti anaerobnog alaktatnog i laktatnog energetskog mehanizma. Babin, B. (2012), preporučuje da se radi i primjenjuje individualini oblik rada.

Vaterpolo kao kolektivni sport spada u grupu polistrukturalnih kompleksnih sportova i koji se razlikuje od drugih kolektivnih sportova, jer se igra u potpuno drukčijem i specifičnom mediju – vodi. U vaterpolu su zastupljen sve vrste kretanja i ciklična i aciklična karaktera, sa vrlo složenim motoričkim i taktičkim zahtjevima. Visok nivo efikasnosti i sportskog nadigravanja u vaterpolu zahtjeva maksimalnu ovlađanost svim tehničko-taktičkim elementima, visok nivo tjelesne pripremljenosti, a koja se zasniva na određenim morfološkim odlikama, motoričkim, funkcionalnim sposobnostima i drugim antropološkim karakteristikama (Dopsaj, 1993). Ako se posmatra vaterpolo igr

the aspect of energy capacity, we can establish that the top water polo player need to have high developed all three energy systems (alactate, lactate and anaerobic), (Dopsaj and Matkovic, 1994). Also, during the game player is doing lots of horizontal and vertical moves with the ball or without her, with or without contact with opponent player (Dopsaj and Matkovic, 1999).

Knowing all these factors in long term development of young players are precondition for quality program, with optimum material basis, and personnel potential. Falk,B., Lidor,R., Lander,Y., and Lang,B. (2004) were studied problem of identification talents and early development of young players. Melchiorri,G., Padua, E., Sardella, F., Manzi, V., Tancredi, V., and Bonifazi, M. (2010) were analysing physiological profile of water polo player and they get results of dependence physiological variables and quality level of players. Sekulic, D., Zenic, N., and Markovic, G. (2005) were using non-linear analyse and they determined connection between anthropometric variables and indicator of motoric endurance. Researches that suit to this theme are not find which shows on actuality and interest of this science artical.

## METHODS OF RESEARCH

### *Sample of respondents*

Total sample of respondents is 50 players from swimming-water polo club „Dabar“ from Sarajevo at age of 12-14 years, they are separated in two groups. In first group there is 25 swimmers and in second group there is 25 water polo players at age 12-14 years. All respondents are active in training process. We analysed time of speed swimming in all disciplines on 25m, 50m and 100m.

### *Sample of variables*

Every respondent was tested and his speed was measured in crawl technique on three different lengths which represent criterion variables:

1. Speed swimming in crawl technique on 25m (BK25M)
2. Speed swimming in crawl technique on 50m (BK50M)
3. Speed swimming in crawl technique on 100m (BK100M)

### *Description of research*

- All respondents had the same terms for testing
- Testing was completed in time period from 18:00

može se primjetiti da igrači uglavnom plivaju kratke dionice sa maksimalnim mogućnostima i različitim tehnikama. Uz vremensko ograničenje igre, i ukupan preplivani obim, sa aspekta energetskih kapaciteta, može se tvrditi da vrhunski vaterpolo igrač mora posjedovati visoko razvijena sva tri energetska sistema (alaktatni, laktatni i aerobni), (Dopsaj & Matković, 1994). Takođe, to kom utakmicu igrač izvodi veliki broj kretanja u vodi u horizontalnom i vertikalnom položaju, sa loptom ili bez nje, sa ili bez kontakta sa protivničkim igračem (Dopsaj & Matković, 1999).

Poznavanje svih čimbenika u dugoročnom razvoju mladih igrača, pravovremenosti u razvoju određenih motoričkih sposobnosti u tzv. senzitivnim fazama preduvjet su za kvalitetan program, naravno uz optimalnu materijalnu bazu i kadrovske potencijale. Falk, B., Lidor, R., Lander, Y., & Lang, B. (2004) proučavali su problem identifikacije talenata i ranog razvoja mladih igrača. Melchiorri, G., Padua, E., Sardella, F., Manzi, V., Tancredi, V., & Bonifazi, M. (2010) analizirali su fiziološki profil vaterpolo igrača i dobili podatke o zavisnosti fizioloških varijabli i kvalitativne razine igrača. Sekulić, D., Zenic, N., & Marković, G. (2005) primjenom ne-linearne analize utvrdili su vezanost između antropometrijskih varijabli i pokazatelja motoričke izdržljivosti. Istraživanja i radovi koji odgovaraju problematici ovog rada nisu pronađeni što ukazuje na aktualnost i zanimljivost ovoga znanstvenog priloga.

## METODE ISTRAŽIVANJA

### *Uzorak ispitanika*

Ukupan uzorak ispitanika činilo je 50 ispitanika Plivačko-vaterpolo kluba “Dabar” iz Sarajeva uzrasne dobi 12-14 godina, podijeljen je na dvije grupe od kojih je prvu grupu činilo 25 plivača i drugu grupu 25 vaterpolista uzrasne dobi 12 – 14 godina. Svi ispitanici su uključeni u sistematski trenažni proces. Analizirano je vrijeme brzine svih ispitanika u disciplinama na 25m, 50m i 100m.

### *Uzorak varijabli*

Svaki ispitanik je pojedinačno testiran i mjerena je brzina preplivavanja kralj tehnikom tri dionice koje su predstavljale kriterijske varijable i to.

1. Brzina plivanja kralj tehnikom na 25 metara (BK25M).
2. Brzina plivanja kralj tehnikom na 50 metara (BK50M).
3. Brzina plivanja kralj tehnikom na 100 metara (BK100M).

### *Opis istraživanja*

- Svi ispitanici su imali iste uslove za testiranje.

- to 21:00 at the same day
- They were separated in many groups during testing
  - Swimmers were swimming-swimmers crawl, water polo players swummed-water polo crawl
  - Testing was complete in a pool where the temperature of water was 27°C, moisture of the space - 58,7%, air temperature - 29,64°C and concentration of chlorine 0.5 mg/L, which is in acceptable terms
  - Firstly they were tested on 25m, then on 50m and at the end on 100m
  - All data were entered in measured lists of every respondent

### METHODS OF PROCESSING RESULTS

Results that we got were processed in program packet SPSS 12.0 for Windows. For all variables we calculated the main statistical parameters:

- Mean-arithmetic mean
- Min-min result of measurement
- Max- max result of measurement
- Rang
- Std. Dev.- standard deviation
- Skewness
- Kurtosis

For establishment of differences in speed swimming with crawl technique on 25m, 50m and 100m between swimmers and water polo players we used T-test analysis of results for independent samples.

### RESULTS

Swimming on 25m (BK25M) was performed with start jump and finishing on the end of the pool. Swimming on 50m (BK50M) was performed with start jump and with turn on 25m.

Swimming on 100m (BK100M) was performed also with start jump and with turns on every 25m. Time measuring for all lengths was measured manually (chronometer) with exactness of 1/10 seconds.

In table 1. Is showed main descriptive statistic parameters of applied variables for both group of respondents (swimmers and water polo players). In this analysis we can see that the respondents which belong in group of swimmers have better results. Average speed for swimmers on 25m is 14,2 sec, average speed for water polo players 17,2sec. When we watch min and max results there is a big difference in speed, we can see that the swimmers are much faster than water polo players. Min result for swimmers is 12,07sec, min result for water polo

- Testiranje je izvršeno u vremenu od 18:00 do 21:00 istog dana.
- Podjeljeni u više grupe prilikom testiranja.
- Plivači su plivali – plivački kral, a vaterpolisti vaterpolo kral.
- Testiranje je izvršeno u bazenu u kojem je temperatura vode bila - 27 °C, vlažnost prostora - 58,70%, temperatura vazduha - 29,64 °C i koncentracija hlorova 0,5 mg/L, što je bilo u prihvatljivim granicama.
- Testiranje brzine plivanja je prvo izvršeno na 25 metara za sve ispitanike, zatim na 50 metara i na kraju na 100 metara.
- Svi podaci su uneseni u mjerene liste svakog ispitanika

### METODE OBRADE PODATAKA

Obrada dobivenih podataka vršena je u programskom paketu SPSS 12.0 for Windows. Za sve primjenjene varijable izračunati su osnovni statistički deskriptivni parametri:

- Mean – aritmetička sredina,
- Min – minimalni rezultat mjerena,
- Max – maksimalni rezultat mjerena,
- Rang – Raspon
- Std. Dev. – standardna devijacija.
- Skewness – koeficijent simetričnosti
- Kurtosis – koeficijent spljoštenosti.

Za utvrđivanje razlika u brzini plivanja kral tehnikom na dionicama 25m, 50m i 100m kral tehnikom između plivača i vaterpolista primjenjena je analiza rezultata T-testa za nezavisne uzorke.

### REZULTATI

Dionica plivanja na 25m (BK25M) se izvodila sa startnim skokom i završavala na kraju bazena. Dionica plivanja na 50m (BK50M) se izvodila sa startnim skokom i okretom na 25 metara, a dionica plivanja na 100m (BK100M) se izvodila takođe sa startnim skokom i okretima na svakih 25 m. Mjerenje vremena za sve dionice plivanja vršeno je ručno (chronometrom) s tačnošću od 1/10 sekunde.

U tabeli 1 prikazani su osnovni centralni i disperzionalni parametri primjenjenih varijabli za obje grupe ispitanika (plivači i vaterpolisti). Analizom osnovnih centralnih i disperzionalnih parametara rezultata plivanja na 25m (BK25M) kral tehnikom može se vidjeti da ispitanici koji pripadaju grupi plivača imaju bolje prosječene rezultate od grupe ispitanika vaterpolista, jer su prosječna vrijednost rezultata plivanja na 25m kod plivača 14,2 sek, a kod vaterpolista 17,2 sek. Uvidom u vrijednosti minimalnih (Min) i maksimalnih (Max) rezultata uočljiva je razlika u korist grupe ispitanika plivača. Minimalni rezultat kod plivača iznosi 12,0 sek., a kod vaterpolista 16,0 sek. Najkraći

**Table 1.** Main descriptive statistic parameters of applied variables for both group of respondents (swimmers and water polo players)**Tabela 1.** Osnovni deskriptivni statistički parametri primijenjenih varijabli za obje grupe ispitanika (plivača i vaterpolista)

	Descriptive Statistics															
	N		Range		Min		Max		Mean		Std. dev.	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error		
BK25MP	25	5.00	12.00	17.00	14.20	.30	1.50	2.25	-.20	.464	-.80	.902				
BK50MP	25	11.08	26.10	37.18	29.33	.58	2.94	8.68	1.40	.464	1.78	.902				
BK100MP	25	8.93	59.27	68.20	63.84	.60	3.01	9.08	.05	.464	-1.59	.902				
BK25MV	25	2.00	16.00	18.00	17.20	.15	.76	.58	-.36	.464	-1.13	.902				
BK50MV	25	9.00	31.00	40.00	36.72	.68	3.43	11.79	-.77	.464	-1.05	.902				
BK100MV	25	13.23	64.77	78.00	69.48	.72	3.62	13.16	1.45	.464	1.87	.902				

**Legend:** N-number of respondents, Range, Min-minimum result of measurement, Max-maximum result of measurement, Mean-The arithmetic mean, Std.dev.- standard deviation, Variance, Skewness- Measures of asymmetry, Kurtosis- Measure of elongation

players is 16,0sec. Standard deviation at swimmers is 1,50 and at water polo players is 0,57. Range is the simplest but the least precise dispersion measure. Range at swimmers is bigger and it is 5,0 and for water polo players is 2,0.

Variance as sum of quadrat deviations of empirical results and arithmetic mean is bigger for swimmers and it is 2,25 for water polo players is 0,58.

Analysing the main central and desperzion parameters of results in swimming crawl technique on 50m (BK50M) we can see that better average results have swimmers, the average result in 50m for swimmers is 29,3sec, average results for water polo players is 36,72sec. When we watch min and max results there is a big difference in speed, we can see that the swimmers are much faster than water polo players. Min result for swimmers is 26,10sec, water polo players min result is 31,0sec. Max result for swimmers is 37,18sec, max result for water polo players is 40,0sec. Standard deviation for swimmers is 2,94, for water polo players is 3,43. Range for swimmers is bigger and it is 11,0, for water polo players is 9,0. Variance for swimmers is 8,68, for water polo players 11,79.

Analysing the main central and desperzion parameters of results in swimming crawl technique on 100m (BK100M) we can see that better average results have swimmers, the average result in 100m for swimmers

**Legenda:** N-broj ispitanika, Range – rang, Min – minimalni rezultat mjerena, Max – maksimalni rezultat mjerena, Mean – aritmetička sredina, Std. Dev. – standardna devijacija, variance – varijansa, Skewness – koeficijent asimetrije, Kurtosis – koeficijent izduženosti.

skok kod sportista je 125 cm, a kod ne sportista 91 cm. Maksimalni rezultat kod plivača iznosi 17,0 sek., a kod vaterpolista 18,0 sek. Standardna devijacija (Std. Dev) kod plivača iznosi 1,50. a kod vaterpolista 0,57. Opseg (Range, engl.) je najjednostavnija, ali i najmanje precizna mjera disperzije. Kod plivača opseg je veći i iznosi 5,0, a kod vaterpolista 2,0. Varijansa (Variance) kao suma kvadriranih odstupanja empirijskih rezultata i aritmetičke sredine je veća kod plivača i iznosi 2,25, a kod vaterpolista 0,58. Imajući u vidu da se radi o mjerenu vremena plivanja kraul tehnikom na 25, 50 i 100m to manji rezultat ima bolju vrijednost.

Analizom osnovnih centralnih i disperzionih parametara rezultata plivanja kraul tehnikom na 50m (BK50M), može se vidjeti da bolje prosječne vrijednosti rezultata imaju ispitanici koji pripadaju grupi plivača u odnosu na grupu ispitanika vaterpolista, jer su prosječna vrijednost rezultata plivanja na 50m kod plivača 29,33 sek, a kod vaterpolista 36,72 sek. Uvidom u vrijednosti minimalnih (Min) i maksimalnih (Max) rezultata uočljiva je razlika u korist grupe ispitanika plivača. Minimalni rezultat kod plivača iznosi 26,10 sek., a kod vaterpolista 31,0 sek. Maksimalni rezultat kod plivača iznosi 37,18 sek., a kod vaterpolista 40,0 sek. Standardna devijacija (Std. Dev) kod plivača iznosi 2,94, a kod vaterpolista 3,43. Opseg (Range) kod plivača je veći i iznosi 11,0, a kod vaterpolista 9,0. Varijansa (Variance) kod plivača iznosi 8,68, a kod vaterpolista 11,79.

Analizom osnovnih centralnih i disperzionih parametara rezultata plivanja na 100m (BK100M) kraul tehnikom može se vidjeti da ispitanici koji pripadaju grupi plivača imaju bolje

is 63,84sec, for water polo players 69,84sec. Also all others descriptive parameters are better at swimmers than at water polo players.

By analysing descriptive statistic parameter for both groups we can say that swimmers have much better results in speed swimming with crawl technique on all lengths (25m, 50m and 100m)

**Table 2.** Matrix intercorrelation of applied variables for group of swimmers

		Correlations		
		BK25MP	BK50MP	BK100MP
BK25MP	Pearson Correlation	1.00	-.096	.350
	Sig. (2-tailed)		.648	.086
	N	25	25	25
BK50MP	Pearson Correlation	-.096	1.00	-.252
	Sig. (2-tailed)	.648		.225
	N	25	25	25
BK100MP	Pearson Correlation	.350	-.252	1.00
	Sig. (2-tailed)	.086	.225	
	N	25	25	25

**Legend:** Pearson Correlation-coefficient of correlation, Sig.-significance, N-number of respondents

Analysing of Matrix intercorrelations of applied variables for group of swimmers We can say that there is no significant statistic relationship, the reason is that correlation coefficients are statistically insignificant.

**Table 3.** Matrix correlation for group of water polo players

		Correlations		
		BK25MV	BK50MV	BK100MV
BK25MV	Pearson Correlation	1.00	-.010	.120
	Sig. (2-tailed)		.964	.567
	N	25	25	25
BK50MV	Pearson Correlation	-.010	1.00	.465*
	Sig. (2-tailed)	.964		.019
	N	25	25	25
BK100MV	Pearson Correlation	.120	.465*	1.00
	Sig. (2-tailed)	.567	.019	
	N	25	25	25

\*. Correlation is significant at the 0.05 level (2-tailed).

**Legend:** Pearson Correlation-coefficient colerration, Sig-significance, N-number of respondents

Analysing of Matrix intercorrelations of applied variables for group of water polo players, we can say that there is significant statistic relationship between speed swimming crawl technique on 50m and speed swimming crawl technique on 100m.

prosječene rezultate od grupe ispitanika vaterpolista, jer su prosječna vrijednost rezultata plivanja na 100m kod plivača 63,84 sek, a kod vaterpolista 69,84 sek. Takođe, i ostali deskriptivni parametri su bolji kod grupe plivača u odnosu na vaterpoliste. Sve varijable imaju normalnu raspodjelu podataka.

Analizama deskriptivnih statističkih parametara obje grupe ispitanika (tabela 1.) može se konstatovati da su plivači postigli bolje rezultate u brzini preplivavanja kral tehnikom svih dionica (25, 50 i 100m) u odnosu na vaterpoliste.

**Tabela 2.** Matrica interkorelacija primijenjenih varijabli kod grupe plivača

**Legenda:** Pearson Correlation – koeficijent korelacije, Sig. – značajnost, N - broj ispitanika

Analizom matrice interkorelacijske primijenjenih varijabli kod grupe plivača može se konstatovati da nema statistički značajne povezanosti, jer su korelacioni koeficijenti statistički bezznačajni.

**Tabela 3.** Matrica korelacija za grupu vaterpolista

**Legenda:** Pearson Correlation – koeficijent korelacije, Sig. – značajnost, N - broj ispitanika

Analizom matrice interkorelacijske primijenjenih varijabli kod grupe vaterpolista može se uočiti statistički značajna povezanost između brzine plivanja kral tehnikom na 50 m i brzine plivanja na 100m, jer je koeficijent povezanosti statistički značajan i iznosi ,47. Ostali koefficijenti korelacijske statistički nisu značajni.

**Table 4.** Analise of T-test results**Tabela 4** Analiza rezultata T-testa

		Independent Sample Test								
		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
BPK25M	Equal variances assumed	7.81	.007	-8.91	48	.000	-3.00	.33	-3.67	-2.32
	Equal variances not assumed			-8.91	35.66	.000	-3.00	.33	-3.68	-2.31
BPK50M	Equal variances assumed	3.15	.082	-8.15	48	.000	-7.38	.90	-9.20	-5.56
	Equal variances not assumed			-8.15	46.92	.000	-7.38	.90	-9.20	-5.56
BPK100M	Equal variances assumed	.12	.722	-5.97	48	.000	-5.63	.94	-7.53	-3.74
	Equal variances not assumed			-5.97	46.43	.000	-5.63	.94	-7.53	-3.73

**Legenda:** t - T test, df - stepeni slobode, Sig.- nivo statističke značajnosti), Mean Difference - razlika aritmetičkih sredina, Std. Error Difference - standardna greška aritmetičkih sredina)

In table 4. is showed the results of T-test for measuring the speed in swimming on 25m, 50m and 100m with crawl technique for group of swimmers and water polo players. Based on this analise of T-test we can say that there is statisticly significant difference in swimming speed in all three lenghts (25m, 50m and 100m) between swimmers and water polo players of the club „Dabar“ from Sarajevo. We can say that swimmers were faster in statistic sgnificance 99%.

## DISCUSSION

Research results are expected and show us logical development of speed in swimming for respondents. It was expected that swimmers will get better results in speed swimming crawl technique on 25m, 50m and 100m. Speed is motoric ability which is highly conditioned by genetic code and it depends on relation between fast contractile muscle fibers and slow contracile muscle fibers which is genetic conditioned and it can not be changed under the influence of training. Also, it must be said that without right technique and coordination it could bring to stagnation in speed results and it could bring speed barrier (Milanovic, 2017.) that is the reason why learning the right technique should be first and then we should develope speed. More we go in analysing basic decriptive parameters it is visible that absolute values of minimum, average and maximum result of all applied variables (BK25M,BK50M,BK100M) go to benefit for the swimmers group. Also it is not hard to notice that the swimmers are more homogeneous group than water polo players group in speed on 50m and 100m. It is necessary to explain more why the swimmers get better results in all measured swimming lenght. The chosen sample of respondents ( swimmers and water polo players) were in closely at the same time in

**Legenda:** t - T test, df - stepeni slobode, Sig.- nivo statističke značajnosti), Mean Difference - razlika aritmetičkih sredina, Std. Error Difference - standardna greška aritmetičkih sredina)

U tabeli 4 prikazani su rezultati T-testa za mjerjenje brzine plivanja na dionicima 25m, 50m i 100 m kralj tehnikom za grupu ispitanika plivača i grupu ispitanika vaterpolista. Na osnovu analize rezultata T-testa može se konstatovati da je postoji statistički značajna razlika u brzini plivanja u sve tri testirane dionice (25m, 50m i 100m) između plivača i vaterpolista Plivačko-vaterpolo kluba "Dabar" iz Sarajeva, u korist plivača na nivou statističke značajnosti od 99%.

## DISKUSIJA

Dobijeni rezultati istraživanja su očekivani i ukazuju na logičnosti u razvoju brzine plivanja kod tretiranih ispitanika. Naime, bilo je za očekivati da će plivači postići bolje rezultate u brzini plivanja kralj tehnikom na dionicama 25m, 50m i 100m. Brzina je motorička sposobnost koja je visokim koeficijentom uslovljena genetskim kodom i zavisi od odnosa brzokontraktilnih i sporokontraktilnih mišićnih vlakana koji je genetski uslovljen i nemože se mijenjati pod uticajem trenažnog rada. Uz to treba istaći da bez pravilne tehnike i koordinacije vrlo brzo dolazi do stagnacije rezultata u brzini i pojave brzinske barijere (Milanović, 2007.) zbog čega je učenje tehnike osnova prije početka rada na razvoju brzine.

Detaljnijom analizom osnovnih deskriptivnih parametara uočljivo je da apsolutne vrijednosti minimalnog, prosjecnog i maksimalnog rezultata svih primijenjenih varijabli (BK25M, BK50M, BK100M) idu u prilog grupi ispitanika koji pripadaju grupi plivača. Takođe, nije teško uočiti da su plivači homogenija grupa od grupe vaterpolista u brzini plivanja na 50m i 100m. Potrebno je detaljnije pojasniti zbog čega su plivači postigli bolje rezultate u brzini plivanja u svim mjerjenim dinocama plivanja.

Odarbani uzorak ispitanika (plivači i vaterpolisti) su u približnom istom vremenskom trenažnom procesu koji su u prvoj godini treniranja imali zajednički plan i program obuke

training process, who in the first training year had the same plan and program of training swimming techniques. After first year of training together on swimming techniques, swimmers continued perfecting swimming techniques, water polo players had specific training program which included perfecting water polo crawl technique and other techniques in water polo game. The position of the body is very important for the swimmers, specially establishing a favorable position, so the swimmer would not waste its energy on holding on the water surface and relativley high level of utilization. The position of the body is almost horizontal which provides minimal resistance, that is the best hydrodynamic position. Body position in water polo crawl technique is little bit different because the angle between the longitudinal part of the body and water surface is higher because of the ball management and pasing the ball, that is the reason why water polo is physiological and psychological demanding sport. During the training process swimmers can use group and individual way of work, where we can use more time for correction swimmers technique, unlike water polo players werhe the time can be used to correct techniqueof every swimmer, while in case of waterpolo players the time must be used also for tehniqual elements of the game. (Leko and Zoretic, 2010). That kind of approach may result with better average technique results. Anderson, Hopkins, Roberts and Pyne (2008) also say that combination of fitness and technique could be very important for competitive accomplishments. Making better assumptions for speed development in swimming means that swimmers need to have bigger level of basic motoric abilities wich can be achieved with continuos work and knowing the laws and principles of swimmers training proces . Also knowing the laws of growing and development of a child is important, as wel as monitoring progress under the influence of training with the clear goals. (Zoretic, D., Wertheimer, V., Fajdetic, M. 2010).

## CONCLUSION

The conclusion is that if we could extend support phase and the main (propulsion) phase we could get much better results in speed swimming with water polo crawl, but again swimming crawl is more efficient in speed swimming. We can assume that if water polo players swimm with the ball (counterattack) they bring their head in the water they would reduce frontal resistance and they would bring their body closer ideal position in water and with that they would increase speed swimming. But we also must say that if water polo players put their head in water they will have problem with opponents.

tehnike plivanja. Poslije prve godine zajedničkog trenažnog rada na usvajanju tehnika plivanja, plivači su nastavili rad na usavršavanju tehnike plivanja, dok je vaterpolistima uključen specifični program obuke koji je uključivao ovlađavanjem vaterpolo kraul tehnikom plivanja i drugim tehnikama vaterpolo igre. Za plivača je veoma važan položaj tijela, naročito uspostavljanje povoljnog položaja, kako bi manje trošio svoju energiju za svoje održavanje na površini vode i relativno visokog nivoa iskoristenosti. Položaj tijela u vodi je gotovo u horizontalnom položaju što obezbeđuje minimalni otpor, tj. najpovoljniji hidrodinamički položaj. Položaja tijela kod vaterpolo kraul tehnike kojom se služe vatepolisti se nešto razlikuje, jer je ugao između uzdužne ose tijela i površine vode veći zbog vođenja lopte, dodavanja lopte i izvođenje drugih tehničkih elemenata, zbog čega se vaterpolo sport ubraja u fiziološki i psihološki veoma zahtjevan i mentalno izazovan sport (Snyder, 2008). Takođe, specifičnost vaterpolo kraul tehnike plivanja odnosi se i na izvođenje faze propulzije u kojoj se prilikom faze prenosa ruke po novi zaveslaj primjećuje kraća trajektorija kretanja ruke, a samim tim i ulazak u narednu fazu je nešto kraći što dovodi do toga da je faza podupiranja i glavna (propulzivna) faza nedovoljno iskorištena. Ramena su nešto više podignita prema gore čime se povećava i čeoni otpor što usporava brzinu plivanja vaterpolista.

Dok su vaterpolisti trebali usvajati i nove elemente tehnike vaterpolo sporta, dotle su plivači bili usmjereni na kontinuirano usavršavanje tehnike uključujući i međusobnu takmičarsku komponentu čime su stvorili bolje pretpostavke za brže plivanje na pomenutim dionicama, što bi mogao biti mogući razlog boljih rezultata kod grupe plivača.

Takođe, treba imati u vidu i biomehaničke principe položaja tijela tijela u vodi kod plivača koje je gotovo u horizontalnom položaju i položaja tijela kod vaterpolo kraul tehnike kod koje je ugao između uzdužne ose tijela i površine vode veći zbog vođenja lopte, dodavanja lopte i dr. u odnosu na položaj tijela plivača. Dosadašnja istraživanja (Snyder, 2008) ukazuju da je vaterpolo sport fiziološki i psihološki veoma zahtjevan i mentalno izazovan sport.

U toku trenažnog procesa kod plivača se više može koristiti grupni i individualni oblik rada, gdje se više vremena može koristiti za korekciju tehnike svakog plivača, za razliku kod vaterpolista gdje se moralo voditi računa i na tehničke elemenata koji čine samu igru (Leko i Zoretić, 2010.). Takav pristup može uvijek rezultirati boljim prosječnim ocjenama usvojenosti tehnike, a ujedno i biti korektor u poboljšanju rezultata brzine plivanja.

Anderson, Hopkins, Roberts i Pyne (2008) takođe navode da je kombinacija kondicionih i tehničkih faktora važna za takmičarska dostignuća.

This kind of leading of ball should be tried in friendly games, on that way we could see his efficiency. We need to approach this team by setting new goal and we need to prove this scientifically and send results to experts from water polo sport.

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Stvaranje boljih prepostavki za razvoj brzine u plivanju podrazumijeva posjedovanje većeg nivoa bazičnih motoričkih sposobnosti koje se postižu kontinuiranim radom i poznavanjem zakonitosti i principa trenažnog procesa plivača. Takođe, važno je poznavanje zakonitosti rasta i razvoja organizma djeteta, kao i praćenje njihovog napredovanja pod uticajem trenažnog rada sa jasno postavljenim etapnim ciljevima (Zoretić, D., Wertheimer, V., Fajdetić, M. 2010).

## ZAKLJUČAK

Može se doći do sljedećeg zaključka a to je, kada bi uspjeli produžiti fazu podupiranja i glavna (propulzivna) faza došli bi do efikasniji rezultata u brzini plivanja vaterpolo kraljem, ali opet plivački kralj je efikasniji u brzini plivanja. Može se predpostaviti da prilikom plivanja sa loptom (kontranapad) spustimo lice u vodu i tim smanjimo čeoni otpor i približimo tjelo idealnom položaju u vodi, a samim tim bi i povećali brzinu plivanja. Treba naglasiti ako se spusti lice u vodu dolazi problema takozvanog bježanja lopte od igrača i smanjena vidljivost prilikom vođenja lopte. Ovakav način vođenja lopte sa licem u vodi može se probati kroz realizaciju plana i programa vaterpolista i prilikom prijateljskih utakmica kako bi mogli vidjeti njegovu efikasnost potom je prihvati ili odbaciti. Naravno, da se treba uraditi i naučno pristupiti postavljanju novog cilja, sve ovo naučno dokazati i plasirati rezultate stručnjacima u vaterpolu.

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# EDUCATION FOR DEMOCRATIC CITIZENSHIP AND HUMAN RIGHTS EDUCATION (EDC/HRE) IN PHYSICAL EDUCATION

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**Abstract:** The subject of this research is connection between EDC/HRE key concepts and physical education. The aim is to examine students' sensibility in recognition the significance of special key concept and realizing a possibility of its implementation in school work within the physical education course. Data were collected in the school year 2016/2017 and elaborated by qualitative research methods. The Conclusion is that students do not recognise the connection between special key concept and school practice and they are not ready to implement them. They see school as community suitable for practicing knowledge and skills in field of EDC/HRE.

**Key words:** EDC/HRE key concepts, Physical Education, School, Teaching.

## INTRODUCTION

Education for Human Rights in primary and secondary educational level is worldwide program developed after ending the Decade for Human Rights (1995-2004). In Southeast Europe, education for democratic citizenship began with the training of teachers from Bosnia and Herzegovina with the aim of "supporting the process of peace making" (Gollob, Krapf 2008, 9). The positive outcomes of the programme enabled its dissemination to all states members of the Council of Europe, in order to fully implement the terms and recommendations of the *Charter of Education for Democratic Citizenship and Human Rights Education* at national, intra national, counties, cantons, entities, provinces and other communities. During 2007. OHCHR, UNESCO and OSCE decided that the context of human rights is ready to join the education for democratic citizenship, emphasizing that they should be part of every man's education from his/her early years (Battaini Dragoňi 2016). As institution, school has been recognized to pro-

# OBRAZOVANJE ZA DEMOKRATSKO GRAĐANSTVO I OBRAZOVANJE ZA LJUDSKA PRAVA (EDC/HRE) U FIZIČKOM VASPITANJU

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**Apstrakt:** Predmet rada je povezivanje ključnih koncepta EDC/HRE sa fizičkim vaspitanjem sa ciljem procene senzibilisanosti studenata za prepoznavanje značaja konkretnog ključnog koncepta i uviđanja mogućnosti za njegovu primenu u nastavnom radu u okviru predmeta fizičko vaspitanje. Podaci su prikupljeni u školskoj 2016/2017. godini i obrađeni metodama kvalitativnog istraživanja. Zaključak je da studenti ne prepoznaju vezu između konkretnog ključnog koncepta i nastavne prakse i da ne iskazuju spremnost da ih koriste. Školu vide kao zajednicu pogodnu za upražnjavanje znanja i veština iz oblasti demokratskog građanstva i ljudskih prava.

**Ključne reči:** Ključni koncepti EDC/HRE, fizičko vaspitanje, škola, nastava.

## UVOD

Ostvarivanje obrazovanja za ljudska prava u prvom i drugom nivou školskih sistema svih zemalja sveta, svetski je program koji je nastao nakon završetka Dekade obrazovanja za ljudska prava (1995-2004). Na području jugoistočne Evrope obrazovanje za demokratsko građanstvo je započelo obukom nastavnika iz Bosne i Hercegovine sa ciljem da se kroz njega „podrži proces izgradnje mira“ (Gollob, Krapf 2008, 9). Pozitivni ishodi programa su omogućili njegovo širenje na sve države članice Saveta Evrope, kako bi se na nacionalnom nivou i u okviru unutarnacionalnih okruga, kantona, entiteta, pokrajina i drugih oblika zajednica u potpunosti primenjivale odredbe i preporuke iz *Povelje o obrazovanju za demokratsko građanstvo i obrazovanju za ljudska prava*. Savet Evrope, Visoki komesarijat za ljudska prava (OHCHR), UNESCO i OEBS su tokom 2007. godine doneli odluku da se obrazovanju za demokratsko građanstvo pridruži i kontekst ljudskih prava, uz napomenu da treba da budu deo

vide education which will help children to grow and live in the world of differences which, if they are properly understood, do not divide but enrich people (Zuković, 2006).

### **EDC/HRE KEY CONCEPTS THROUGH THE PRISM OF PHYSICAL EDUCATION**

Education for Democratic Citizenship (EDC) mostly refers to democratic rights and responsibilities and is focused on the role of young people in particular community. Human Rights Education (HRE) is engaged in broader range of human rights and main freedoms in every part of human life (Gollob, Krapf, Ólafsdóttir & Weidinger, 2010). Concepts of democracy and human rights are pervading through all 9 EDC/HRE key concepts: 1. Equality, 2. Responsibility, 3. Diversity and Pluralism, 4. Rights and Freedom, 5. Conflict, 6. Media, 7. Rules and Law, 8. Identity, 9. Government and Politics. They can be studied either vertical and adapt to the level of student's understanding and different ages, and horizontal, when they create a broad network of understanding. They can be applied in one or more subjects, teachers can include them in teaching contents by their own choice, enabling acquire procedural knowledge which includes reasonable processes which child can be understandable to every child (Stojanović, Nedimović, Sturza Milić, 2016).

Most of the recent research studies were directed to assessment of sport's impact to quality of life (of sportsmen) in regards to persons age (Oxyzoglou, Oxyzoglou, 2011; Nešić, Srdić, Jezdimirović, 2016; Benson, Bruner, 2018; Jones, 2018). A common fact to all is that sport is initiator of wide spectre of activities and action which support social inclusion, decrease the level of racism, violence and xenophobia and contributes to development of gender equality (European Commission, 2007; Spaaij, Magee, Jeanes, 2014). Physical education in teaching process is seen as one of five fields of education and understood as outcome of holistic implementation of knowledge, skills and attitudes of physical education, i.e. lifetime values (Lazić, Popov, 2016; Đokić, 2017). It follows the motion as natural necessity of human body through which child / student learn about environment, understand causal relations and change perception of reality. Physical education has irreplaceable role in all activities which contribute to forming the motor habits and consciences development of physical and psychic health, achieving the positive influence to cognitive functioning (Popov, Jakovljev, 2017).

### **METHOD**

The research was provided in school 2016/2017 year in within teaching subject Pedagogy of Sport and

obrazovanja svakog čoveka od najranijih godina (Battaini Dragoni 2016). Škola je pozvana da pruži vaspitanje i obrazovanje koje će pomoći odrastanju i življenu u svetu različitosti koje, ako su pravilno shvaćene, ne dele nego obogaćuju ljude (Zuković, 2006).

### **KLJUČNI KONCEPTI EDC/HRE KROZ PRIZMU FIZIČKOG VASPITANJA**

Obrazovanje za demokratsko građanstvo (EDC) se u najvećoj meri odnosi na demokratska prava i na odgovornosti i usmereno je više na ulogu mlađih u zajednici. Obrazovanje za ljudska prava (HRE) se bavi širim spektrom ljudskih prava i osnovnih sloboda u svakom području ljudskog života (Gollob, Krapf, Ólafsdóttir & Weidinger, 2010). Pojmovi demokratije i ljudskih prava se prožimaju kroz svih devet ključnih koncepta EDC/HRE: 1. jednakost, 2. odgovornost, 3. različitost i mnoštvo, 4. prava i slobode, 5. konflikti, 6. mediji, 7. pravila i zakoni, 8. identitet, 9. vlast i politika. Mogu se izučavati vertikalno i prilagoditi nivou razumevanja učenika i različitim uzrastima i horizontalno, kada stvaraju mrežu razumevanja. Primjenjivi su u jednom ili u više predmeta, a nastavnici ih po sopstvenom izboru uključuju u sadržaj, omogućavajući sticanje proceduralnih znanja koja u sebe uključuju svrhovite procese koje dete razume (Stojanović, Nedimović, Sturza Milić, 2016).

Većina dosadašnjih studija se bavila procenom uticaja sporta na kvalitet života (sportista) u odnosu na životnu dob (Oxyzoglou, Oxyzoglou, 2011; Nešić, Srdić, Jezdimirović, 2016; Benson, Bruner, 2018; Jones, 2018). Zajedničko za sve je da je sport pokretač širokog spektra aktivnosti i delatnost koja podržava socijalnu inkluziju, smanjuje rasizam, nasilje i ksenofobiju i doprinosi razvoju rodne ravnopravnosti (European Comission, 2007; Spaaij, Magee, Jeanes, 2014). U nastavnom procesu govori se o fizičkom vaspitanju koje se sagledava kao jedno od pet vaspitnih oblasti i razume kao ishod holistički primjenjene znanja, umeća i stavova o fizičkoj aktivnosti, odnosno vrednostima za ceo život (Lazić, Popov, 2016; Đokić, 2017). Prati pokret kao prirodnu potrebu ljudskog tela uz koju dete/učenik uči o okruženju, razume uzročno-posledične veze i menja percepciju stvarnosti. Ima nezamenljivu ulogu u svim aktivnostima koje doprinose formiranju motornih navika i razvoju svesti o fizičkom i psihičkom zdravlju, ostvarujući pozitivan uticaj na kognitivno funkcionisanje (Popov, Jakovljev, 2017).

### **METOD**

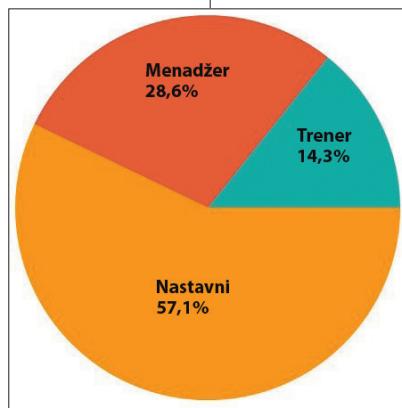
Istraživanje je realizovano u školskoj 2016/2017. godini u okviru nastavnog predmeta Pedagogija sporta

Exercise, with students of 2<sup>nd</sup> year of undergraduate studies in the Faculty of Sport Sciences of the Pan-European University Apeiron Banjaluka, in three educational courses: pedagogical-teaching, sport trainer, sport manager. The subject of this research is connection between EDC/HRE key concepts and physical education. The aim is assessment of students' sensibility in recognising significance of special key concept and realizing possibility of its implementation in school work within the subject of physical education. Relevant data for this research were student's seminar papers which were elaborate by software platform QDA Miner Lite 2.0, arranged for qualitative researches. Student evaluated key concept Government and Politics, Media, Conflict, Equality, Responsibility.

## RESULTS

The largest number of students in this research study for teacher in physical education (Illustration 1).

**Illustration 1.** Research sample according to study programme



Key concepts distribution (illustration 2) shows that the most interest among students was for government and politics (42.9%), while others were equally represented (per 14.3%).

**Illustration 2.** Representation of EDC/HRE key concepts

Table 1 shows relation between the chosen key concept and study programme.

**Table 1.** Key concepts according to study programme.

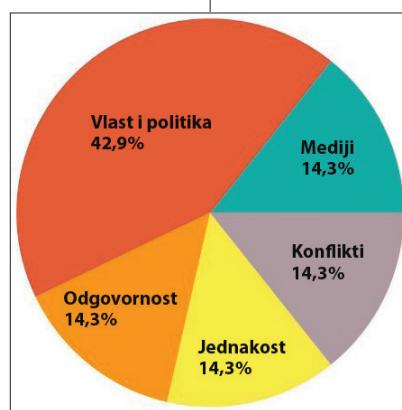
Ključni koncept / Key concept	Broj jedinica / Number of units	Studijski smer / Study programme
Vlast i politika / Government and Politics	3	Sportski menadžer (1), Pedagoško-nastavni (2) / Sport manager (1), Pedagogical-teaching (2)
Mediji / Media	1	Sportski trener / Sport trainer
Konflikti / Conflict	1	Sportski menadžer / Sport manager
Jednakost / Equality	1	Pedagoško-nastavni / Pedagogical-teaching
Odgovornost / Responsibility	1	Pedagoško-nastavni / edagogical-teaching

i vježbanja, sa studentima 2. i 3. godine osnovnih studija Fakulteta sportskih nauka Panevropskog univerziteta Apeiron Banjaluka, na smerovima pedagoško-nastavni, sportski trener i sportski menadžer. Predmet rada je povezivanje ključnih koncepata EDC/HRE sa fizičkim vaspitanjem. Cilj je procena senzibilisanosti studenata za prepoznavanje značaja konkretnog ključnog koncepta i uviđanje mogućnosti za njegovu primenu u nastavnom radu u okviru predmeta fizičko vaspitanje. Do podataka za istraživanje se došlo analizom sadržaja seminarskih radova studenata koji su obrađeni upotrebom softverske platforme QDA Miner Lite 2.0 namenjenoj kvalitativnim istraživanjima. Studenti su obradili ključne koncepte vlast i politika; mediji; konflikti; jednakost; odgovornost.

## REZULTATI

Najveći broj studenata koji je učestvovao u istraživanju se obrazuje za pedagoško-nastavni smer u oblasti fizičkog vaspitanja (Ilustracija 1).

**Ilustracija 1.** Uzorak istraživanja prema studijskom smeru



Distribucija ključnih koncepata (Ilustracija 2) pokazuje da je najveće interesovanje studenata bilo za vlast i politiku (42,9%), dok su ostali ključni koncepti bili ravnomerno zastupljeni (po 14,3%).

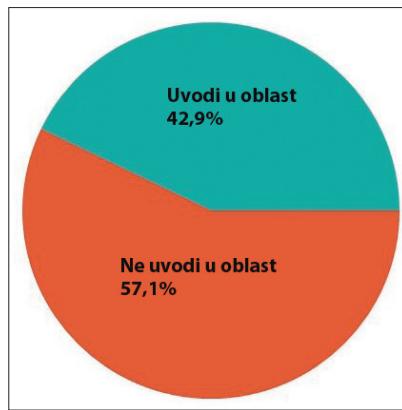
**Ilustracija 2.** Zastupljenost ključnih koncepta EDC/HRE

U tabeli 1 je prikazan odnos izabranog ključnog koncepta i studijskog programa.

**Tabela 1.** Ključni koncepti prema studijskom smeru

Distribution of the introduction code in the field of physical education showed that students in 42.9% introduce the special key concept in school, i.e. in the field of physical education (Illustration 3). They do this for key concepts conflict, responsibility and equality.

**Illustration 3.** Introduce / do not introduce the EDC/HRE key concept in school / teaching of physical education



Observing the same code from the aspect of study programme it is obvious that connection between theoretically evaluated EDC/HRE key concept and possibility of its implementation in physical education in school has been established in two students works from pedagogical-teaching study programme (28.6% of sample) and in one from sport manager study programme (14.3% of sample).

## DISCUSSION

The students precisely described the special key concept and in 52.1% stopped at that point, with no improvement in further ‘transfer’ in the teaching practice. Those who did it explained it in certain way:

*Key concept Conflict:* “Nonviolent solution is something to strive in conflict resolution. It will be more difficult to solve the conflict if one side wants to defeat the other one. Conflict does not have to take negative foretoken. Often, without conflict there are no new solutions”.

*Key concept Responsibility:* “By studying ecology children learn how to live with it and what it means. From an ecological point of view, education contributes a lot to environment in the future. Children should be supported to consider their results and experiences and to agree about what the expression ‘taking responsibility’ means”.

*Key concept Equality:* “Students in schools learn to introduce and accept each other. They discover common characteristics they were not aware before. It is very important that teacher direct and advise children to accept different student, since he/she is the same like others, at the end, we are humans”.

The conclusion is that students see key concepts more as set of principles of personal responsibility and healthy life styles than frameworks of physical education in schools. In this way, they are approaching the accomplishment of the educational task of physical education mentioned in other studies (Hackney, 2006; Đokić, 2017; Popov, Jakovljev, 2017; Rađević, Vukadinović, 2017). The lack

Distribucija koda Uvodi u oblast fizičkog vaspitanja pokazala je da studenti u 42,9% uvode konkretni ključni koncept u školu, odnosno u oblast fizičkog vaspitanja (Ilustracija 3). To čine za ključne koncepte konflikti, odgovornost i jednakost.

**Ilustracija 3.** Uvodi / ne uvodi ključni koncept EDC/HRE u školu / nastavu fizičkog vaspitanja

Kada se isti kod posmatra sa aspekta studijskog programa, primećuje se da je veza između teorijski obrađenog ključnog koncepta EDC/HRE i mogućnosti njegove primene u nastavi fizičkog vaspitanja uspostavljena u dva studentska rada sa pedagoško-nastavnog studijskog smera (28,6% ukupnog uzorka) i u jednom sa studijskog smera sportski menadžer (14,3% ukupnog uzorka).

## DISKUSIJA

Studenti su vrlo precizno opisivali konkretni ključni koncept i u 52,1% se zaustavljali na tom mestu, ne nastavljući dalje u njihovo ‘prebacivanje’ u konkretnu nastavnu praksu. Oni koji su to učinili objasnili su to na sledeći način:

*Ključni koncept Konflikti:* „Nenasilno rješenje je nešto čemu treba težiti u rješavanju konfliktova. Sukob će biti mnogo teže rješen ako jedna strana ima želju da u toj situaciji porazi onu drugu. Konflikt ne mora da nosi negativan predznak. Često bez sukoba nema ni novih rješenja.“

*Ključni koncept Odgovornost:* „Učenjem o ekologiji djeca uče kako se živi ekološki i šta se pod tim podrazumjeva. Vaspitanje u ekološkom smislu mnogo doprinosi okolini u budućnosti. Djecu treba podstići da razmatraju svoje rezultate i iskustva, da se usaglašavaju oko izraza ‘preuzimanje odgovornosti’.“

*Ključni koncept Jednakost:* „Učenici u školama uče da upoznaju i prihvate jedni druge. Otkrivaju zajedničke karakteristike kojih pre toga nisu bili svesni. Važno je da nastavnik dobro usmjerava i savjetuje decu da prihvate učenika koji je drugačiji od njih, jer je on isti kao i ostali učenici, na kraju, ljudi smo.“

Može se zaključiti da studenti ključne koncepte sagledavaju pre kao principe lične odgovornosti i primenu zdravih stilova života nego kao okosnice rada u nastavi fizičkog vaspitanja. Time se približavaju ostvarenju vaspitnog zadatka fizičkog vaspitanja, o čemu je pisano i u drugim studijama (Hackney, 2006; Đokić, 2017; Popov, Jakovljev, 2017; Rađević, Vukadinović, 2017). Nedostatak istraživanja tiče

of research concerns the size of the sample which can be overcome in further researches, by providing conditions in order to obtain larger and better balanced sample. The advantage of research is in confirming students' sensibility in connecting the key concept and teaching practice. That changes the role and responsibility of a teacher as well.

## CONCLUSION

In task-based learning of academic writing and for the purpose of specific subject, students have shown that they can use more sources of information combining them at the same time with different techniques. Analysing their seminar papers with obvious freedom of conclusion, they are still not empowered to apply deductive method of conclusion and to connect abstract key concept with teaching practice in school, especially physical education. That is the reason why students cannot see their role as creators of programme which improve attitudes of physical education, setting them up as lifelong values. It is very significant that they connect this notion to the school climate, confirming that they understand it as a mini community, suitable for knowledge and skills implementation from democratic citizenship and human rights.

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se veličine uzorka koji bi u budućem radu trebalo da bude prevaziđen obezbeđivanjem uslova u cilju dobijanja većeg i bolje izbalansiranog uzorka. Prednost je u potvrđivanju potrebe povećanja senzibilisanosti studenata u povezivanju ključnog koncepta i nastavne prakse, čime se menja uloga i odgovornost nastavnika u praksi.

## ZAKLJUČAK

U zadatoj formi akademskog pisanja i za potrebe konkretnog nastavnog predmeta, studenti su uspešno pokazali da mogu da koriste više izvora informacija uz različite tehnike njihovog kombinovanja. Analizom njihovih radova i iskazane slobode zaključivanja može se reći da još uvek nisu u dovoljnoj meri osnaženi da primenom deduktivnog zaključivanja apstraktni ključni koncept dovedu u vezu sa nastavnom praksom, posebno sa fizičkim vaspitanjem. Stoga ne vide ni svoju ulogu kao kreatora programa koji unapređuje stavove o fizičkim aktivnostima, postavljajući ih kao celoživotne vrednosti. Značajno je što svoja zapažanja povezuju sa školskom klimom, potvrđujući da je razumeju kao mini zajednicu pogodnu za upražnjavanje znanja i vешćina iz oblasti demokratskog građanstva i ljudskih prava.

# RELATIONS OF MORPHOLOGICAL CHARACTERISTICS AND AEROBIC DURABILITY OF FUDBALERS OF DIFFERENT AGE CATEGORIES

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**Abstract:** The aim of the study was to analyze if there is a connection between some anthropometric measurements and a test for assessing aerobic ability in footballers of different age categories. 65 players were subjected to these measurements, of which 25 players aged 13-14 years (pioneers); 20 players aged 15-16 years (cadets) and 20 players aged 17-18 years (juniors). By using standard anthropometric instruments, body height, body weight, median volume of the chest and aerobic endurance were measured using a 20m "shuttle run" test. Using linear regression analysis, it was found that there is no statistically significant effect of anthropometric variables on a variable (20m "shuttle run") of all three age players. In these ages, obviously some other characteristics have more influence on the manifestation of aerobic ability. The results of the research can be used by experts in the field of sports in further planning and organizing training contents.

**Keywords:** aerobic ability, anthropometry, football players, connectivity.

## INTRODUCTION

Measuring and monitoring the levels of aerobic endurance and morphological characteristics is an integral part of training in most sports (Farraly, 1995a; Farraly, 1995b; Jones, 1997). At Loughborough University, in 1988, a 20m "shuttle run" test was presented as an easy way to measure aerobic ability and aerobic oxygen consumption (Bale, & Doust, 1992). The test has become one of the most popular and most valid tests to date for

# RELACIJE MORFOLOŠKIH KARAKTERISTIKA I AEROBNE IZDRŽLJIVOSTI FUDBALERA RAZLIČITIH UZRASNIH KATEGORIJA

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**Sažetak:** Cilj istraživanja bio je analizirati da li postoji povezanost između nekih antropometrijskih mera i testa za procenu aerobne sposobnosti kod fudbalera različitih uzrasnih kategorija. Merenjima je bilo podvrgnuto 65 fudbalera, od toga 25 fudbalera uzrasta 13-14 godina (pionira); 20 fudbalera uzrasta 15-16 godina (kade-ta) i 20 fudbalera uzrasta 17-18 godina (omladinaca). Korisćenjem standardnih antropometrijskih instrumenata izmereni su telesna visina, telesna masa, srednji obim grudnog koša i aerobna izdržljivost pomoću testa 20m „shuttle run“. Primenom linearne regresione analize utvrđeno je da ne postoji statistički značajan uticaj sistema antropometrijskih varijabli na varijablu (20m „shuttle run“) kod sva tri uzrasta fudbalera. U navedenim uzrastima očito neke druge karakteristike više utiču na manifestaciju aerobne sposobnosti. Rezultati rada mogu poslužiti stručnjacima u oblasti sporta u daljem planiranju i organizovanju trenажnih sadržaja.

**Ključne reči:** aerobna sposobnost, antropometrija, fudbaleri, povezanost.

## UVOD

Merenje i praćenje nivoa aerobne izdržljivosti kao i morfoloških karakteristika je sastavni deo treninga u većini sportova (Farraly, 1995a i Farraly, 1995b; Jones, 1997). Na Loughborough University je davne 1988. godine predstavljen test 20m „shuttle run“ kao jednostavan način za merenje aerobne sposobnosti i aerobne potrošnje kiseonika (Bale, & Doust, 1992). Test je postao jedan od najpopularnijih i najvalidnijih testova do danas za

assessing the aerobic ability of athletes and can be used to estimate maximum of oxygenation (aerobic endurance) or  $\text{VO}_{2\text{max}}$ . He has several names by which is known in the sports world, such as *Multistage Fitness Test MSFT*, *Beep Test*, *Bleep Test*. The test is mostly for the purpose of finding out the results of aerobic endurance. Aerobic ability is an essential component in most sports. The test-20m "shuttle run" was designed for individuals such as footballers. This test provides scientifically verified information on-site, enabling people who are monitoring and measuring achievements in sports to effectively monitor aerobic endurance. The equipment necessary for this kind of test is minimal, and thus reduces access to laboratory equipment, most commonly used by sports experts, and a full estimate of aerobic capacity can be done without major demands (Wilkinson, & Moore, 1995; Davis, 1996; Brewer & Davis, 1998).

Football features a continuous flow of activities with variable intensity and a very low coefficient of performance according to the time of possession of the ball. A football player during a match runs around 10 km (Reilly, Clarus, & Stibbe, 1993; Mayhew, & Wenger, 1985). In doing so, a light run (less than 11km/h, less than 80% of the maximum oxygen consumption- $\text{VO}_{2\text{max}}$ ) is represented in the largest percentage of overall movements, followed by walking and intense running (11-18 km/h; about 80%  $\text{VO}_{2\text{max}}$ ), then sprint (11-27 km/h; <85%  $\text{VO}_{2\text{max}}$ ). By the nature of cyclical movements, this corresponds to aerobic needs of about 80% of the maximum oxygen consumption (Helgerud, Engen, & Wisloff, 2001). Maximum oxygen consumption is the largest amount of oxygen a person can take from the inhaled air during dynamic physical activity that engages large muscle groups (Wagner, 1996). Running efficiency represents oxygen debt at a sub-maximal exercise intensity and can vary as much as 20% for athletes with approximate  $\text{VO}_{2\text{max}}$  value. Good aerobic ability undoubtedly influences the performance of explosive movements of the footballers, both in terms of quantity (number of sprints), as well as the quality, that is, the intensity and tempo of cyclical movements. Studies by Reilly, Clarus, & Stibbe (1993b) show that, especially in football, good aerobic capacity of an organism is one of the most important preconditions for achieving top results. A survey conducted by Stankovic, Demir, & Hadziahmetovic (2007a) indicates that pioneers have the worst results in aerobic endurance, and that cadets have the best average values. The authors also state that the basicanthropometric characteristics were in negative correlations with aerobic endurance in all three age groups of footballers. Also results obtained by Bouchard, Dionne, Simoneau,

procenu aerobne sposobnosti sportista i može se koristiti za procenu maksimalnog unosa kiseonika (aerobne izdržljivosti) ili  $\text{VO}_{2\text{max}}$ . On ima nekoliko naziva preko kojih se poznaje u svetu sporta, kao što su *Multistage Fitness Test*, *MSFT*, *Beep Test*, *Bleep Test*. Test je najviše u svrsi saznanja rezultata aerobne izdržljivosti. Aerobna sposobnost je bitna komponenta u većini sportova. Test-20 m „shuttle run“ je i bio dizajniran za pojedince kao što su fudbaleri. Taj test daje naučne potvrđene informacije na licu mesta, omogućavajući na taj način ljudima koji se bave praćenje i merenjem dostignuća u sportu da efektivno prate aerobnu izdržljivost. Oprema neophodna za ovaku vrstu testa je minimalna, te se na taj način smanjuje pristup laboratorijskim uređajima, najčešće korištenim od strane stručnjaka u sportu, a puna procena aerobnog kapaciteta se može obaviti bez većih zahteva (Wilkinson, & Moore, 1995; Davis, 1996; Brewer, & Davis, 1998).

Fudbal karakteriše kontinuiran tok aktivnosti sa promenljivim intenzitetom i veoma niskim koeficijentom uspešnosti prema vremenu posedovanja lopte. Fudbaler u toku utakmice pređe oko 10 km (Reilly, Clarus, & Stibbe, 1993a; Mayhew, & Wenger, 1985). Pri tome je lagano trčanje (manje od 11km/h; manje od 80% maksimalne potrošnje kiseonika- $\text{VO}_{2\text{max}}$ ) zastupljeno u najvećem procentu od ukupnih kretnih radnji, posle čega idu hodanje i intenzivno trčanje (11-18 km/h; oko 80%  $\text{VO}_{2\text{max}}$ ), a zatim sprint (11-27 km/h; < 85%  $\text{VO}_{2\text{max}}$ ). Po prirodi cikličnih kretnih aktivnosti to odgovara aerobnim potrebama od oko 80% maksimalne potrošnje kiseonika (Helgerud, Engen, & Wisloff, 2001). Maksimalna potrošnja kiseonika je najveća količina kiseonika koju osoba može da preuzme iz udahnutog vazduha tokom dinamičke fizičke aktivnosti koja angažuje velike mišićne grupe (Wagner, 1996). Ekonomičnost trčanja predstavlja kiseonički dug na submaksimalnom intenzitetu vežbanja i može variрати i preko 20% kod sportista sa približnom vrednošću  $\text{VO}_{2\text{max}}$ . Dobra aerobna sposobnost nesumnjivo utiče i na izvođenje eksplozivnih kretnih radnji fudbalera, kako u smislu kvantiteta (broj sprinteva), tako i kvaliteta, odnosno intenziteta i tempa cikličnih kretnji. Istraživanja Reilly, Clarus & Stibbe (1993b) pokazuju da, posebno u fudbalu, dobar aerobni kapacitet organizma predstavlja jedan od najvažnijih preduslova za postizanje vrhunskih rezultata. Istraživanje sprovedeno od strane Stanković, Demir i Hadžiahmetović (2007a) ukazuje da pioniri poseduju najslabije rezultate u aerobnoj izdržljivosti, a da kadeti imaju najbolje prosečne vrednosti. Autori još navode da su osnovne antropometrijske karakteristike bile u negativnim korelacionama sa aerobnom izdržljivošću kod sve tri uzrasne grupe fudbalera. Kođe nalazi do-

Boulay, (1992a) indicate that morphological characteristics have little impact on maximum aerobic endurance. The inheritance can be interpreted as 25-50% of the variation between the individuals, especially when comparing the athletes, the difference in maximum oxygen consumption and aerobic endurance is reduced to around 10% with increasing age (Wilmore, & Costill, 2005). Maximum oxygen consumption decreases with age, and the average drop rate is usually accepted at a level of about 1% per year or 10% per decade after 25 years of age.

The aim of the research is to point out the results based on the relations of individual morphological characteristics and aerobic abilities, from which further suggestions could be given for working with certain age groups of footballers.

## MATERIALS AND METHODS

Measurement of basic morphological characteristics and functional abilities was performed on a sample of 65 respondents, FC ‘Radnicki’ from Sombor. Out of the total number of respondents, there were 25 footballers aged 13-14 years classified as pioneers; 20 players aged 15-16 years classified as cadets and 20 players aged 17-18 years who made a junior group.

**Table 1.** Structure of the sample of footballers

Age groups	sample
Pioneers (13/14 years)	25
Cadets (15/16 years)	20
Juniors (17/18 years)	20
Total Σ	65

An estimate of anthropometric dimensions included the measurement of one variable for estimating the longitudinal dimension of the skeleton: 1) *Body height* (mm) and two variables for estimating volume and body weight 2) *Body mass* (kg) and 3) *Median circumference of the chest* (mm) considering IBP International Biological Program for each anthropometric measure. The height of the body was measured by an anthropometer after Martin. The respondent was without shoes. He stood on a flat surface, with heels together, his head placed in the position of the “Frankfurt Horizontal”. The distance from the surface to the top of the head was measured. The result was expressed in values of 0.1 cm. Body weight was measured by digital medical scale. The respondent was standing on a scale dressed only in underwear. Results are expressed in values of 0.1 kg. The median circumference of the chest was measured by centimeter band. The respondent was stand-

bijeni od strane Bouchard, Dionne, Simoneau, Boulay, (1992a) ukazuju da morfološke karakteristike slabo utiču na maksimalnu aerobnu izdržljivost. Naslednost se može protumačiti od 25-50% varijacije između individua, pogotovo kada se porede sportisti, razlika u maksimalnoj potrošnji kiseonika i aerobnoj izdržljivosti se smanjuje do oko 10% sa porastom godina (Wilmore, & Costill, 2005). Maksimalna potrošnja kiseonika se smanjuje sa godinama, a prosečna mera pada je ponajčešće prihvaćena na nivou oko 1% godišnje ili 10% po dekadi nakon 25 godina starosti.

Cilj istraživanja je da se na osnovu rezultata ukaže na odnose pojedinih morfoloških karakteristika i aerobne sposobnosti pri čemu bi se moglo dati dalje sugestije za rad sa određenim uzrasnim grupama fudbalera.

## MATERIJAL I METOD

merenje osnovnih morfoloških karakteristika i funkcionalne sposobnosti je bilo izvršeno na uzorku od 65 ispitanika, fudbalera FK „Radnički“ iz Sombora. Od ukupnog broja ispitanika bilo je 25 fudbalera uzrasta 13-14 godina klasifikovanih kao pioniri; 20 fudbalera uzrasta 15-16 godina klasifikovanih kao kadeti i 20 fudbalera uzrasta 17-18 godina koji su činili grupu juniora.

**Tabela 1.** Struktura uzorka fudbalera

Uzrasne grupe	uzorak
Pioniri (13/14 god.)	25
Kadeti (15/16 god.)	20
Juniori (17/18 god.)	20
Ukupno Σ	65

Procena antropometrijskih dimenzija uključivala je merenje jedne varijable za procenu longitudinalne dimenzionalnosti skeleta i to 1) *Telesnu visinu* (mm) i dve varijable za procenu volumena i mase tela 2) *Telesnu masu* (kg) i 3) *Srednji obim grudnog koša* (mm) prema poštovanju internacionalnog biološkog programa IBP za svaku antropometrijsku meru. Visina tela merena je antropometrom po Martinu. Ispitanik je bio bez obuće. Stajao je na ravnoj podlozi, skupljenih peta, glave postavljene u položaj „frankfurtske horizontale“. Merila se udaljenost od podloge do temena glave. Rezultat se iskazivao u vrednostima od 0,1 cm. Telesna težina merena je digitalnom medicinskom vagom. Ispitanik je stajao na vagi odevan samo u donje rublje. Rezultati se iskazivato u vrednostima od 0,1 kg. Srednji obim gudnog koša merio se centimetarskom trakom. Ispitanik je stajao opruženih ruku niz telo. Merio se obim najšireg dela grudnog

ing his arms streched down the body. The volume of the widest part of the chest was measured. The result was read on the lower part of the chest bone (manubrium sterni). The values were expressed in 0.1 cm. Measurement was also performed once. These results were taken from the Sports Dispensary in Sombor, where all these footballers have their own sports/medical cards, and the measurement was done immediately before testing the functional capability.

A 20m "shuttle run" test from the Fitness test group was used to assess functional abilities, and to estimate aerobic endurance, i.e. to check the maximum oxygen intake. This test was performed through a continuous running between two lines of 20m distance to the sound that sounds from the CD player. The person being tested was behind one of the lines and turned to look at another line and started running when instructions from the CD player were heard. The speed at the start of the test was of extremely low intensity. The respondent was continuously running between two lines. He turned around when the signal from the recorded material was being heard. After one minute, the sound was emphasized and the sound signal time was reduced. Such sound signal continued every minute. If the line was not reached at the time of each beep, the respondent had to run to the line and then turned and tried to catch the step and rhythm of the two subsequent sounds, so he had to be timely in any hearing of sound from the tape. In addition, if the line was touched before the sound, the respondent had to wait until the sound was heard. The test was stopped if the respondent failed to reach the line after a beep. There are several versions of this test, but one general version has a starting load of 8.5 km / h, which increases by 0.5 km / h every minute. The result of the test is the number of running distances. As necessary equipment for the performance of this test, it was used: flat, unbroken surface, conical markers, 20 m "shuttle run" adequate audio tape, CD player, notebook for entering results.

Descriptive statistics for the calculation of descriptive statistics of anthropometric and functional variables were used in data processing: arithmetic mean (AS), standard deviation (S), minimum and maximum values of measurement results, coefficient of variation (KV). In order to determine the statistically significant correlation between anthropometric and functional variables, a linear regression analysis was used.

## RESULTS

The results of descriptive statistics presented in Table 2 indicate that pioneer age players are homogeneous in terms of body height, body weight and chest development, while this can not be ascertained for the

koša. Rezultat se očitavao na donjem delu grudne kosti (*manubrium sterni*). Vrednosti su se iskazivale u 0,1 cm. Merenje se vršilo takođe jedanput. Ovi rezultati su preuzeti iz Sportskog dispanzera u Somboru, gde svi ovi fudbaleri imaju svoje sporsko/medicinske kartone, a merenje se obavilo neposredno pred testiranje funkcionalne sposobnosti.

Za procenu funkcionalne sposobnosti bio je korišten 20m „shuttle run“ test iz grupe Fitnes testova, a služio je za procenu aerobne izdržljivosti, tj. za proveru maksimalnog unosa kiseonika. Ovaj test se izvodio kroz kontinuirano trčanje između dve linije udaljenosti od 20m na zvuk koji se oglašava sa CD plejera. Osoba koja se testira nalazila se iza jedne od linija i okrenuta je bila tako da gleda ka drugoj liniji i započinje trčanje kada se instrukcije sa CD plejera oglase. Brzina na početku testiranja je bila izuzetno niskog intenziteta. Ispitanik je kontinuirano trčao između dve linije. Okretao se kada se signal sa snimljenog materijala oglašavao. Nakon jednog minuta, zvuk se naglašavao i smanjivalo se vreme oglašavanja zvučnog signala. Takvo oglašavanje se nastavljalо svaki minut. Ako liniju nije dostigao u vreme svakog zvuka, ispitanik je morao trčati do linije i zatim se okrenuti i pokušati da uhvati korak i ritam dva naredna oglašavanja, znači morao je da bude pravovremen pri svakom oglašavanju zvuka sa trake. Sem toga, ako je liniju dotaknuo pre oglašavanja zvuka, ispitanik je morao da sačeka dok se zvuk nije oglasio. Test se zaustavljao ako ispitanik nije uspeo da stigne na liniju nakon zvučnog signala. Postoji nekoliko verzija ovog testa ali jedna uopštena verzija ima startno opterećenje pri trčanju od 8,5 km/h, koje se povećava za 0,5 km/h na svaki minut. Rezultat testa je broj pretrčanih distanci. Kao potrebna oprema za izvođenje ovog testa, koristila se: ravna, neisprekidana površina, kupasti markeri, 20 m „shuttle run“ adekvatna audio traka, CD plejer, sveska za upisivanje rezultata

U obradi podataka bila je korištena deskriptivna statistika za izračunavanje deskriptivnih statistika antropometrijskih i funkcionalne varijable: aritmetička sredina (AS), standardna devijacija (S), minimalne i maksimalne vrednosti rezultata merenja, koeficijent varijacije (KV). Radi utvrđivanja statistički značajne povezanosti između antropometrijskih i funkcionalne varijable, bila je korištena linearna regresiona analiza.

## REZULTATI

Rezultati deskriptivnih statistika prikazanih u tabeli 2 upućuju na činjenicu da su fudbaleri pionirskog uzrasta homogeni u pogledu telesne visine, telesne mase i razvijenosti grudnog koša, dok se to ne može konstatovati za

20m "shuttle run" aerobic endurance rating. Cadets are also homogeneous in all three anthropometric variables, while this can not be ascertained as in the pioneers for 20m"shuttle run" test. The same conclusions can be found for junior footballers.

**Table 2.** Descriptive statistics of variables for all three examined categories of footballers

Varijabla / Variable	Grupa / Group	AS	S	MIN	MAX	KV(%)	SWp
Telesna visina (mm) / Body height (mm)	Pioniri / Pioneers	1545.27	60.12	1448	1654	3.89	0.52
	Kadeti / Cadets	1635.13	60.33	1520	1723	3.69	0.69
	Juniori / Juniors	1723.67	45.34	1652	1789	2.63	0.37
Telesna masa (0,5 kg) / Body mass (0.5 kg)	Pioniri / Pioneers	459.00	30.28	399	502	6.60	0.54
	Kadeti / Cadets	526.33	45.48	450	610	8.64	0.96
	Juniori / Juniors	605.07	45.72	521	710	7.56	0.93
Srednji obim grudnog koša (mm) / Median circumference of the chest (mm)	Pioniri / Pioneers	723.47	41.85	650	789	5.78	0.10
	Kadeti / Cadets	829.07	44.62	750	888	5.38	0.21
	Juniori / Juniors	840.27	52.51	756	927	6.25	0.77
20 m "shuttle run" (frek.) / 20 m "shuttle run" (freq.)	Pioniri / Pioneers	53.00	10.54	39	70	19.89	0.11
	Kadeti / Cadets	69.80	11.05	51	90	15.83	0.09
	Juniori / Juniors	75.13	12.74	50	91	16.95	0.15

**Legend:** AM-arithmetic mean; S-standard deviation; MIN-minimum measurements results; MAX-maximum measurements results; CV – coefficient of variation; SWP - Shapiro Wilk Normality test p-value.

The results of the regression analysis of 20m "shuttle run" in Table 3 for pioneers indicate that there is no statistically significant effect of the system of anthropometric (predictor) variables on the criterion ( $P=0.25$ ) at the value of the multiple correlation coefficient  $R=0.55$ , which explains 30% of common variability. No anthropometric variables show a statistically significant effect on the test criterion.

**Table 3.** Regression analysis of 20m 'shuttle run' for pioneers

Varijabla / Variable	r	p	r <sub>part</sub>	p <sub>part</sub>	Beta	p <sub>bete</sub>
Telesna visina / Body height	-0.41	0.07	-0.44	0.14	-0.57	0.14
Telesna masa / Body mass	-0.08	0.38	0.28	0.35	0.34	0.35
Srednji obim grudnog koša / Median circum. of the chest	0.37	0.09	0.30	0.33	0.27	0.33

$$R=0.55 \quad R^2=0.30 \quad P=0.25$$

**Legend:** r - Pearson coefficient of correlation; p - the level of statistical significance for r; rpart - the value of the partial correlation coefficient; ppart - level of statistical significance for rpart Beta - regression coefficient; pbete - level of significance of regression coefficient; R - multi-correlation coefficient; R2 - determination coefficient; P - significance of multi-correlation coefficient.

varijablu za procenu aerobne izdržljivosti 20m „shuttle run“. Kadeti su takođe homogeni u sve tri antropometrijske varijable, dok se to ne može konstatovati kao i kod pionira za test 20m „shuttle run“. Isti zaključci se mogu konstatovati i za fudbalere juniorskog uzrasta.

**Tabela 2.** Deskriptivni statistici varijabli za sve tri ispitivane kategorije fudbalera

**Legenda:** AS-aritmetička sredina; S-standardna devijacija; MIN-minimalne vrednosti rezultata merenja; MAX-maksimalne vrednosti rezultata merenja; KV - Koeficijent varijacije; SWP - nivo statističke značajnosti Shapiro Wilk testa.

Rezultati regresione analize 20m „shuttle run“ u tabeli 3 za pionire ukazuju da ne postoji statistički značajan uticaj sistema antropometrijskih (prediktorskih) varijabli na kriterijum ( $P=0.25$ ), pri vrednosti koeficijenta multiple korelacije  $R=0.55$ , što objašnjava 30% zajedničkog varijabiliteta. Nijedna antropometrijska varijabla ne pokazuje statistički značajan uticaj na ispitivani kriterijum.

**Tabela 3.** Regresiona analiza 20m „shuttle run“ za pionire

**Legenda:** r - Pirsonov koeficijent korelacijske; p - nivo statističke značajnosti za r; r<sub>part</sub> - vrednost koeficijenta parcijalne korelacijske; p<sub>part</sub> - nivo statističke značajnosti za r<sub>part</sub>; Beta - regresijski koeficijent; p<sub>bete</sub> - nivo značajnosti regresijskog koeficijenta; R - koeficijent multiple korelacijske; R<sup>2</sup> - koeficijent determinacije; P - značajnost koeficijenta multiple korelacijske.

Also, for cadet age footballers (Table 4) there is no statistically significant effect on the predictor system of anthropometric variables on the criterion ( $P=0.55$ ), at the value of the multiple correlation coefficient  $R=0.41$ , which explains a total of 17% of the total variability. Also, in this case, there is no effect of any predictor variable on the set criterion.

**Table 4.** Regression analysis of 20m ‘shuttle run’ for cadets

Varijabla / Variable	r	p	$r_{part}$	$p_{part}$	Beta	$p_{beta}$
Telesna visina / Body height	0.29	0.14	-0.09	0.78	-0.16	0.78
Telesna masa / Body mass	0.33	0.12	0.16	0.61	0.26	0.61
Srednji obim grudnog koša / Median circum. of the chest	0.38	0.08	0.26	0.40	0.34	0.40

$$R=0.41 \quad R^2=0.17 \quad P=0.55$$

The results in Table 5 indicate that even in this case, there is no statistically significant effect on the predictor system of anthropometric variables on the criterion ( $P = 0.14$ ), which in this case explains 38% of the total variability.

**Table 5.** Regression analysis of 20m ‘shuttle run’ for juniors

Varijabla / Variable	r	p	$r_{part}$	$p_{part}$	Beta	$p_{beta}$
Telesna visina / Body height	-0.42	0.06	-0.07	0.83	-0.07	0.83
Telesna masa / Body mass	-0.23	0.21	-0.09	0.76	-0.08	0.76
Srednji obim grudnog koša / Median circum. of the chest	0.61	0.01	0.48	0.10	0.55	0.10

$$R=0.61 \quad R^2=0.38 \quad P=0.14$$

## DISCUSSION

the results of this study pointed to the fact that the basic anthropometric measures, body height, body mass and median circumference of the chest did not show any significant effect on the results of the aerobic endurance test for FC ‘Radnicki’ from Sombor in all three age categories (pioneers, cadets and juniors). It is probable that the aerobic ability of footballers of these ages is significantly influenced by some other characteristics and abilities that were not the subject of research. In the pioneer age, the effect of earlier experience in the earlier development period of the individual is likely to be predominant (the individual differences in the respondents were evident). In this period, footballers pay more attention to the training of elements of football technique, so the results of the common variability (30%) of the predictor system with the criterion result in the 20m “shuttle run” are easily explained. The aerobic abilities of the pioneer age players are different and vary from the person to person and the level of training. In this period, aerobic capacity is not so emphasized in training, as more atten-

Takođe ni kod fudbalera kadetskog uzrasta (tabela 4) ne postoji statistički značajan uticaj prediktorskog sistema antropometrijskih varijabli na kriterijum ( $P=0.55$ ), pri vrednosti koeficijenta multiple korelacije  $R=0.41$ , što objašnjava ukupno 17% zajedničkog varijabiliteta, Takođe ni u ovom slučaju ne postoji uticaj nijedne prediktorske varijable na postavljeni kriterijum.

**Tabela 4.** Regresiona analiza 20m „shuttle run“ za kadete

Rezultati u tabeli 5 ukazuju da ni u ovom slučaju ne postoji statistički značajan uticaj prediktorskog sistema antropometrijskih varijabli na kriterijum ( $P=0.14$ ), što u ovom slučaju objašnjava 38% zajedničkog varijabiliteta.

**Tabela 5.** Regresiona analiza 20m „shuttle run“ za juniore

## DISKUSIJA

Rezultati ovoga istraživanja ukazali su na činjenicu da osnovne antropometrijske mere, *Telesna visina*, *Telesna masa* i *Srednji obim grudnog koša*, ne pokazuju značajan uticaj na rezultate testa za procenu aerobne izdržljivosti kod fudbalera FK „Radnički“ iz Sombora u sve tri uzrasne kategorije (pioniri, kadeti i juniori). Verovatno da na aerobnu sposobnost fudbalera ovih uzrasta značajno utiču neke druge karakteristike i sposobnosti koje nisu bile predmet istraživanja. U pionirskom uzrastu verovatno preovladava svojim većim delom uticaj ranijeg iskustva u ranijem periodu razvoja jedinke (individualne razlike kod ispitanika su bile evidentne). U ovom periodu kod fudbalera se veća pažnja posvećuje obučavanju elemenata tehnike fudbala, pa su i rezultati zajedničkog varijabiliteta (30%) prediktorskog sistema sa kriterijumom rezultat u testu 20m „shuttle run“ lako objasnjeni. Aerobne sposobnosti fudbalera pionirskog uzrasta su različite i zavise od osobe do osobe kao i nivoa treniranosti. U ovom periodu aerobna sposobnost nije toliko naglašena na treninzima, jer se još uvek veća pažnja posvećuje ele-

tion is paid to elements of football technique. Even the game lasts for 80 minutes, and less attention is paid to the development of aerobic ability due to the growth and development of the organism, and the fact that with the intensive development of aerobic spontaneity, it should begin after the intense growth phase of the organism, which is yet to come about in this age category. Some respondents can run 70 distances, and others only 39 in the 20m "shuttle run" test. Ostojic (2006) lists data on the body height and weight of the footballers showing a great variation. The author also states that insufficient height is not a lack of football in itself, although it affects the position on the team. The average values of anthropomorphological parameters are likely to have minimal significance according to the high variability.

In cadet age, aerobic ability is higher than in pioneers and is fairly balanced, although there are also high achievers (90 distances) and those running only 59 distances. In this age development period, special attention is paid to aerobic endurance, so the results of homogeneity can be attributed to the way and method of training. With junior footballers, even more importance is given to the development of aerobic endurance, as the time of the competition increases to 90 minutes. It should also be noted that during this period the energy needs of the organism in the football vary and depend to a great extent on the ranking of the competition, the position on the team, the stages of the training cycle and the age (Reilly, Bangsbo, & Franks, 2000). Such requirements imply the exceptional physical fitness of all the athletes in the field in all age categories. It is known that aerobic ability depends on three essential factors:  $\text{VO}_{\text{2max}}$ , anaerobic threshold and cost-effectiveness (Pate, & Kriska, 1984; Pelemiš, Mitrović, Cicović, & Lolić, 2011), i.e. running economy. For football players aged 15-16 years old, despite turbulent anatomical and physiological changes that shake the body of children, anthropometric characteristics did not have an impact on the test results for assessing aerobic endurance. During this period, great attention is paid to the development of aerobic endurance. Various games are applied with two, three, four goals, where players play 2 to 2, 3 to 3, 4 to 4 with and without auxiliary players for 4 to 8 minutes. Such trainings led to the homogeneous results of a selective group of football cadets, as well as junior age. Anthropometric characteristics did not have a significant impact on aerobic capacity, i.e. the results of the test for its assessment, so it is possible that aerobic ability at this age affect other characteristics and level of training of the football player. Such results coincide with the research of Stankovic, Demir, & Hadziahmetovic (2007b). The greatest influence

mentima tehnike fudbala. Čak i utakmica traje 80 minuta, a manja pažnja se posvećuje razvoju aerobne sposobnosti usled zakonista rasta i razvoja organizma i činjenice da se sa intenzivnim razvojem aerobne sposobnosti treba početi nakon faze intenzivnog rasta organizma, koja tek treba da usledi kod ove uzrasne kategorije. Neki ispitanici mogu da trče 70 distanci, a neki samo 39 u testu 20m „shuttle run“. Ostojić (2006) navodi podatke o telesnoj visini i telesnoj masi fudbalera koji pokazuju veliku varijaciju. Autor takođe navodi da nedovoljna visina nije sama po sebi nedostatak za fudbalski sport, mada utiče na izbor pozicije u timu. Prosečne vrednosti antropomorfoloških parametara verovatno imaju minimalan značaj shodno velikom varijabilitetu.

Kod fudbalera kadetskog uzrasta aerobne sposobnosti su na višem nivou nego kod pionira i prilično su izjednačeni, mada i ovde postoje ispitanici koji ostvaruju izuzetne rezultate (90 pretrčanih distanci), a i oni koji trče svega 59 distanci. U ovom uzrasnom periodu razvoja fudbalera posebna pažnja počinje da se posvećuje aerobnoj izdržljivosti, pa se i rezultati homogenosti mogu pripisati načinu i metodi treninga. Kod fudbalera juniorskog uzrasta, još veći značaj se pridaje razvoju aerobne izdržljivosti, jer se i vreme takmičenja povećava na 90 minuta. Takođe je potrebno napomenuti da u ovom periodu energetske potrebe organizma u fudbalu variraju i u velikoj meri zavise od ranga takmičenja, pozicije u timu, faze trenjačnog ciklusa i uzrasta (Reilly, Bangsbo & Franks, 2000). Takvi zahtevi podrazumevaju izuzetnu fizičku pripremljenost svih sportista na terenu u svim uzrasnim kategorijama. Poznato je da aerobna sposobnost zavisi od tri bitna faktora:  $\text{VO}_{\text{2max}}$ , anaerobnog praga i ekonomičnosti rada (Pate & Kriska, 1984; Pelemiš, Mitrović, Cicović i Lolić, 2011), tj. ekonomičnosti trčanja. Kod fudbalera uzrasta 15-16 godina, i pored burnih anatomsко-fizioloških promena koje „potresaju“ telo dece, antropometrijske karakteristike nisu imale uticaj na rezultate testa za procenu aerobne izdržljivosti. U ovom periodu se velika pažnja posvećuje razvoju aerobne izdržljivosti. Primenuju se razne igre na dva, tri, četiri, gola gde igrači igraju 2 na 2, 3 na 3, 4 na 4 sa i bez pomoćnih igrača u trajanju od 4 do 8 minuta. Ovakvi treninzi su doveli do homogenih rezultata selektcionisane grupe fudbalera kadetskog, pa i juniorskog uzrasta. Antropometrijske karakteristike nisu imale značajan uticaj na aerobnu sposobnost, tj. rezultate testa za njenu procenu, pa je moguće da na aerobnu sposobnost u ovom uzrastu imaju uticaj neke druge karakteristike i nivo treniranosti fudbalera. Ovakvi rezultati se poklapaju sa istraživanjem Stankovića, Demira i Hadžiahmetovića (2007b). Na aerobnu spo-

on the aerobic ability of the footballer, is genetic predisposition and level of training. The results of this work are confirmed by the claims that the anthropometric characteristics have little effect on the aerobic ability of the footballers, as confirmed by the studies of Bouchard, Dionne, Simone, & Boulay (1992b).

Also, among the oldest age players (17-18 years old), ie junior, the anthropometric characteristics did not have significant impact on the 20m "shuttle run" test results. In these categories, great attention is paid to the development of aerobic ability, because the respondents have already mastered the elements of tactics, the more complex training of tactics and better physical preparation begins. Players are subjected to more stress, regardless of place in the team. As a consequence of such training, the anthropometric characteristics did not affect the aerobic ability of young people. Good, or sufficiently developed aerobic ability, affects: increase in physical abilities, reduce injuries, increase physical strain, reduce tactical mistakes caused by fatigue, reduce technical errors, maintain a high speed of reaction and action and work on stable health, so it is necessary to develop and train it begins with the completed phase of intensive growth of children. Football is predominantly aerobic sport, so one of the main determinants of success is aerobic endurance defined by maximum oxygen consumption ( $VO_{2\max}$ ). In the last few decades, the high linkage of this parameter to a higher number of football performance indicators (calculated distance, number of repetitions and total distance of high intensity, speed of recovery) has been determined (Ostojić, 2015). What is also important is the anaerobic glycolytic system. As we know, a football player makes 100 to 200 sprints per game in the 5-10 m range (Verheijen, 1997). The principle in which the glycolytic system functions is the use of energy from anaerobic glycolytic depots. This process takes place without the presence of oxygen, with the production of lactate coming. Blood lactate concentration indicator is the activation of glycolytic energy processes. The players are actively activating the glycolytic energy system in situations when they perform several consecutive sprints without a break. In these situations, there is an increase of blood lactate concentration to 8 - 12 mmol / l (Weineck, 1994).

In working with pioneers, cadets and juniors, more attention should be paid to the development of aerobic ability. Further monitoring and development of morphological characteristics and aerobic abilities is recommended, but also the training process should not be so much focused on the influence of morphological characteristics in the process of improving aerobic abilities. The authors recommend that the next research should be

sobnost fudbalera najviše uticaja ima genetska predodređenost i nivo treniranosti. Rezultati ovoga rada potvrđuju i tvrdnje da antropometrijske karakteristike slabo utiču na aerobnu sposobnost fudbalera, što su potvrdila i istraživanja Boucharda, Dionnea, Simonea, Boulay (1992b).

Takođe ni kod fudbalera najstarijeg ispitivanog uzrasta (17-18 godina), tj. juniora, antropometrijske karakteristike nisu imale značajne uticaje na rezultate testa 20 m „shuttle run“. Kod ovih kategorija se velika pažnja posvećuje razvoju aerobne sposobnosti, jer su ispitanici već savladali elemente taktike, počinje složenija obuka taktike i bolja fizička priprema. Igrači su podvrgnuti većem opterećenju, bez obzira na mesto u timu. Kao posledica takvih treninga, proisteklo je da antropometrijske karakteristike ne utiču na aerobnu sposobnost omladinaca. Dobro, odnosno dovoljno razvijena aerobna sposobnost utiče na: povećanje telesnih sposobnosti, smanjenje povreda, povećanje psihičke opterećenosti, smanjenje taktičkih grešaka uslovljenih umorom, smanjenje tehničkih grešaka, održavanje visoke brzine reakcije i radnji i na stabilnije zdravlje, pa je stoga treba razvijati a njen trening počinje sa završenom fazom intenzivnog rasta dece. Fudbal je sport dominantno aerobnog tipa, pa je jedna od glavnih determinanti uspešnosti aerobna izdržljivost definisana maksimalnom potrošnjom kiseonika ( $VO_{2\max}$ ). U poslednjih nekoliko decenija utvrđena je visoka povezanost ovog parametra sa većim brojem indikatora uspešnosti u fudbalu (pretrčana distanca, broj ponavljanja i ukupna distanca visokog intenziteta, brzina oporavka) (Ostojić, 2015). Takođe se važnost pridaje i anaerobnom glikolitičkom sistemu. Kao što nam je poznato fudbaler napravi od 100 do 200 sprinteva po utakmici u intervalu od 5–10 m (Verheijen, 1997). Princip na kojem funkcioniše glikolitički sistem je korišćenje energije iz anaerobnih glikolitičih depoa. Taj proces odvija se bez prisutnosti kiseonika, pri čemu dolazi do produkcije laktata. Koncentracija laktata u krvi indikator je aktivacije glikolitičkih energetskih procesa. Fudbaleri u velikoj meri aktiviraju glikolitički energetski sistem u situacijama kad izvode više uzastopnih sprinteva bez pauze. U tim situacijama dolazi do povećanja koncentracije laktata u krvi do 8 – 12 mmol/l (Weineck, 1994).

U radu sa pionirima, kadetima i juniorima trebalo bi veću pažnju posveti razvoju aerobne sposobnosti. Preporučuje se dalje praćenje i razvoj morfoloških karakteristika i aerobne sposobnosti, ali se isto tako ne trba u trenažnom procesu toliko osvrtati na uticaj morfoloških karakteristika u procesu poboljšanja aerobnih sposobnosti. Autori preporučuju da se nadredna istraživanja baziraju na ispitivanju povezanosti

based on examining the correlation of anaerobic abilities to the body composition because it would provide information on better implementation of the methods of work in the training process. All of this will contribute to better results in the competition of all examined age categories

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#### Statement

The authors have equally contributed to the paper.

#### Conflict of interest

We declare there is not conflict of interest between authors.

anaerobnih sposbnosti sa telesnom kompozicijom, jer bi se doble informacije o boljem sprovođenju metoda rada u trenažnom procesu. Sve ovo će doprineti boljim rezultatima na takmičenju svih ispitivanih uzrasnih kategorija.

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#### Izjava

Izjavljujemo da su autori podjednako doprineli radu.

#### Konflikt interesa

Između autora ne postoji interesni konflikt.

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# THE SPINAL COLUMN STATE OF ADOLESCENT BOYS OF DIFFERENT LEVELS OF PHYSICAL ACTIVITY

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**Abstract:** The sedentary form of behaviour; the effective holding of the body are potential causes of the formation of muscular asymmetries, and thus of poor body posture. The aim of the paper is to determine the differences in posture of children of different levels of physical activity. The research involved an assessment of a sample of 42 handball players  $13.02 \pm 0.89$  years and 32 non-athletes  $13.16 \pm 0.88$  years. Three tests were used to evaluate the presence of poor posture, to evaluate the scoliotic poor posture - Adam's forward bend test, to estimate the kyphotic poor posture - Reclination test with the contraction of the extensor muscle to assess the lordotic poor posture - Contraction test of the abdominal muscles. The obtained results of the chi square of the test indicate that there are no statistically significant differences between the analysed groups of subjects regarding the presence of the scoliotic ( $p = 0.85$ ), the kyphotic ( $p = 0.77$ ) and the lordotic poor posture ( $p = 0.82$ ) between the defined groups. The assumption is that boys are involved in sports activities due to the impaired posture in adolescent age, in order to prevent further progression and formation of new bodily deformities and to avoid similar conditions.

**Key words:** spinal column, athletes, non-adherents, adolescents.

## INTRODUCTION

Good postural status or proper posture can also be defined as a condition of a good musculoskeletal balance that prevents the onset and progressive development of postural disorders and those structures that hold the body in an upright position or in some other position, either in motion or while resting (Madić, 2014). Systemic inactiv-

# STANJE KIČMENOG STUBA DEČAKA ADOLESCENTNOG UZRASTA RAZLIČITOG STEPENA FIZIČKE AKTIVNOSTI

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**Apstrakt:** Sedentarni oblik ponašanja, nepravilno držanje tela su potencijalni uzročnici formiranja mišićnih asimetrija, a time i narušenih držanja tela. Cilj rada je utvrđivanje razlika u držanju tela dece različitog nivoa fizičke aktivnosti. Istraživanje je podrazumevalo procenu na uzorku od 42 rukometara  $13,02 \pm 0,89$  godina i 32 nesportista  $13,16 \pm 0,88$  godina. Za procenu prisustva narušenih držanja primenjena su tri testa; za procenu skoliočnog lošeg držanja – Adams bending test, za procenu kifotičnog lošeg držanja – Test reclinacije sa kontrakcijom mišića ekstenzora i za procenu lordotičnog lošeg držanja – Test kontrakcije abdominalnih mišića. Dobijeni rezultati hi kvadrat testa ukazuju da ne postoje statistički značajne razlike između analiziranih grupa ispitanika u pogledu prisustva skoliočnog ( $p=0,85$ ), kifotičnog ( $p=0,77$ ) i lordotičnog lošeg držanja ( $p=0,82$ ) između definisanih grupa. Pretpostavka je da se dečaci zbog narušenosti posture u adolescentnom uzrastu uključuju u sportske aktivnosti, kako bi sprečili dalje progresije i nastajanje novih.

**Ključne reci:** kičmeni stub, sportisti, nesportisti, adolescenti.

## UVOD

Dobar posturalni status odnosno pravilno držanje tela može se još definisati kao stanje dobrog mišićno – skeletnog balansa koji štiti od nastajanja i progresivnog razvoja posturalnih poremećaja i onih struktura koje drže telo u uspravnom stavu ili nekom drugom položaju, bilo u kretanju ili pri mirovanju (Madić, 2014). Sistemska neaktivnost i trendovi aktuelnih životnih stilova mladih doprinose porastu narušenih držanja tela

ity and current lifestyles trends contribute to the growth of poor posture of young people at the general level. Postural status is the result of previous growth and development, but also the result of physical activity (Jordan et al 2010).

The impact of long-term muscular inactivity or contraindicated physical activity can directly lead to muscular imbalance that influences the normal posture (Straker et al., 2008; Geldhof et al., 2007). There are many factors that can directly or indirectly affect the occurrence of poor posture. One of the leading risk factors for the formation of poor body holding is the increased body weight. Many authors who have dealt with a poor body holding have come to the conclusion that the scoliotic poor posture is in correlation with body weight (Trajković and Nikolić, 2008; Vlaškalić et al., 2006; Tudor et al., 2009). Studies (Esposito et al., 2013; Milošević et al., 2007a, Milošević et al 2007b) also confirm that obesity is one of the leading causes of impaired body posture. Researcher Mitova (2015) indicates that poor body postures, when it comes to the spinal column, have been steadily increasing and tend to significantly increase.

The effects of school bag load on spinal column also influence the creation of postural imbalances in school children (Popova-Ramova and Lazovic, 2010). In adolescents, the percentage of deformities has increased in the last 15 years (Kratenova et al., 2007; Aksonova et al., 2012; Watanabe et al., 2007) caused by sedentary habits, reduced activity and strength of the musculoskeletal system. Activities aimed at preventing poor body holding can largely affect their creation. Active involvement of the muscles that affect the holding of the body can reduce or completely eliminate the degree of imbalance (Grabar, 2014). For this reason, a proper kinesiological treatment is necessary in order to achieve functional adjustment of the muscular system and thus eliminate or mitigate the degree of impairment (Kučić i Kosinac, 2009; Bogdanović i Marković, 2009; Đokić i Stojanović, 2010; Jovović i Čanjak, 2012). Sports activities or targeted training effects can significantly prevent the occurrence of postural deviations. If sensitive periods are used correctly for the application of kinesiological treatments, there is less chance of disturbing the condition of the musculoskeletal system. Studies show that children and adolescents who are physically active during their youth tend to become healthier adults (Vlaškalić et al., 2006).

In line with this, the aim of this paper was to determine whether there are differences in the presence of impaired postures in children who are actively engaged in sports (handball for no more than 1 year) and children who are not engaged in sports activities.

na generalnom nivou. Posturalni status je rezultat pret-hodnog rasta i razvoja, ali i rezultat fizičke aktivnosti (Jordan i sar. 2010).

Uticaj dugotrajnog mišićnog inaktiviteta ili kontra-indikovane fizičke aktivnosti mogu direktno da dovedu do mišićnog disbalansa što se manifestuje na normalno držanje tela (Straker i sar., 2008; Geldhof i sar., 2007). Postoje mnogi faktori koji mogu direktno ili indirektno da utiču na pojavu lošeg držanja tela. Jedan od vodećih rizika faktora za nastajanje narušenih držanja tela je povećana telesna masa. Mnogi autori koji su se bavili narušenom posturom došli su do zaključka da je skolio-tično loše držanje u korelaciji sa telesnom masom (Trajković i Nikolić, 2008; Vlaškalić i sar., 2006; Tudor i sar., 2009). Istraživanja (Esposito i sar., 2013; Milošević i sar. 2007a, Milošević i sar. 2007b), takođe potvrđuju da je gojaznost jedan od vodećih uzročnika narušenog lošeg držanja tela. Istraživanja Mitove (2015) ukazuju da su narušena držanja tela, kada je u pitanju kičmeni stub, u stalnom porastu i imaju izrazitu tendenciju porasta.

Opterećenost kičmenog stuba težinom školske torbe takođe utiče na stvaranje posturalnih disbalansa kod školske dece (Popova-Ramova i Lazović, 2010). Kod adolescenata, poslednjih 15 godina povećan je procenat deformiteta (Kratenova i sar., 2007; Aksonova i sar., 2012; Watanabe i sar., 2007) prouzrokovani sedentarnim navikama i smanjenom aktivnošću i snagom mišićno-zglobnog sistema. Aktivnostima usmerenim na prevenciju lošeg držanja tela umnogome može da se utiče na stvaranje istih. Aktivno angažovanje mišića koji utiču na držanje tela može da se smanji ili potpuno ukloni stepen disbalansa (Grabara, 2014). Upravo iz tog razloga je neophodan pravilan kinezološki tretman kako bi se došlo do funkcionalnog prilagođavanja mišićnog sistema i na taj način uklonio ili ublažio stepen narušenosti (Kučić i Kosinac, 2009; Bogdanović i Marković, 2009; Đokić i Stojanović, 2010; Jovović i Čanjak, 2012). Sportskim aktivnostima ili usmerenim treningu bitno se može spriječiti nastajanje posturalnih odstupanja. Ukoliko se senzitivni periodi pravilno iskoriste za primenu kinezološkog tretmana manje su šanse da dođe do narušavanja stanja koštano mišićnog sistema. Istraživanja pokazuju da deca i adolescenti koji su fizički aktivni tokom mладости izrastaju u zdravije odrasle osobe (Vlaškalić i sar, 2006).

Shodno iznesenom, cilj rada je bio da se proceni da li postoje razlike u prisustvu narušenih držanja tela dece koja se aktivno bave sportom (rukometom ne više od 1 godine) i dece koja se ne bave sportskom aktivnošću.

## METHOD

The research was transversal. A draft of non-experimental research was used, specifically *Ex post facto* draft. In line with the nature of the scientific research, the empirical method was used, the applied method was used due to the aim of undertaking, while according to the knowledge of the problem, a confirmatory method was used. In relation to the degree of control, a semi-field method was applied.

The sample consisted of a total number of 80 male respondents: 48 handball players – (engaged in handball for at least 1 year) of HC “Borac” from Banja Luka ( $3,02 \pm 0,89$  years old) and 32 respondents who are not engaged in sports and are attending the elementary school “OŠ Miloš Dujić” in Čelinac ( $3,16 \pm 0,88$  years). Respondents who were previously divided into two subunits were approximately of similar age, body height, body weight and nutritional status ( $p > 0,05$ ), (Table 1) which was a good starting point for further comparisons of the spinal column. Given that there is a very active handball club in Čelinac with a large number of handball school students every year, it was interesting to analyse their spinal column state.

**Table 1.** Sample of respondents and descriptive statistics of anthropometric characteristics

Parametar / Parameter	Vrednost / Value			
	N	%		
Ukupan uzorak / Total sample	80	100		
Rukometari / Handball players	42	52.50		
Nesportisti / Non-athletes	38	47.50		
Parametri / Parameters	AS	S	MIN	MAX
Godine ukupno za ceo uzorak / Age for a whole sample	13.08	0.88	12	14
Rukometari / Handball players	13.02	0.89	12	14
Nesportisti / Non-athletes	13.16	0.88	12	14
Telesna visina (cm) / Body height (cm)	165.59	11.26	148	192
Rukometari / Handball players	166.98	11.94	150	192
Nesportisti / Non-athletes	163.50	9.97	148	190
Telesna masa (kg) / Body weight (kg)	60.28	12.18	40	93
Rukometari / Handball players	60.74	12.79	40	93
Nesportisti / Non-athletes	59.59	11.36	40	87
BMI (kg/m <sup>2</sup> )	21.82	2.89	17.01	29.30
Rukometari / Handball players	21.61	2.91	17.01	28.76
Nesportisti / Non-athletes	22.16	2.85	17.72	29.30

**Legend:** AS - arithmetic mean, S - standard deviation, MIN - minimum recorded result of measurement, MAX - maximum recorded result of measurement -  $p \leq 0,05$  there is statistically significant difference between groups, BMI body mass index

For the assessment of postural status, standardised tests (Buckup, 2005, Neumann, 2010) were applied in a medical institution in Banja Luka by a physician:

## METOD

Istraživanje je bilo transverzalnog karaktera. Koristio se nacrt neekperimentalnih istraživanja, tačnije *Ex post facto* nacrt. Prema prirodi naučnih istraživanja koristio se empirijski metod, prema cilju preduzimanja aplikativna metoda, dok je prema poznavanju problema bila korištena konfirmativna metoda. U odnosu na stepen kontrole primenjivao se poluterenski metod.

Uzorak je činilo ukupno 80 ispitanika muškog pola i to: 48 ispitanika koji se bave rukometom- najmanje 1 godinu RK „Borac“ iz Banja Luke ( $3,02 \pm 0,89$  godina) i 32 ispitanika koji se sportom ne bave, a učenici su „OŠ Miloš Dujić“ u Čelincu ( $3,16 \pm 0,88$  godina). Ispitanici koji su unapred bili podeljeni na dva subuzorka, bili su približno sličnih godina starosti, telesne visine, telesne mase i stanja uhranjenosti ( $p > 0,05$ ), (Tabela 1) što je bila dobra polazna osnova za dalje komparacije o stanju kičmenog stuba. S obzirom da je u Čelincu vrlo aktivan rukometni klub, da ima velik broj polaznika škole rukometa svake godine, interesantno je bilo analizirati njihovo stanje kičmenog stuba.

**Tabela 1.** Uzorak ispitanika i deskriptivni statistici antropometrijskih karakteristika

**Legenda:** AS – aritmetička sredina, S – standardna devijacija, MIN – minimalni zabeleženi rezultat merenja, MAX – maksimalan zabeležen rezultat merenja –  $p \leq 0,05$  postoji statistički značajna razlika između grupa, BMI-indeks telesne mase

Za procenu posturalnog statusa primjenjeni su standardizovani testovi (Buckup, 2005, Neumann, 2010) u medicinskoj ustanovi u Banja Luci od strane lekara fizijatra:

1. Adam's Forward Bend Test, for assessing the scoliotic impaired holding of the body;
2. Reclination test with the contraction of the extensor muscle for the estimation of the kyphotically disturbed holding of the body, and
3. Abdominal muscle contractions, for assessing lordotic disturbed body posture.

The degree of postural disorder is evaluated from 0 to 2, where 0 is a normal finding. A slight degree of deformity, which is completely flexible (corrective) is rated by grade 1 and is classified into a functional muscular skeletal disorder. A clearly inflexible (unable to be corrected) structural deformity is rated by 2.

Of the anthropometric characteristics, the following are taken into consideration:

1. Body weight (kg),
2. Body height (cm) and
3. BMI indirectly calculated (kg / m<sup>2</sup>) by formula:

$$BMI = \frac{\text{Body weight(kg)}}{\text{Body height (m)}^2}$$

Given that it was a juvenile sample of respondents, the provisions of the Helsinki Declaration on the Child Participation in Research were applied.

For the realisation of the paper, the statistical procedures of the IBM Statistics 20.0 software were used: calculation of data frequencies where the frequency of the data responses in the ordinal and nominal variables are displayed, as well as the results of descriptive statistics for calculating the basic descriptive statistical interval and scale variables: arithmetic means (AS), standard deviation (S). The level of p <0.05 was taken to determine the level of statistical significance. For the purposes of determining the differences in the representation of deformities between the two previously formed subunits, a  $\chi^2$  (*chi square*) test was used. Student's t-test was used to determine differences in anthropometric characteristics.

## RESULTS

The obtained results  $\chi^2$  square test (Table 2) for the *Adam's forward bend test* variable indicate that there are no statistically significant differences (p = 0.85) between the analysed groups of subjects regarding the presence of scoliotic poor posture.

1. Adams bending test, za procenu skoliotičnog narušenog držanja tela;
2. Reklinacije sa kontrakcijom mišića ekstenzora, za procenu kifotičnog narušenog držanja tela i
3. Kontrakcije abdominalnih mišića, za procenu lordotičnog narušenog držanja tela.

Stepen posturalnih poremećaja je ocenjivan od 0 do 2, pri čemu je 0 normalan nalaz. Blagi stepen deformiteta, koji je potpuno fleksibilan (korektivan) ocenjivan je ocenom 1 i svrstava se u funkcionalni mišićno skeletni poremećaj. Jasno nefleksibilan (nekorektibilan) strukturalni deformitet, ocenjivan je ocenom 2.

Od antropometrijskih karakteristika u razmatranje su uzete sledeće:

1. Telesna masa (kg),
2. Telesna visina (cm) i
3. Indirektno je izračunat BMI (kg/m<sup>2</sup>) putem formule:

$$BMI = \frac{\text{Telesna masa (kg)}}{\text{Telesna visina (m)}^2}$$

S obzirom na to da se radilo o maloletnom uzorku ispitanika, primenjene su odredbe Helsinške deklaracije o pravima učestvovanja dece u istraživanjima.

Za realizaciju rada koristili su se statistički postupci softverskog programa IBM *Statistics* 20.0: izračunavanje frekvencija podataka gde su prikazane frekvencije odgovora za podatke na ordinalnim i nominalnim varijablama, kao i rezultati deskriptivne statistike za izračunavanje osnovnih deskriptivnih statističkih intervalnih i razmernih varijabli: aritmetička sredina (AS), standardna devijacija (S). Za određivanje nivoa statističke značajnosti uziman je nivo od p<0,05. Za potrebe utvrđivanja razlika u zastupljenosti deformiteta između dva unapred formirana subuzorka korišćen je  $\chi^2$  kvadrat test. Radi utvrđivanja razlika u antropometrijskim karakteristikama primenjen je Studentov t-test.

## REZULTATI

Dobijeni rezultati  $\chi^2$  kvadrat testa (Tabela 2) za varijablu *Adams bending test* ukazuju da ne postoje statistički značajne razlike (p=0,85) između analiziranih grupa ispitanika u pogledu prisustva skoliotičnog lošeg držanja tela.

**Table 2.** Adam's forward bend test (scoliosis) chart in relation to the group of respondents

Varijabla / Variable	Grupa / Group		
	Rukometari / Handball players	Nesportisti / Non-athletes	Ukupno / In total
Frekvencija / Frequency	29	20	49
% u okviru grupe / % within the group	60.4%	62.5%	61.3%
% ukupno / % in total	36.2%	25.0%	61.3%
Frekvencija / Frequency	19	12	31
% u okviru grupe / % within the group	39.6%	37.5%	38.8%
% ukupno / % in total	23.8%	15.0%	38.8%

$$\chi^2 = 0,04 \quad p=0,85 \quad df=1$$

Taking into account the obtained results  $\chi^2$  square test of *Reclination test with the contraction of the extensor muscle* variable (Table 3), they indicate that there are no statistically significant differences between the analysed subunits with regard to the presence of the kyphotic poor posture ( $p = 0.77$ ).

**Table 3.** Contigenic table Reclination test with the contraction of the extensor muscle (kyphosis) in relation to the group of respondents

Varijabla / Variable	Grupa / Group		
	Rukometari / Handball players	Nesportisti / Non-athletes	Ukupno / In total
Frekvencija / Frequency	33	23	56
% u okviru grupe / % within the group	68.8%	71.9%	70.0%
% ukupno / % in total	41.2%	28.7%	70.0%
Frekvencija / Frequency	15	9	24
% u okviru grupe / % within the group	31.2%	28.1%	30.0%
% ukupno / % in total	18.8%	11.2%	30.0%

$$\chi^2 = 0,09 \quad p=0,77 \quad df=1$$

The obtained results  $\chi^2$  square test of the *Abdominal muscle contractions for assessing lordotic disturbed body posture* variable (Table 4) indicate that there are no statistically significant differences ( $p = 0.82$ ) between the analysed groups of subjects regarding the presence of scoliotic poor posture.

**Table 4.** Contigenic table Abdominal muscle contractions (lordosis) in relation to the group of respondents.

Varijabla / Variable	Grupa / Group		
	Rukometar / Handball player	Nesportisti / Non-athletes	Ukupno / In total
Frekvencija / Frequency	38	26	64
% u okviru grupe / % within the group	79.2%	81.2%	80.0%
% ukupno / % in total	47.5%	32.5%	80.0%
Frekvencija / Frequency	10	6	16
% u okviru grupe / % within the group	20.8%	18.8%	20.0%
% ukupno / % in total	12.5%	7.5%	20.0%

$$\chi^2 = 0,05 \quad p=0,82 \quad df=1$$

**Tabela 2.** Kontigencijska tabela Adams bending test (skolioza) u odnosu na grupu ispitanika

Uzimajući u obzir dobijene rezultate  $\chi^2$  kvadrat testa varijable *Reklinacija sa kontrakcijom mišića ekstenzora* (Tabela 3) upućuju na nepostojanje statistički značajnih razlika između analiziranih subuzoraka u pogledu prisustva kifotičnog lošeg držanja tela ( $p=0,77$ ).

**Tabela 3.** Kontigencijska tabela Test reklinacije sa kontrakcijom mišića ekstenzora (kifoza) u odnosu na grupu ispitanika

Rezultati  $\chi^2$  kvadrat testa varijable *Kontrakcije abdominalnih mišića za procenu lordotičnog lošeg držanja tela* (Tabela 4) upućuju na nepostojanje statistički značajnih razlika između analiziranih subuzoraka ( $p=0,82$ ).

**Tabela 4.** Kontigencijska tabela Kontrakcija abdominalnih mišića (lordoza) u odnosu na grupu ispitanika

## DISCUSSION

The results of the study indicate that respondents of predefined groups (handball players and non-athletes) are of similar height (handball players  $TV = 166.98$  cm to  $TV = 163.50$  cm in non-athlete subjects), similar body mass ( $TM = 60,74$  kg to  $TM = 59.59$  kg) and nutrition status ( $BMI = 21.61$  to  $BMI = 22.16$ , Table 1). Taking into account the reference values of the National Center for Disease Control and Prevention (2000), it is possible to estimate an average normal amount of nutrition of both analysed subunits compared to their average age. Such data can be justified by the enviable level of physical activity of the respondents involved in handball activities. On the other hand, children who do not engage in sports have a potentially greater risk of developing premature and obesity ( $BMI = 22.16$ ), but they can still be regarded as naturally fed (Bukara-Radujković and Zdravković, 2009; Hills- Andersen and Byrne, 2011).

The obtained results indicate that there is no statistical significance in the presence of a scoliotic, lordotic, and kyphotic poor posture in two different subunits. One of the most endangered age groups in terms of impaired postures is adolescents, as it is a period in which rapid changes occur, rapid development of the organism, and the fact that accelerated growth processes do not correspond to the development and condition of the muscular system. Such processes often carry negative consequences, which can be taken as one of the reasons for the results obtained. If we look at the age of the sample, we can conclude that physical activity - handball did not cause a difference between the two groups in the form of better results of the more active sample of the respondents. Observing data in the Adam's bend forwrd test, it can be noticed that 37.5% of the non-athlete subjects had a slight degree of curvature (grade 1) or the so-called A flexible deformity versus 39.6% of handball players. On this basis, it can be assumed that respondents practicing handball, perhaps for health reasons (noted deviations and recommendations from doctors), began to handle handball, thinking that in this way they will provide support to their developing organism and act in order to stop further progress (strengthening the skeletal muscular system through the training process) of detected changes. The research Jandrić (2015) points to the connection of healthy life habits and impaired body posture, and movement and sport clearly fall into the elements of quality of life, and it has been proven that impaired body structure can be seen even in athletes (Jandrić, Jankovic and Vranić, 2009).

Another aspect of interpreting the results obtained can be seen from the point of muscle asymmetry. The

## DISKUSIJA

Rezultati istraživanja ukazuju da su ispitanici unapred definisanih grupa (rukometari i nesportisti) sličnog telesnog rasta u visinu (rukometari  $TV=166,98$  cm prema  $TV=163,50$  cm kod ispitanika koji se ne bave sportom), slične telesne mase ( $TM=60,74$  kg prema  $TM=59,59$  kg) i stanja uhranjenosti ( $BMI=21,61$  prema  $BMI=22,16$ , Tabela 1). Uzimajući u obzir referentne vrednosti Nacionalnog centra za kontrolu bolesti i preventivu (*Centers for Disease Control and Prevention*, 2000) može se konstatovati prosečno normalan obim uhranjenosti oba analizirana subuzorka u odnosu na svoj prosečan uzrast. Ovakvi podaci se mogu opravdati zavidnim nivoom fizičke aktivnosti ispitanika koji su uključeni u sportske aktivnosti tipa rukomet. Sa druge strane, deca koja se ne bave sportom imaju potencijalno veći rizik za razvoj predgajznog i gojaznog stanja ( $BMI=22,16$ ) ali se i dalje mogu posmatrati kao normalno uhranjeni (Bukara-Radujković i Zdravković, 2009; Hills- Andersen i Byrne, 2011).

Dobijeni rezultati istraživanja ukazuju na nepostojanje statističke značajnosti kod prisustva skoliotičnog, lordotičnog i kifotičnog lošeg držanja tela kod dva različita subuzorka. Jedna od najugroženijih uzrasnih populacija za narušeno stanje posture čine adolescenti, jer je reč o periodu u kome dolazi do brzih promena, naglog razvoja organizma i činjenice da ubrzani procesi rasta ne odgovaraju razvoju i stanju mišićnog sistema. Takvi procesi vrlo često sa sobom nose i negativne posledice, što se može uzeti kao jedan od razloga za dobijene rezultate. Ako se pogleda godište uzorka, može da se konstatiše da fizička aktivnost – rukomet nije prouzrokovao razliku između dve grupe u vidu boljih rezultata aktivnijeg uzorka ispitanika. Posmatrajući podatke u varijabli *Adams bending test* može se uočiti da je 37,5% ispitanika nesportista imalo blagi stepen krvine (ocena 1) ili tzv. fleksibilan deformitet naspram 39,6% ispitanika koji se bave rukometom. Na osnovu toga može da se prepostavi da su ispitanici koji treniraju rukomet možda baš iz zdravstvenih razloga (konstatovanih odstupanja i preporuke lekara) počeli da se bave rukometom, misleći da će na taj način obezbediti potporu svom organizmu u razvoju i delovati u pravcu zaustavljanja daljeg napredovanja (jačajući skeletno mišićni sistem kroz trenažni proces) detektovanih promena. Istraživanje Jandrić (2015) ukazuje na povezanost zdravih životnih navika i narušenih držanja tela, a kretanje i sport jasno spadaju u elemente kvaliteta života, a dokazano je da se i narušenost telesne strukture može videti i kod sportista (Jandrić, Janković i Vranić, 2009).

Drugi aspekt tumačenje dobijenih rezultata, može da se posmatra iz ugla mišićnih asimetrija. Dominacija

dominance of the stronger limb, which is conditioned by the structure of handball and biomechanical requirements that can contribute to muscular asymmetries (Jasycyak, 2008), could potentially cause the spinal column state in children who are engaged in handball. This refers to functional asymmetry caused by hemispherical domination of the brain, which implies the use of the dominant hand (Krzykała, 2012), which is the case with the handball game and the structure of the movement in it. Mostoflei and Banica (2010) point to the functional (instrumental) lateralisation described as being acquired by dominant motor skills for body extremity (hand - foot) by social learning and construction during voluntary interactions with the environment (training) that can again be associated with movements (elements) in handball (leading the ball, throwing the ball, catching and adding, and above all and pointing to the goal).

It should be emphasised that the representation of mild curvature or degree of flexible deformity in the results of the study (grade 1) was 28.1% of the presence of kyphotic impaired posture in non-athlete children, 18.8% of poor lordotic poor posture and a scoliotic poor posture of 37.5 %. As in the previous case, subjects engaged in handball had a higher percentage of mild degree of curvature or a more flexible deformity, and in this test (Reclination test with the contraction of the extensor muscle) 31.2% versus 28.1% of non-athletes. In the variable contraction of abdominal muscles, a higher percentage of a slight degree of curvature (grade 1) or a flexible deformity in the handball group (20.8% vs. 18.8%) was recorded.

Shifts in the frontal and sagittal levels could justify the biomechanical requirements of handball. Domination of one limb, in handball sports, strengthens the muscles of the scapular-lopatic region of one hand, and this can lead to the eventual pulling of the spinal column to the right or left side. Uneven muscular strength of the back and shoulder regions (*m. infraspinatus*, *m. supraspinatus*, *m. rhomboideus major*, *m. rhomboideus minor*, *m. subscapularis*) may have an effect on the occurrence of a scoliotic impaired holding by pulling spinal column in a group of boys who are actively engaged in handball, so the differences between the groups must be viewed through the prism of one hand's dominance. Kendall et al. (1983) describe in their research the possible impact of a "stronger", dominant, side of the body on the impaired posture occurrence.

Similar observations on the state of musculature or some changes in the spinal column in the form of impaired posture can be found in the research of Andrašić et al. (2015) where the existence of impaired body hold-

jačeg ekstremiteta koja je uslovljena strukturom rukometne igre i biomehaničkih zahteva koji mogu da doprinisu mišićnim asimetrijama (Jasycyak, 2008) potencijalno je mogla da prouzrokuje i stanje kičmenog stuba kod dece koja se bave rukometom. Ovde se misli na funkcionalnu asimetriju prouzrokovanoj hemisfernom dominacijom mozga što implicira korišćenje dominantne ruke (Krzykała, 2012) što je slučaj sa rukometnom igrom i strukturom pokreta u njoj. Mostoflei i Banica (2010) navode funkcionalnu (instrumentalnu) lateralizaciju koju opisuju kao stečenu od strane dominantne motoričke veštine za telesni ekstremitet (ruka – nogu) socijalnim učenjem i izgradnjom za vreme dobrovoljnih interakcija s okolinom (treningom) koja se opet može povezati sa pokretima (elementima) u rukometu (vodenje lopte, bacanje lopte, hvatanje i dodavanje, a pre svih i šut na gol).

Treba naglasiti da je u rezultatima istraživanja zastupljenost blage krvine ili stepena fleksibilnog deformiteta (ocena 1) zastupljenost kifotičnog lošeg držanja kod dece koja se ne bave sportom bila 28,1%, lordotičnog lošeg držanja 18,8% a skoliotičnog lošeg držanja najveća 37,5%. Kao i u prethodnom slučaju, ispitanici koji se bave rukometom, imali su veći procenat blagog stepena krvine ili fleksibilnog deformiteta i kod ovog testa (*Reklinacija sa kontrakcijom mišića ekstenzora*), 31,2% naspram 28,1% nesportista. U varijabli *Kontrakcija abdominalnih mišića* je zabeležen veći procenat blagog stepena krvine (ocena 1) ili fleksibilnog deformiteta kod grupe rukometara (20,8% prema 18,8%).

Upravo pomeranja u frontalnoj i sagitalnoj ravni mogla bi da opravdaju biomehaničke zahteve rukometne igre. Dominacije jednog ekstremiteta, u sportovima tipa rukometa, ojačavaju mišice skapularno – lopatične regije jedne ruke i time može da dođe do eventualnog povlačenja kičmenog stuba u desnu ili levu stranu. Neujednačena snaga mišića leđa i rameno-lopatične regije (*m. infraspinatus*, *m. supraspinatus*, *m. rhomboideus major*, *m. rhomboideus minor*, *m. subscapularis*) može da ima uticaj na pojavu skoliotičnog narušenog držanja povlačenjem kičmenog stuba kod grupe dečaka koji se aktivno bave rukometom, pa se dobijene razlike između grupa moraju posmatrati kroz prizmu dominacije jedne ruke. Kendall i sar. (1983) u svom istraživanju opisuju mogući uticaj „jače“, dominantne, strane tela na pojavu narušene posture.

Slična zapažanja o stanju muskulature ili nekih promena na kičmenom stubu u vidu narušenih držanja tela se mogu pronaći i u istraživanju Andrašića i sar. (2015) gde je uočeno takođe postojanje narušenih držanja tela

ing in a group of athletes involved in volleyball at different ages 11 to 16 years old was noticed. The authors point to the existence of statistically significant differences between the age groups examined in the variables for assessing the spinal column deviation at the frontal level (scoliosis assessment), with athletes of older age groups with a higher percentage of representation of impaired postures, where the impaired postures and length of sports engagement are clearly connected. Similar results are also described by Krneta et al (2012) who have determined the existence of certain deviations from the normal holding of the body in volleyball players from Vojvodina and also the occurrence of scoliotic poor postures. What can be said is that the impaired posture has a clear connection with the sports experience. These allegations only confirmed the previous experience and the results of the research in the field of muscular asymmetries on the population of athletes, where major or minor deviations were found in the frontal or sagittal level.

## CONCLUSION

No statistically significant differences were found between children involved in the handball training exercise, for a period not longer than one year, and boys who are not engaged in sports. Sport subjects even have poorer spinal columns in the frontal (scoliotic poor posture) and sagittal level (kyphotic and lordotic poor body) than those who are not engaged in sports. The results of previous studies of other authors from similar areas have been confirmed. In order to fully understand the impact of the training process, it will be necessary to monitor the same sub-sample of the respondents in the future and repeat the same tests to assess the impaired posture after a period of one year.

The overall repertoire of program models, regardless of whether it is a continuation of physical education or other organised forms of physical activity, must be redesigned and put more emphasis on proper growth and development. Include more children of junior primary school in sports activities of extracurricular character (sports clubs). This research also draws attention to the need for more intense prevention of impaired postures. Trainers, PE teachers and kinesiologists should work to reduce the occurrence of impaired body holding.

kod grupe sportista koji se bave odbojkom različitih uzrasta od 11 do 16 godina. Autori ukazuju na postojanje statistički značajnih razlika između ispitivanih starosnih grupa u varijabli za procenu odstupanja kičmenog stuba u frontalnoj ravni (procena skolioze) pri čemu su sportistkinje starijih uzrasnih grupa sa većim procentom zastupljenosti narušenih držanja, gde su u jasnoj vezi narušena držanja i dužina bavljenja sportom. Slične rezultate opisuju i Krneta i saradnici (2012) koji su utvrdili postojanje određenih odstupanja od normalnih držanja tela kod odbokšica iz Vojvodine i takođe pojavu skoliotičnih loših držanja. Ono što se može konstatovati je da narušena držanja tela imaju jasnu povezanost sa sportskim stažom. Ovakvim navodima samo su potvrđena dosadašnja iskustva i rezultati istraživanja na polju mišićnih asimetrija na populaciji sportista, gde su utvrđena veća ili manja odstupanja u frontalnoj ili sagitalnoj ravni.

## ZAKLJUČAK

Nisu utvrđene statistički značajne razlike između dece koja su uključena u trenažni proces bavljenja rukometom, ne duže od 1 godine, i dečaka koji se ne bave sportom adolescentnog uzrasta. Ispitanici koji se bave sportom čak imaju i lošije držanje kičmenog stuba u frontalnoj (skoliotično loše držanje tela) i sagitalnoj ravni (kifotično i lordotično loše držanje tela) od ispitanika koji se ne bave sportom. Potvrđeni su rezultati dosadašnjih ranijih istraživanja drugih autora iz slične oblasti. Kako bi se u celosti sagledao uticaj trenažnog procesa neophodno bi bilo u budućnosti pratiti isti subuzorak ispitanika i ponoviti iste testove za procenu narušenih držanja tela nakon perioda od godinu dana.

Ukupan repertoar programskih modela, bez obzira da li se radi o nastavi fizičkog vaspitanja ili drugim organizovanim vidovima fizičke aktivnosti, moraju se redizajnirati i veći akcenat staviti na pravilan rast i razvoj. Uključiti veći broj dece mlađeg osnovnoškolskog uzrasta u sportske aktivnosti vannastavnog karaktera (sportske klubove, sportska društva). Ovim istraživanjem je takođe skrenuta pažnja na potrebu intenzivnije prevencije narušenih držanja tela. Na trenerima, pedagozima fizičke kulture, kineziologima je da svojim radom utiču na smanjenje pojave narušenih držanja tela.

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# POSSESSION OF PREDISPOSITION FOR THE SAFETY OF BUSINESS MANAGEMENT IN SPORTS

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**Abstract:** The aim of this research is to determine the possession of predisposition for the success of doing business management in the sport. The study was conducted on a sample of 120 managers of sports clubs in Tuzla Canton and Brčko District. A sample of 20 variables is drawn from the survey "Do you have the potential to be a manager?". Survey results showed that 31 respondents possess many skills and abilities that are required for a successful manager, 63 respondents have some of the skills and abilities to successfully manage, and 26 respondents do not possess adequate skills and the ability to successfully manage others.

It is obvious that respondents who want to be successful managers need to pay attention to the managerial skills and techniques in which they feel the weakest.

It is logical that different levels of management require different levels of given skills and knowledge. At lower levels of management the need for a higher level of technical knowledge is pronounced. The fact is that –top managers, in contrast to managers at lower levels of the organization, must have a high ability of conceptual thinking based on a high degree of creation and imagination. These are the qualities and skills that cannot be acquired through the educational process.

**Keywords:** managers, skills, abilities, management, success.

## INTRODUCTION

"The Art of Conducting by, with, or through other people."

### *Mary Parker Follett*

The word "manager" implies professional managers, hired professionals from this field within the organization, who are authorized to lead its business and tasked to do so in a more efficient and effective way.

Many authors define management in different ways. The most widely cited definition of management is the definition of an American business theorist from the early 1930s Mary P. Follett, which defines management as "... the art of doing jobs with people's help". Without going deeper into the elaboration of the various definitions of management in this book, management is defined as (1) all business activities (managerial functions) (2) performed by managers, (3) within the appropriate business-organizational form (organization), (4) by engaging the necessary resources (5) with the tendency to ensure a proper balance between effectiveness and efficiency over a short and long term.

Sports professionalism brought a whole new philosophical and business approach to sports. Coaches, players and other active sportsmen started to work for money. This change has allowed the birth of a completely new sphere of sports in "sport management". Sport management today represents a new practical and scientific field that deals with the business side of sports (Mikić, 2013).

Sports management is a discipline that, apart from theoretical, has important practical application.

Sport management is a process of forecasting, modeling, planning, programming, organizing, managing and securing policies and controlling people, material, financial and other organizational resources of a sports organization. Sport management as part of the general management deals with specific problems of organization and

management in sports or in a particular sports organization with the rational use of limited resources. (Bartoluci, Škorić, 2009).

The task of sports management is to analyze problems in sport, determine the causes of the situation, choose various, alternative solutions in order to achieve the goals as successful as possible. The goals of management in sports are specific, and can be classified as, achieving sports goals in a certain time and achieving business goals of a sports organization. The objectives are mutually conditioned because the achievement of sports results is not possible without the achievement of business goals (organizational, material, financial). At the same time, the level of sports results directly affects the achievement of business goals such as club income, material costs, salaries, taxes, etc. Therefore, the fundamental function of sports management is related to achieving the goals of sports organizations (Mikić, 2013).

The process of managing sports organizations is a process of guiding and influencing collaborators and executors in achieving the goals of a sports organization (Mikić, 2013).

Management of organizations is significantly different today than ever before in history.

Although the majority wants to manage because of excitement, status, power and other responsibilities, managerial guidance is not something that comes with itself. Successful managerial leadership requires certain skills, competencies, competencies, as well as a desire for managerial leadership (Mikić, 2013).

The aim of this research is to determine managerial roles and predispositions for the performance of managerial tasks in sport.

## METHODOLOGY OF RESEARCH

### ***Sample respondents***

The population from which the sample of respondents was drawn up were managers of sports clubs: football, basketball, volleyball, handball, tennis and karate. The sample consisted of 120 managers of sports clubs in Tuzla Canton and Brcko District.

### **Variables**

The sample variables predicate the questions from the Questionnaire "Do you have a predisposition to be a manager" (Source: Robbins PS, De Cenzo AD, 1998, 14-15). A total of 20 variables were applied.

1. MUDRHR - I can make others do what I want to do
2. JUPSRU - I always evaluate my work assignments
3. NVDMKI - I do not like mixing into office intrigues
4. VSKZOP - I love the freedom that open-ended goals provide.
5. RNKSUM - I do the best when things are settled and calm
6. UOPVGLJ - I enjoy the oratorical presentations to large groups of people
7. SUSSOZ - I'm sure of my ability to do difficult tasks
8. NEVOPI - I do not like to write
9. VRTPRO - I like to solve difficult problems
10. JASOOS - I'm an organized person
11. TJRDDP - It's hard for me to tell others that they have made a mistake
12. VDRFSD - I like to work fixed hours every day
13. GNRPTP - I'm looking at paperwork as a trivial business
14. VPDNNS - I like helping others learn new things
15. VORASA - I like to work alone
16. VDKZŠ - I believe that it is important who you know, not what you know
17. VRNSIV - I like to do several things at the same time
18. DSUSNO - I'm good at managing money
19. RVSPSK - I prefer to get out of the quarrel rather than let things get out of control
20. ZRANAR - I can work on my computer.

### ***Description of research and data processing***

The survey was conducted on a sample of 120 respondents - managers of sports clubs with the goal of determining whether the respondents have a managerial talent, or whether they have predispositions to be managers. The obtained results of the conducted questionnaire were processed and interpreted on the basis of the following criteria:

For questions 1,2,4,6,7,9,10,11,13,14,16,17,18 and 20 give 5 points for each KJ response, 4 points for SM, 3 points for NS, 2 points for DS, one point for PS. For other questions, score in the opposite order, which means 1 point for KJ, 2 points for SM, etc. Count points. What does the total score mean?

The maximum number of points is 100. The number of points between 80 and 100 indicates that you possess many skills that a successful manager needs. The given score indicates that you also have a strong desire to manage others. The number of points between 40 and 79 indicates that you have some of the abilities to manage successfully, but you need a little improvement. Learning new skills and experiences can serve you. The number of points below 40 indicates that your abilities are hidden and that you have low desire to manage others. Someone in this category who wants to be a manager should pay attention to the managerial skills and techniques in which he feels the weakest.

The data were processed with basic descriptive statistics and expressed through frequencies and percentages.

## RESULTS AND DISCUSSION

In Table 1, an assessment of each issue of managerial talent is expressed through frequency and percentage.

*Table 1. Estimation of responses expressed through frequencies and percentages*

Br.	Variables	KJ	SM	NS	DS	PS	Summary
1.	MUDRHR	18 15%	76 63,3%	18 15%	8 6,6%	-	120 100 %
2.	JUPSRU	32 26,6%	54 45%	24 20%	8 6,6%	2 1,6%	120 100%
3.	NVDMKI	22 18,3%	34 28,3%	26 21,6%	18 15%	20 16,6%	120 100%
4.	VSKZOP	60 50%	31 25,8%	16 13,3%	13 10,8	-	120 100%
5.	RNKSUM	46 38,3%	28 23,3%	23 19,1%	14 11,6	7 5,8	120 100%
6.	UOPVGLJ	42 35%	36 30%	31 25,8%	7 5,8%	4 3,3	120 100%
7.	SUSSOZ	62 51,6%	27 22,5%	20 16,6%	9 7,5%	2 1,6%	120 100%
8.	NEVOPI	58 48,3%	23 19,1%	21 17,5%	15 12,5%	3 2,5%	120 100%
9.	VRTPRO	59 49,1%	18 15%	28 23,3%	10 8,3%	5 4,1%	120 100%
10.	JASOOS	51 42,5%	21 17,5%	24 20%	15 12,5%	9 7,5%	120 100%
11.	TJRDDP	38 31,6%	29 24,1%	31 25,8%	16 13,3	6 5%	120 100%
12.	VDRFSD	29 24,1%	32 26,6%	28 23,3%	24 20,0%	7 5,8%	120 100%
13.	GNRPTP	53 44,1%	27 22,5%	19 15,8%	16 13,3%	5 4,1%	120 100%
14.	VPDNNS	59 49,1%	28 23,3%	27 22,5%	4 3,3%	2 1,6%	120 100%
15.	VORASA	71 59,1%	19 15,8%	22 18,3%	6 5%	2 1,6%	120 100%
16.	VDVKZŠ	68 56,6%	14 11,6%	18 15%	15 12,5%	5 4,1%	120 100%
17.	VRNSIV	49 40,8%	21 17,5%	24 20%	19 15,8%	7 5,8%	120 100%
18.	DSUSNO	46 38,3%	26 21,6%	31 25,8%	13 10,8%	4 3,3%	120 100%
19.	RVSPSK	61 50,8%	18 15%	19 15,8%	16 13,3%	6 5%	120 100%
20.	ZRANAR	108 90%	6 5%	-	6 5%	-	120 100%

Table 1 shows the frequencies and percentages for each given answer to the question asked. We will analyze only some of the answers offered. Question No. 1, which represents the first offered variable MUDRHR – I can make others do what I want to do, 76 respondents or 63.3% responded to the second alternative SIMILAR TO ME. This

means that the manager can influence 63.3% of his subordinates to do what he wants.

To the question no. 7, which represents the seventh offered variable SUSSOZ - I'm sure of my ability to do difficult tasks, 62 respondents or 51.6% answered to the first alternative, LIKE ME. This means that the manager thinks that 51.6% of his subordinates are sure of their ability to perform difficult tasks like him.

To the question no. 15, which represents the fifteen variable VORASA - I like to work alone, 71 respondents or 59.1% responded to the first alternative, which means that 59.1% of respondents have the same opinion as their superior manager.

To the question no. 16, which represents the sixteenth variable VDKZŠ - I believe that it is important who you know, not what you know, 68 respondents or 56.6% answered to the first alternative, I. This means in concrete terms that 56.6% of respondents consider, as their superiors, that is is important who you know. It is interesting that more than 50% of respondents are of the same opinion as their superiors that it is important who you know. Such opinion is probably a reflection of the state of affairs in society, that is, the great influence in decision making is the one of party affiliation and the corruption of the decision-making structures.

**Table 2.** Results of a survey of managerial talent

Number of respondents	Number of points	Having managerial talent
31	80 – 100	Possessing the skills needed for a successful manager
63	40 – 79	Possessing some of the abilities to manage successfully
26	< 40	Little desire to manage others
<b>Total: 120</b>	-	-

In Table 2, the results of the Survey on Ownership of Managerial Talent are presented.

The results of the survey show that 31 respondents possess many skills that are needed for a successful manager. The score also indicates that these managers have a strong desire to manage others.

Analyzing further research results, it can be concluded that 63 respondents have some of the abilities to manage successfully, but they need further improvement. Learning new skills and experiences can be used to improve management.

The results indicate that in 26 respondents the abilities are hidden and they have low desire to manage others. Someone in this category of respondents who wants to be a manager should pay attention to the managerial skills and techniques in which he feels the weakest.

## CONCLUSION

Successful managers must possess appropriate managerial skills, in addition to desirable managerial experience. The demand for managerial work, especially at higher organizational levels, is also reflected in the fact that managers, in addition to a high educational level, must also possess appropriate skills that cannot be acquired through the educational process itself. The presented results show that 31 respondents possess many skills and abilities that are needed for a successful manager.

The knowledge and skills that managers must possess can be classified into three categories (Katz, RL, 1974, according to Šunje 2002): technical knowledge in terms of knowing the way of doing business process, interpersonal skills in terms of communication skills with others, skills of working with others and the ability to motivate others, conceptual abilities in terms of the ability of managers to think conceptually, activating the "right side of the brain", with a high degree of imagination and creativity.

It is logical that different levels of management require different levels of given skills and knowledge. Lower levels of management are more demanding for a higher level of technical knowledge. This study found that 63 respondents had some of their abilities and skills for successful management, but they need further advancement and acquisition of new knowledge and skills, as well as acquiring experience. The fact is that top managers, unlike managers at lower organizational levels, must have a high ability of conceptual thinking based on a high degree of creativity and imagination. These are the characteristics and skills that cannot be acquired through the educational process.

The results of this research are partly related to the possession of some skills for successful management, and are consistent with the research that has been carried out (Šunje, 2002, Biberović et al.).

It was found that 26 respondents do not possess adequate management skills. It is certain that if someone in this category of respondents has a desire to be a manager, he should pay more attention to the managerial skills and techniques in which he feels the weakest.

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## POSJEDOVANJE PREDISPOZICIJA ZA USPJEŠNOST OBAVLJANJA MENADŽERSKIH POSLOVA U SPORTU

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**Apstrakt:** Cilj ovog istraživanja je utvrđivanje posjedovanja predispozicija za uspješnost obavljanja menadžerskih poslova u sportu. Istraživanje je provedeno na uzorku od 120 rukovodilaca sportskih klubova sa teritorije Tuzlanskog kantona i Brčko distrikta. Uzorak od 20 varijabli je izvučen iz upitnika „Imaš li predispozicije da budeš menadžer?“. Rezultati istraživanja pokazuju da 31 ispitanik posjeduje mnoge vještine i sposobnosti koje su potrebne uspješnom menadžeru, 63 ispitanika posjeduju neke od vještina i sposobnosti za uspješno upravljanje i 26 ispitanika ne posjeduju adekvatne vještine i sposobnosti za uspješno upravljanje drugima.

Očigledno je da ispitanici koji žele da uspješno upravljaju treba da obrate pažnju na menadžerske vještine i tehnike u kojima se osjećaju najslabijim.

Logično je da različiti nivoi menadžmenta imaju potrebu za različitim nivoima datih vještina i znanja. Na nižim nivoima menadžmenta izraženija je potreba za većim nivoom tehničkih znanja. Činjenica je da top – menadžeri, za razliku od menadžera na nižim organizacionim nivoima, moraju posjedovati visoku sposobnost konceptualnog promišljanja zasnovanu na visokom stepenu kreacije i imaginacije. Riječ je o osobinama i vještinama koje se ne mogu stići kroz edukacijski proces.

**Ključne riječi:** menadžeri, vještine, sposobnosti, upravljanje, uspješnost.

## PILATES IN SPORT DANCE TRAINING

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**Abstract:** The aim of this paper is to point out the many advantages of using the Pilates method of exercise in comprehensive preparations of dancers. Using Pilates as a training model in sport dance, largely ensures easier movement performance technique, more effective dance couple movement, provides better dance expression, prevents injuries and ensures the longevity of a dancer's career. Introducing dancers to intellectual and kinesthetic relations between dance and Pilates also promotes the achievement of goals such as the increased body awareness, improved musculoskeletal integration, and in general, provide better health for dancers. Diversity of various Pilates instruments does not make exercise monotonous and allows for a progressive effect on mobility and stability of all dance performances.

**Keywords:** dance/ stability/ mobility/ posture.

### INTRODUCTION

Physical preparations in sport dance are based on understanding both artistic and sports aspects of various dance genres. The training process in sport dance requires a multidisciplinary approach so that the dancers could efficiently respond to the choreography demands in their interaction with their dance partners. Besides mastering one's own movements, the sport dancers must coordinate the technique demands, music movements, etc. with the skills of their dance partners. The training methods traditionally used in dance sport practices are not enough to prepare the dancers for larger, physically demanding aspects of dance performance. Pilates is a revolutionary exercise technique, designed by Joseph Pilates, based on the synergy of the body and mind. It represents a system of exercises for strengthening and stretching designed to strengthen the central part of the body (where the CTT-center of gravity of the body is also positioned). This part of the body is a controller of all kinds of movements, mo-

## PILATES U TRENINGU PLESAČA SPORTSKOG PLESA

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**Sažetak:** Cilj rada je ukazivanje na mnoge prednosti primjene Pilates metode vježbanja u svestranoj pripremi plesača. Primjena Pilatesa kao trenažnog modela u sportskom plesu može uveliko olakšati tehniku izvođenja pokreta, osigurati ekonomičnije kretanje u paru, pomoći u boljoj plesnoj ekspresiji, sprječiti povređivanje i osigurati dugovječnost plesne karijere. Upoznavanje plesača sa intelektualnim i kinestetičkim vezama između plesa i Pilatesa, takođe, pospješuje otvarivanje ciljeva kao što su povećana svijest o tijelu, poboljšane mišićno-koštanog integracije, i uopšte, omogućava bolje zdravlje plesača. Bogatstvo primjene različitih Pilates instrumenata ne čini ga monotonim za rad, a omogućava progresivni učinak na mobilnost i stabilnost plesne izvedbe.

**Ključne riječi:** ples, stabilnost, mobilnost, postura

### UVOD

Fizička priprema plesača temelji se na razumijevanju umjetničkih i sportskih potreba različitih plesnih žanrova. Trenažni proces u sportskom plesu zahtjeva multidisciplinarni pristup kako bi plesači na efikasan način odolijevali zahtjevima koreografije koja se izvodi u interakciji sa plesnim partnerom. Osim ovladavanja vlastitim kretnjama plesači sportskog plesa, zahtjeve u pogledu tehnike izvođenja, kretanja uz muziku, itd. treba da iskoordinišu sa vještinama plesnog partnera. Metode treninga koji se, već tradicionalno, primjenjuju u plesnoj praksi nisu dovoljne kako bi pripremile plesače za veće, fizički zahtjevnije aspekte plesne izvedbe. Pilates je revolucionarna tehnika vježbanja, osmišljena od strane Joseph Pilates-a koja se bazira na usklađivanju tijela i uma. Predstavlja sistem vježbi za jačanje i istezanje osmišljen s ciljem jačanja središnjeg dijela tijela (gdje se nalazi i CTT-centar težišta tijela) koji je kontrolor svih vrsta kretanja, mobilizacije kičmenog stuba

bilization of the spine and the development of flexibility, strength and balance of the whole body. It is believed that a movement based on the synergy of body and mind allows easy and efficient movement, thereby eliminating the phenomenon of "poor" motion patterns. Especially emphasized are the movements that improve body posture, i.e. that accentuate the movements which correct problems in achieving proper body posture, muscle imbalance and establishing the neuromuscular patterns (Pilates, 1998). The purpose of Pilates method is based on the possibility of developing strength while improving flexibility, giving the muscles the necessary slenderness and elongation, making the body more beautiful and harmonious without any fear of building large muscles as the result of other conventional methods of exercise (Šebić and Podrug-Arapović, 2012). Long and spindly muscles contribute to a greater aesthetic affirmation of dance movements of various complexities. The basic principles of Pilates exercise are equivalent to the principles of dance expression. Concentration, control, centering, precision, fluidity and breathing techniques are integral parts of a comprehensive approach to the Pilates method of exercise. The concentration and control are related to the connection of mind and body, reaching of kinesthetic awareness and achieving the quality neuromuscular coordination by providing precise and controlled movements in requested sequence and rhythm. The control is also ensured by centering movement initiated from the deep muscles around the spine and deep abdominal muscles. Further activation involves the energy expansion to the lateral parts of the body. Such an approach in realization of movements provides fine nuancing in intensity of performing various dance styles and movements (Ljubojević and Bijelić, 2014). Controlling your own body's movements ensures successful performance of dance figures in couples. Precision is the basis of dance techniques. Dance technique training implies performing precise dance moves with the desired aesthetic performance quality. The principle of precision refers to the trajectory of movement of the body or its parts in space, the precise beginning and the precise ending. It also includes body angles, length of movement, the exact amplitude of movement and precise positioning of all aspects while performing Pilates exercises. Precision requirements in performing dance choreographies in sport dance (Latin American and standard dance) represent the foundation of proper technical interpretation of various dance styles. This is especially pronounced in younger dance categories and lower dance levels. Technically correct performance implies precision in musical interpretation of movement. Fluidity, as a unique principle of Pilates method involves

i razvoja fleksibilnosti, snage i ravnoteže cijelog tijela. Smatra se da pokret zasnovan na sinergiji tijela i uma omogućava lako i efikasno kretanje, eliminajući pri tom pojavu „siromašnih“ kretnih obrazaca. Posebno se naglašavaju kretanja koja poboljšavaju pravilno držanje tijela, odnosno akcentuju kretanja koja korigiraju probleme u pravilnoj tjelesnoj posturi, mišićnu neravnotežu i uspostavljanje neuromuskularnih obrazaca (Pilates, 1998). Smisao pilates metode je bazirana na mogućnosti razvijanja snage uz istovremeno unapređenje fleksibilnosti, dajući mišićima neophodnu vinkost i izduženost, čineći tijelo ljepšim i skladnijim bez bojazni od mišića velikog obima koji su posljedica drugih konvencionalnih metoda vježbanja (Šebić i Podrug-Arapović, 2012). Dugi i vretenasti mišići doprinose većoj estetskoj afirmaciji plesnih pokreta različitog nivoa složenosti. Osnovni principi pilates vježbanja ekvivalentni su principima plesnog izraza. Koncentracija, kontrola, centriranje slivenih pokreta, preciznost, fluidnost i tehnike disanja integralni su dijelovi sveobuhvatnog pristupa u pilates metodi vježbanja. Koncentracija i kontrola se odnose na povezivanje uma i tijela, uspostavljanje kinestetičke svjesnosti, odnosno, uspostavljanje neuromišićne koordinacije osiguravajući promišljene i kontrolisane pokrete sa tačno određenim slijedom i ritmom. Kontrola se, takođe, postiže centriranjem pokreta iniciranih iz dubokih mišića oko kičme i dubokih trbušnih mišića. Dalja aktivacija podrazumijeva širenje energije prema lateralnim dijelovima tijela. Ovakav pristup u realizaciji pokreta i kretanja omogućava fino nijansiranje intenziteta izvođenja slivenih stilizovanih plesnih figura (Ljubojević i Bijelić, 2014). Kontrola kretanja vlastitog tijela obezbjeđuje uspješnu izvedbu plesnih figura u paru. Preciznost je osnova plesne tehnike. Trening plesne tehnike odnosi se na izvođenje tačno pozicioniranih pokreta sa željenom estetskom kvalitetom izvođenja. Princip preciznosti odnosi se na trajektoriju kretanja tijela ili njegovih dijelova u prostoru, tačan početak i tačan kraj. Podrazumijeva tjelesne uglove, dužinu trajanja pokreta, tačnu amplitudu kretanja, odnosno precizno pozicioniranje svih aspekata tijela pri izvođenju pilates vježbi. Zahtjevi u pogledu preciznosti pri izvođenju plesnih koreografija u sportskom plesu (latinomaričkih i standardnih plesova) predstavljaju osnovu pravilne tehničke interpretacije različitih plesova. To je naročito izraženo kod mlađih plesnih kategorija i nižih plesnih nivoa. Tehnički ispravno izvođenje podrazumijeva preciznost u muzičkoj interpretaciji kretanja. Fluidnost, kao jedinstven princip pilates metode, podrazumijeva dinamičnost, tečnost i logičan slijed pokreta u nizu pri čemu je gracioznost izvođenja značajnija od brzine (Šebić i Po-

dynamic and logical sequence of movements with flowing effect in which the performing grace is more important than the speed (Ljubojević and Šebić, 2017) The point is in free movement that contributes to the elasticity of joints and muscles. Fluidity in movement is reflected by a quality dance technical interpretation. In addition, proper breathing during exercise is a necessary factor of primarily healthy approach to training that enables harmonious movement and proper muscle balance. Proper breathing during dancing allows better coordination of mental, energy and motor components of choreographic presentations. Besides that, proper breathing makes energy consumption more economical during dancing, which is particularly important when we know that the sport dancers perform the majority of dances at the level of high intensity stress, except in waltz, tango, samba and rumba (Zagorc, Karpuljak and Fiedl, 1999). The anatomical and conceptual similarities between Pilates and dance, as well as numerous benefits of Pilates for dancers' development, explain the lasting and growing popularity of Pilates among the dance communities throughout the world (Berkow, 2011).

### **Pilates in dance training**

The strength and control of the central part of the body, which includes abdominal muscles, lower back, pelvic muscles, the hips and the inside of the thigh, is the basis for proper execution elements of various dance techniques. Good body control in dance motions occurs as result of good coordination and balance through muscle tension of the central part of the body. In order to establish and maintain proper posture in performing different elements of dance in couples, sport dancers have to "learn" how to activate the muscles of the central part of the body and thus create the basis for the correct movement of the whole body. Pilates exercise method allows strengthening "the center of the body" which is necessary for establishing and controlling different dance positions, turns, jumps, as well as the complete physical movement in couples. Applying Pilates exercises in the dance training provides better understanding of one's own body movements in space by creating the so-called "sense of body", i.e. creating a connection between mind, body and emotions, which is highly important in aesthetic expression of emotions through movement. Pilates exercises put dancers in the situation of using their own weight for performing controlled, measured and precise movements. Unlike other exercise models, the Pilates exercise method always involves muscle activation of the whole body, without isolation and strengthening of individual muscle segments. This holistic approach leads to a bet-

drug-Arapović, 2012). Suština je u slobodnom kretanju koje doprinosi elastičnosti zglobova i mišića. Fluidnost u kretanju reflektuje se kvalitetnom plesnom tehničkom interperacijom. Pravilno disanje u toku vježbanja neophodan je činilac prvenstveno zdravog pristupa vježbanju koje omogućava skladno kretanje i pravilnu mišićnu ravnotežu. Pravilno disanje u toku plesanja omogućava bolju koordinaciju mentalnih, energetskih i motoričkih komponenata koreografske prezentacije. Osim toga, pravilno disanje potrošnju energije u toku plesa čini ekonomičnjom, što je posebno značajno ako se ima u vidu da plesači sportskog plesa većinu plesova izvode na nivou visoko intenzivnih opterećenja, osim u valceru, tangu, sambi i rumbi (Zagorc, Karpuljak i Fiedl, 1999). Anatom-ske i konceptualne sličnosti plesa i pilatesa, kao i mnoge prednosti pilatesa za cijelovit razvoj plesača, objašnjavaju zašto je ova metoda vježbanja popularna među plesnom populacijom širom svijeta (Berkow, 2011).

### **Pilates u treningu plesača**

Snaga i kontrola središnjeg dijela tijela, koji podrazumijeva mišice abdomena, donjeg dijela leđa, mišice karlice, kukova i unutarnje strane natkoljenice, osnova je pravilnog izvođenja elemenata tehnike različitih plesnih stilova. Dobra tjelesna kontrola pri kretanju plesača rezultat je dobre koordinacije i ravnoteže u korištenju tenzija mišića središnjeg dijela tijela. Da bi uspostavili i održavali pravilno držanje tijela pri izvedbi različitih plesnih elemenata u paru, plesači sportskog plesa treba da „nauče“ kako da aktiviraju mišice centralnog dijela tijela i time stvore osnovu za pravilno kretanje cijelog tijela. Pilates metoda vježbanja omogućuje jačanje „centra tijela“ što je neophodno za uspostavljanje i kontrolu različitih plesnih pozicija, okreta, skokova, ali i cijelovitog tjelesnog kretanja u paru. Primjena pilates vježbi u treningu plesača omogućava bolje razumijevanje kretanja vlastitog tijela u prostoru stvaranjem tzv. „osjećaja za tijelo“, odnosno, stvaranje veze između uma, tijela i emocija što je veoma bitno sa aspekta estetskog izražaja emocija kroz pokrete tijela. Vježbe pilatesa plesače stavlju u situaciju korištenja težine vlastitog tijela kao svojevrsnog opterećenja s ciljem izvođenja kontrolisanih, doziranih i preciznih pokreta. Za razliku od ostalih modela vježbanja pilates metoda uvijek podrazumijeva aktivaciju mišića cijelog tijela u realizaciji zadatog kretanja, bez izolacija i jačanja samo pojedinih mišićnih segmenata. Ovakav cijelovit pristup dovodi do boljeg razumijevanja u korištenju tenzija u mišićima, bilo pri izvođenju pojedinačnih plesnih obrazaca, bilo pri usaglašavanju u korištenju tenzija za izvođenje plesnih obrazaca u paru. Generalno, pilates

ter understanding of the muscle tension use, whether in the performance of individual dance forms, or in the harmonization of tension use in performing dance patterns in couples. Generally, the Pilates method of exercise in dance training is used for strengthening and shaping the muscles of the entire body, improving flexibility and balance, uniting mind and body, developing and maintaining power, establishing and maintaining the proper body posture, as well as for prevention and recovery from injuries typical for dancers. This emphasizes the importance of Pilates method in rehabilitation of dancers. Additionally, besides prevention and rehabilitation, Pilates in dance training is highly applicable in conditioning training, in preparation for training and competition, but also as an exercise model for post-training relaxation.

Pilates training programs in fitness dance training should start gradually and cautiously increase the intensity of exercise. The exercise resistance should be increased over time to produce more power and improved intramuscular coordination. When the muscles are active and "trained", dance movements are performed without unnecessary muscle tension, making them resistant to fatigue. If the muscles are inactive, they become weak and decaying. Pilates exercise builds muscle strength without excessive enlargement of the muscle mass. The springs used in Pilates gyms encourage activation of eccentric muscle strength that allows for lengthening of muscle fibers while the muscle is active. This practice makes it very different from the static weights used in gyms, because as the spring becomes tenser, the stretching of the muscle becomes longer. Kinematic form of Pilates exercise provides directing the weightiness of agonists while assisting and tension in the muscles of antagonists. This way, the antagonistic muscles work together smoothly and effectively without causing the muscle imbalance in duration of the exercise with correct body posture. This type of exercise leads to a safer protection mechanism when performing high amplitude movements and expressed flexibility. Of course, when dosing the tension in order to develop endurance in strength, it is important to know that the training of a single muscle group leads to a reduction in the efficiency of movement. Performing more repetitions with less resistance improves muscular endurance. In the Pilates floor mat exercise, dancers use their own body weight as resistance or use small props such as "rings" or "Thera-Band" resistance bands to create additional resistance. In the aim of achieving all the positive effects of Pilates exercise on dance efficiency, it is necessary to perform isolated workouts at least three times a week.

metoda vježbanja se u treningu plesača koristi za jačanje i oblikovanje mišića cijelog tijela, poboljšanje gipkosti i ravnoteže, ujedinjavanje duha i tijela, za razvijanje i održavanje snage, za uspostavljanje i održavanje pravilne posture tijela, ali i za prevenciju i oporavak od povreda tipičnih za plesače, čime se naglašava rehabilitacioni značaj primjene pilates metoda vježbanja u sportskom plesu. Takođe, osim prevencije i rehabilitacije, pilates se u treningu plesača izrazito primjenjuje u kondicionoj pripremi, kao priprema za trening ili takmičenje, ali i kao model vježbanja za relaksaciju poslije treninga.

Sa primjenom pilates programa u kondicionoj pripremi plesača treba započeti postupno i oprezno povećavajući intenzitet vježbanja. Opterećenje treba povećavati tokom vremena kako bi se proizvela veća snaga i bolja međumišićna koordinacija. Kad su mišići aktivni i „utrenirani“ plesno kretanje izvodi se bez suviše mišićne napetosti, čineći ih otpornim na umor. Ako su mišići neaktivni, postaju slabi i propadaju. Pilates vježbanje gradi snagu mišića bez pretjeranog uvećavanja mišićne mase. Opruge koje se koriste u pilates trenažerima potiču aktivaciju ekscentrične mišićne sile koja omogućuje izduživanje mišićnih vlakana dok je mišić aktivran. To vježbanje čini uveliko drugačijim od statičkih tegova koji se koriste u teretanama, jer kako opruge postaju napetije tako je i istezanje mišića veće. Kinematički obrazac vježbanja pomoću različitih pilates trenažera omogućava usmjerenje opterećenja agonistima uz istovremeno asisitiranje i tenziju u mišićima antagonistima. Na ovaj način suprostavljeni mišići rade zajedno, glatko i efikasno bez izazivanja mišićne neravnoteže sve vrijeme dok se vježbanje izvodi sa korektnom tjelesnom posturom. Ovakav način vježbanja doveće do sigurnijeg zaštinog mehanizma pri izvođenju pokreta velikih amplituda i izražene fleksibilnosti. Naravno, prilikom doziranja opterećenja s ciljem razvoja izdržljivosti u snazi treba voditi računa da treniranje samo jedne mišićne grupe dovodi do smanjenje efikasnosti kretanja. Izvođenje više ponavljanja sa manjim otporom prouzrokuje poboljšanje mišićne izdržljivosti. U pilates vježbanju na parteru plesači koriste opterećenje vlastitog tijela ili se koriste manji rekviziti poput prstenva ili terabend rastezljivih traka koji stvaraju dodatno optrećenje. Da bi se ostvarili svi pozitivni efekti pilates vježbanja na plesnu efikasnost potrebno je izvoditi izolovane treninge minimalno tri puta sedmično.

Kontrola disanja i mentalna koncentracija omogućavaju plesačima da budu svjesni svog pokreta i pomaže da se poveća svijest o senzomotoričkoj „povratnoj“ informaciji od CNS-a. Sinergija djelovanja uma i tijela na kojoj se zasniva pilates vježbanje efikasan je način po-

The control of breathing and mental concentration allows dancers to be aware of their own movements and helps them to increase awareness of sensomotoric "feedback" information from the CNS. The mind-body synergy Pilates is based on is an effective way to improve control of all individual segments of body movement. Mental training and relaxation techniques offered by Pilates exercise can also be used to enhance the dance efficiency and ensure better dance expression. This approach helps dancers to maintain their focus in dance performance and may also be useful in gaining new skills, such as learning new choreographies or seeking new variations in the given dance movements (creativity in performance). Pilates is an ideal tool for better coordination of the joints and muscles caused by creating a new sense of various movements. This expanded awareness of one's own moves and movements (proprioception) makes the physical sense of moving body angles more understandable. This results in higher quality of dance training, faster adoption of new dance forms and a more beautiful dance expression. The positive effects of proprioceptive training for improving balance and dance techniques in sport dancing have already been proven (Ljubojević, 2010).

Authors who have written about the benefits of Pilates method of exercise in dance training (Loosli and Herold, 1992; Parrot, 1993; Fitt, Sturman and McClain-Smith, 1993/1994; Brown and Clippinger 1996 McLain, Carter and Abel, 1997; McMillan, Pretão and Lebe, 1998) all agree that the Pilates can improve the dancer's strength, flexibility, posture and body performance.

### **Pilates and proper body posture**

In general, body posture represents the proper relationship of body parts in relation to each other, in relation to the whole body and in relation to the gravity. More specific, this is the basis for proper biomechanics of movement, especially in multi structural conventional sports with strong aesthetic criteria, such as the sport dance. Proper posture is a precondition of a healthy physical exercise, as well as for performing various dance skills. Good posture is a very important aspect of the dancer's ability to perform slow, technically correct movements, but also, to achieve high aesthetic criteria of performing. Naturally, one mustn't forget that proper positioning of the body in dance movements is the fundamental prerequisite for injury prevention, which will be discussed in more detail later. Previous studies suggest that Pilates training can improve stabilizing muscles of the trunk (Harrington and Davies, 2005; Endleman and Critchely, 2008), as well as that the method can lead to the cre-

boljšanja kontrole kretanja svih pojedinačnih segmenta tjelesnog pokreta. Mentalni trening i tehnike opuštanja koje nudi pilates vježbanje, takođe, se mogu koristiti kako bi se poboljšala plesna efikasnost i uticala na bolju plesnu ekspresiju. Ovakav pristup pomaže u održavanju fokusa plesača pri izvedbi kretanja i, takođe, može biti korisno u sticanju novih vještina, kao što su učenje novih koreografija ili traženja novih varijanti izvođenja zadatak plesnog kretanja (kreativnost u izvođenju). Pilates je idealano sredstvo za bolje koordinisanje zglobova i mišića uzrokovano stvaranjem novih osjećaja za različita kretanja. Ta povećana svijest o vlastitim pokretima i kretnjama (propriocepција) čini da fizički osjećaj u pomjeranju uglova tijela bude više razumljiv, a to rezultuje kvalitetnijim plesnim treningom, bržem usvajaju novih plesnih obrazaca i ljepšoj plesnoj ekspresiji. Dokazani su pozitivni efekti proprioceptivnog treninga na poboljšanje ravnoteže i tehnike izvođenja u sportskom plesu (Ljubojević, 2010).

Autori koji su pisali o prednostima primjene pilates metode vježbanja u treningu plesača (Loosli i Herold, 1992; Parrot, 1993; Fitt, Sturman i McClain-Smith, 1993/1994; Brown i Clippinger 1996; McLain, Carter i Abel, 1997; McMillan, Pretao i Lebe, 1998) slažu se u tome da pilates može poboljšati plesačku snagu, fleksibilnost, posturu tijela i izvođenje.

### **Pilates i pravilno tjelesno držanje (postura)**

U širem smislu, postura tijela predstavlja pravilan odnos dijelova tijela u odnosu jednog na drugi, u odnosu na cijelo tijelo i u odnosu na gravitaciju. U užem, predstavlja osnov za pravilnu biomehaniku kretanja, naročito kod polistrukturalnih konvencionalnih sportova sa izraženim estetskim kriterijem, kakav je i sportski ples. Pravilno držanje tijela preduslov je zdravog fizičkog vježbanja, ali i izvođenja različitih plesnih vještina. Dobra postura je veoma važan aspekt plesačeve sposobnosti da pokrete izvodi lagano, tehnički ispravno, ali i da postigne estetski kriterij takvog izvođenja. Naravno, ne smije se zanemariti ni činjenica da je pravilno pozicioniranje tijela u prostoru osnovni preduslov prevencije povreda kod plesača o čemu će više biti govora kasnije. Dosadašnja istraživanja ukazuju da pilates trening može poboljšati ciljano mišiće stabilizatore trupa (Harrington i Davies, 2005; Endleman i Critchely, 2008) i da ovaj metod vježbanja dovodi do stvaranja neuromuskularnih obrazaca koji pomažu uspostavljanju i održavanju pravilne posture tijela, a da izolovane vježbe snage istih mišićnih grupa nisu dovoljne za poboljšanje tjelesnog držanja (Phillips, 2005). Ovim se akcentuje snaga zajedničkog

ation of neuromuscular patterns that help establishing and maintaining proper body posture. Isolated strength exercises by the same muscle groups are not sufficient in improving body posture (Phillips, 2005). This underlines the power of joint mind and body action, which is the basic principle of Pilates exercise method. The perception of one's own movement, and accordingly, activating the necessary muscles for proper positioning of the body in dynamic motion was the basis in implementation of the Pilates method of exercise explored by McMillan et al. (1998). Exercise included movements on the Pilates reformer: "The Hundred", "Leg Circles", "Long Stretch," "Mermaid," "Seated Side", "Twist" and "Elephant". As the trainings went on, the stress on the reformer increased and the exercises and movement variations changed in order to meet progressive challenges, but without compromising the proper posture. The results are encouraging both for the dancers and coaches, especially those who have problems with establishing and maintaining stability of the upper body, to opt for using the Pilates reformer as a potential method for improving the stabilization of the upper body. Moreover, the results of the study conducted by Kish and Gudde Plastino (2001) of the Pilates method effects on the dancers, indicated an improvement of posture and functional mobility of the adductor leg muscle and hip flexion.

When applying Pilates principles in dance training in aim of establishing proper body posture, the emphasis is on the proper postural alignment, focusing on the suppressed pelvic "ahead and in" and the inside of the thigh muscle activation, i.e. the stabilizer muscles comprised of the abdominal muscles, lower back muscles, the diaphragm muscles and the pelvic muscles (especially m. psoas). Using Pilates workout, CNS can improve the control of the spine when the trunk is exposed to external or internal forces (Sureeporn, Paungmali and Sitilertpisan, 2011). There are many such movements in dance, and are especially related to the dynamic movements of the legs in all directions, accompanied by hand and upper body movement. They are especially expressed when performing turns or complex dance routines in couples.

### **Pilates and injury prevention**

Dancers are exposed to great body stress when performing various and complex choreographies. The possibility of injury is increased by an insufficient control of technique caused by bad posture, or the lack of concentration during the performance. In order to show individuality in their dance expression, the dancers often perform virtuosic high amplitude dance moves in their choreogra-

djelovanja uma i tijela što je osnovni princip vježbanja pilates metode. Percepcija vlastitog kretanja i u skladu s tim, aktiviranje potrebne muskulature za pravilno pozicioniranje tijela pri dinamičkim pokretima bila je osnova u provođenju pilates metode vježbanja koje su istraživali McMillan i sar. (1998). Vježbanje je uključivalo pokrete na pilates reformeru: „The Hundred“, „Leg Circles“, „Long Strech“, „Mermaid“, „Seated Side“, „Twist“ i „Elephant“. Kako su treninzi odmicali opterećenje na reformeru se povećavalo, vježbe i varijacije su se mijenjale kako bi se postigli progresivni izazovi, ali bez kompromitovanja pravilnog držanja tijela. Rezultati ohrabruju plesače i trenere koji imaju probleme sa uspostavljanjem i održavanjem stabilnosti gornjeg dijela tijela da odgovor traže u korištenju pilates reformera kao potencijalnog metoda za poboljšanje stabilizacije gornjeg dijela tijela. Takođe rezultati istraživanja efekata pilates metode koje su na plesačima proveli Kish i Gudde Plastino (2001) ukazuju na poboljšanje držanja tijela i funkcionalne pokretljivosti mišića primicača nogu i fleksije kuka.

Kad se primjenjuju pilates principi u treningu plesača s ciljem uspostavljanja pravilnog držanja tijela, akcenat je na adekvatnom posturalnom poravnanju sa fokusom na potisnutoj karlici „naprijed i unutra“ i aktivaciji mišića unutarnje strane nadkoljenice, odnosno mišićima stabilizatorima koje čine mišići abdomena, donjeg dijela leđa, diafragme i mišićima karlice (posebno m. psoas). Pomoću pilates treninga, CNS može poboljšati kontrolu kičmenog stuba kad je trup izložen vanjskim ili unutarnjim silama (Sureeporn, Paungmali i Sitilertpisan, 2011). Takvih kretanja je u sportskom plesu mnogo, a naročito se odnose na dinamičnije pokrete nogu u svim pravcima, praćenih sa pokretima ruku i gornjeg dijela tijela. Posebno su izražena pri izvođenju okreta, ali i kompleksnih plesnih elemenata u tjelesnom kontaktu sa partnerom.

### **Pilates i prevencija od povreda**

Pri izvođenju različitih i kompleksnih koreografija plesači su izloženi velikom tjelesnom stresu. Mogućnost povređivanja uvećava se nedovoljnom kontrolom tehnike izvođenja prouzrokovane lošim držanjem tijela, ali i nedovoljnoj koncentraciji pri izvođenju. Da bi prikazali individualnost u plesnom izrazu, vrhunski plesači vrlo često u svojim koreografijama izvode virtuzne plesne pokrete velikih amplituda s ciljem prikaza plesnog majstorstva. To su situacije koje zahtijevaju izuzetnu fizičku i mentalnu pripremljenost, jer svaki nedostatak u izvedbi može prouzrokovati povrede plesača. Povrede u plesu najčešće se dešavaju u predjelu stopala, skočnog zgoba, koljena, kuka, karlice i donjeg dijela kičme. Naravno, po-

phies in aim of depicting dance mastery. These situations require extreme physical and mental preparation, because any deficiency in performance can cause injury for dancers. Injuries in dance usually occur in the area of the foot, ankle, knee, hip, pelvis and lower spine. Of course, injuries occur due to a prolonged exposure of the body to physical micro trauma, and most often due to an improper weight dosage during training and improper stretching protocol. Excessive and uncontrolled stretching leads to muscle tension, sprains, fractures and dislocation of joints. Very often, dance injuries stem from a training process "overdose", when muscle fatigue leads to reduced dance efficiency and coordination loss leads to injuries.

In most cases, dance injuries and spinal pain occur because of an improper posture. Bad posture impairs natural gravity line and leads to muscle asymmetry, which, due to negative changes in the biomechanics of movement, can cause problems in the cervical or lumbar spine in long-term exercising. The Pilates exercises are designed to put dancers in the position that provides optimal muscle activation for reducing unnecessary muscle engagement, which potentially leads to an early muscle fatigue, reduced stability of the body, and a slow recovery. The Pilates method of strength training and stretching exercise should be included in the daily schedule of dance activities, or applied as a special training - Pilates training.

### **Pilates and education of dancers**

Many professional dancers have developed the awareness of their own body posture and habits of maintaining good body posture in everyday life. By use of various exercise equipment, Pilates trains and educates dancers to become aware of the positioning of their bodies (kinesthetic sense). This method, also, provides a very effective exercise program that can improve the entire functional stability of dancers by increasing the protective power of the local muscle structures. That means that the strength expressed in the deeper layers of muscles enables the outer muscle layers and body levers to work in a coordinated, seamless and integrated manner. The torso is the basis for correct and focused movement. If the torso is unstable, the arms and legs have to "do" a lot more work in order to perform specific dance moves (Berkow, 2011). This reduces rationalization in movement, which is automatically reflected in the increased energy consumption. The tension in the muscles is lower in lying than standing body position. For this reason, the initial level of Pilates exercise begins after lying positions, precisely for the reason of increasing the awareness of one's own movements without the additional gravitational influence. By mastering the basic Pilates exercises

vrede nastaju uslijed dugotrajnog izlaganja tijela fizičkim mikrotraumama, a najčešće se javljaju uslijed nepravilno doziranog opterećenja u toku treninga i nepravilnog protokola istezanja, odnosno, lošeg programiranja trenaažnog procesa. Preveliko i nekontrolisano istezanje dovodi do napetosti mišićnog tkiva, uganuća, frakturna i dislocirano sti zglobova. Vrlo često povrede u plesu nastaju i uslijed „predoziranog“ treninga, kada mišićni umor dovodi do smanjenja plesne efikasnosti, a gubitak koordinacije do povreda plesača.

Povrede i bolovi kičme kod plesača uglavnom nastaju kao posljedica nepravilne posture tijela. Loše tjelesno držanje kod plesača narušava pravilnu liniju gravitacije i dovodi do mišićne asimetrije, koja, uslijed negativnih promjena u biomehanici kretanja, kod dugo ročnog vježbanja može uzrokovati probleme u vratnom ili lumbalnom dijelu kičme. Pilates vježbe su dizajnirane da stave vježbača u poziciju koja obezbjeđuje optimalnu mišićnu aktivaciju s ciljem smanjenja nepotrebnog mišićnog angažovanja, koje potencijalno dovodi do prevremenog mišićnog zamora, smanjene stabilnosti tijela, ali i usporenog oporavka. Vježbe snage i istezanja pilates metode vježbanja treba da budu sadržane u dnevnom rasporedu plesnih aktivnosti, ali primjenjivane kao poseban trening - pilates trening.

### **Pilates i edukacija plesača**

Mnogi profesionalni plesači imaju razvijenu svijest o sopstvenoj tjelesnoj posturi, te navike o pravilnom držanju tijela imaju i u svakodnevnom životu. Pilates s nizom korištenih rekvizita omogućava plesačima da postanu svjesni pozicioniranja svoga tijela (kinestetički osjećaji). On, takođe, pruža vrlo efikasan program vježbanja koji može unaprijediti plesačevu cijelokupnu funkcionalnu stabilnost povećavajući zaštitnu snagu lokalnih mišićnih struktura. To znači da snaga koja se ispoljava u dubljim slojevima mišića omogućava da vanjski mišićni slojevi i poluge tijela rade koordinisano, sliveno i integrisano. Torzo je temelj pravilnog i usmjerjenog kretanja. Ako je torzo nestabilan, ruke i noge moraju „raditi“ mnogo više da bi se realizovali postavljeni kretni zadaci (Berkowa, 2011). Time se smanjuje racionalizacija kretanja, što se automatski reflektuje i na povećanu energetsku potrošnju. Napetost u mišićima je niža u ležećem, nego u stojećem položaju tijela. Iz tog razloga početni nivo vježbanja i provođenja pilates vježbi počinje iz ležećeg položaja upravo iz razloga da se ovlada svjesnošću o vlastitom kretanju bez dodatnog opterećenja zbog djelovanja gravitacione sile. Savladavajući osnovne pilates vježbe plesačima se povećavaju zahtjevi u pogledu razli-

and principles, demands increase in various positions from which dancers start and end with in Pilates exercises, until the achieved awareness and movement control become useful in performing the prepared dance moves.

Before applying Pilates exercises, dancers should acquire at least the basic knowledge of anatomy and kinesiology, in order to understand better the principles of motion, the musculoskeletal system, the physical demands of dance and elements of safe and efficient movement and structural differences in body types (Ahearn, 2006, according to Berkow, 2011). The Pilates exercises are most beneficial if the training rises gradually and if the dancers are provided with enough information to find their physical centers, to focus their minds, improve their warm-ups, before starting with exercises that are more difficult. It would be best if a same dance teacher instructs the Pilates exercises on the floor mat and dance technique. If this is not possible, dance and Pilates instructors need to consult each other and discuss their common goals, the training methodology and the method of interconnecting Pilates exercises and dance techniques. Programming exercises with a clear understanding of the relations between Pilates and dance moves or concepts is crucial for the dancers' ability to transmit the learned muscular "feeling" from the lying or sitting position to standing dance activities and complex motoric dance patterns (Ahearn, 2006).

## CONCLUSION

The aim of this paper is to point out the many advantages of using the Pilates method of exercise in comprehensive preparations of dancers. The recommendation is given to the dance teachers, coaches, managers, choreographers etc. to include the Pilates concept of practicing in their dance pedagogy, thus providing an excellent supplement for an additional dance conditioning. Introducing dancers to intellectual and kinesthetic relations between dance and Pilates also promotes the achievement of goals such as the increased body awareness, improved musculoskeletal integration, and in general, provide better health for dancers. Pilates exercises should be applied in the dancers' training consistently in any aspects of dance training – preparatory or competitive. Pilates exercises are best when individualized according to the abilities and basic knowledge of dancers. Diversity of various Pilates instruments does not make exercise monotonous, and allows for a progressive effect on mobility and stability of all dance performances. Using Pilates as a training model in sport dance, largely ensures easier movement performance technique, more effective dance couple movement, provides better dance expression, prevents injuries and ensures the longevity of a dancer's career.

čitih pozicija iz kojih počinju i završavaju pilates vježbe sve dok postignuta svjesnost i kontrola kretanja ne bude upotrebljiva pri realizaciji svih planiranih plesnih pokreta i kretanja.

Prije primjene pilates vježbi plesači bi trebali steći barem osnovno znanje o anatomiji i kineziologiji, kako bi bolje razumjeli zakonitosti kretanja, zatim mišićno-koštani sistem, fizičke zahtjeve plesa, elemente sigurnog i efikasnog kretanja i strukturalne razlike u tipovima tijela (Ahearn, 2006, prema Berkowa, 2011). Pilates vježbe su najkorisnije ako se u edukaciji pristupa postepeno i ako se plesačima pruži dovoljno informacija da pronađu svoje tjelesne centre, fokusiraju svoje misli, unaprijede svoje zagrijavanje, prije nego što pređu na komplikovanije vježbe. Najbolje bi bilo ukoliko isti plesni pedagog rukovodi i pilates vježbanjem na podu i plesnom tehnikom. Ako to nije moguće, plesni i pilates instruktori trebaju se međusobno konsultovati i razgovarati o zajedničkim ciljevima, trenažnom metodologijom i načinu međusobnog povezivanja pilates vježbanja i plesne tehnike. Programiranje vježbanja na jasnom razumijevanju veze između pilates vježbi i plesnih pokreta ili koncepata je ključno za sposobnost plesača da prenesu naučeni mišićni "osjećaj" sa ležećeg ili sjedećeg položaja u stojeće plesne aktivnosti i složene motoričke plesne obrasce (Ahearn, 2006).

## ZAKLJUČAK

Cilj rada je ukazivanje na mnoge prednosti primjene Pilates metode vježbanja u svestranoj pripremi plesača. Preporuka je plesnim nastavnicima, trenerima, voditeljima, koreografima da Pilates koncept i vježbe uključe u svoju plesnu pedagogiju, te pruže plesačima odlično sredstvo za dodatnu plesnu pripremu. Upoznavanje plesača sa intelektualnim i kinestetičkim vezama između plesa i Pilatesa, takođe, pospješuje ostvarivanje ciljeva kao što su povećana svijest o tijelu, poboljšane mišićno-koštanog integracije, i uopšte, omogućava bolje zdravlje plesača. Pilates u treningu plesača treba primjenjivati konstantno i u pripremnom i u takmičarskom periodu. Pilates vježbanje najbolje bi bilo individualizovati u skladu sa sposobnostima i predznanjima plesača. Bogatstvo primjene različitih Pilates instrumenata ne čini ga monotonim za rad, a omogućava progresivni učinak na mobilnost i stabilnost plesne izvedbe. Primjena Pilatesa kao trenažnog modela u sportskom plesu može uveliko olakšati tehniku izvođenja pokreta, osigurati ekonomičnije kretanje u paru, pomoći u boljoj plesnoj ekspresiji, spriječiti povredivanje i osigurati dugovječnost plesne karijere.



Figure 1. Some of the Pilates matt exercise for dancers

Slika 1. Prikaz Pilates vježbi na parteru

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