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# SPORTSKE NAUKE I ZDRAVLJE

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### Poštovani čitaoci,

Pred vama je novi broj Časopisa "Sportske nauke i zdravlje", koji je u desetoj godini izdavanja dočekaao i vijest da će uskoro biti indeksiran i u prestižnoj citatnoj bazi Scopus. Ukupno osam radova iz Brazila, Sjedinjenih Američkih Država, Srbije i Bosne i Hercegovine uvršteno je u novo izdanje našeg Časopisa, od kojih su četiri originalna naučna rada, dva pregledna rada, jedno kratko saopštenje i jedan stručni rad.

Teme koje se obrađuju odnose se na značaj snage i jakosti na uspjeh u košarci, efekte neuromuskularne stabilizacije na povećanje funkcionalnosti i mobilnosti lokomotornog sistema, relacije motoričkih sposobnosti i preciznosti za izvođenje šuta u rukometu, važnosti postavljanja igre u vrhunskom fudbalu, pozitivno pravnoj regulativi kao činiocu upravljanja sportskom organizacijom i indeksu tjelesne mase i motorički status predškolske djece i metodološke odrednice treninga snage.

Nadam se da ćete biti zadovoljni našim izborom i da ćete kao i do sada biti naša značajna podrška, slanjem radova za naredni broj Časopisa. Predstavljanje ovog broja Časopisa "Sportske nauke i zdravlje" završavamo u duhu promocije aktivnog stila života:

*„Kretanje može da zamijeni mnoge lijekove, ali nijedan lijek ne može da zamijeni kretanje!“*  
Tissot (1728-1797)

UREDNIŠTVO ČASOPISA

### Dear readers,

In front of you is the new issue of the Journal "Sports Science and Health", which in its tenth year of publication received the news that it will soon be indexed in the prestigious citation database Scopus. A total of eight papers from Brazil, the United States, Serbia and Bosnia and Herzegovina have been included in the new edition of our Journal, of which four are original scientific papers, two review papers, one short press release and one professional paper.

Topics covered relate to the importance of strength and power on basketball success, the effects of neuromuscular stabilization on increasing the functionality and mobility of the locomotor system, the relationship of motor skills and precision for shooting in handball, the importance of setting up a game in top football, positive legal regulations as a factor management of sports organization and body mass index and motor status of preschool children and methodological determinants of strength training.

I hope that you will be satisfied with our choice and that you will, as before, be our significant support, by sending papers for the next issue of the Journal.

We end the presentation of this issue of the Journal "Sports Science and Health" in the spirit of promoting an active lifestyle:

*"Movement can replace many drugs, but no drug can replace movement!"*  
Tissot (1728-1797)

JOURNAL EDITORIAL

# THE IMPORTANCE OF SET PLAYS IN HIGH PERFORMANCE FOOTBALL

WERLAYNE LEITE

Secretariat of Education of the State of Ceará – SEDUC, Brasil

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**Abstract:** *The constant recording and evaluation of goal scoring characteristics are important and can present changes and evolutionary trends in football. The objective of this study was to analyze the importance of set plays actions for high performance football, checking the incidence of goals scored through these actions during the 2018 FIFA World Cup. 169 goals scored in 64 matches played in the tournament were analysed. The data were obtained from the FIFA website database, through official summaries and videos of the goals scored. According to the results, 68 goals (40.2%) were scored in actions originating from set plays. This high number of goals scored shows that these actions can be an important means of determining victory in high performance football matches, especially between teams of the same level. Among the main reasons to explain the results, we can suggest the following: greater training and tactical improvement, causing a better collective efficiency of the teams in the execution of these actions; and the insertion of VAR technology, mainly causing a greater number of penalties.*

**Key words:** *video analysis, match analysis, Russia World Cup, soccer.*

## INTRODUCTION

After the end of any a significant football tournament the researchers investigate the new trends in tactic and more specific the way the goals are scored (Yiannis, 2014). In the literature of football, several studies were focused on some indicators in the analysis of goals scored, e.g.: time the goals were scored throughout the match (Leite, 2013a); the impact of the first goal for the final result of the match (Leite, 2015); type of play that the goals were scored (Yiannakos & Armatas, 2006); among other indicators.

Despite the large number of studies, it is important to constantly record and evaluate the characteristics of scoring goals in football, because they can present changes and evolutionary trends (Yiannakos & e Armatas, 2006). In football, the goal is the most important aspect of the match and it is important to study it in order to understand it more specifically and to apply the gathered knowledge in real sport settings (Santos, Mendes, Maurício, Furtado, Sousa & Pinheiro, 2016).

Not surprisingly, any researchers are dedicated to the study of the offensive process in football, seeking to establish a relationship between the offensive match methods implemented, and the success in obtaining the goal (Santos et al., 2016). Among the main indicators studied in high performance football, the set plays actions are among the most important. Set plays suppose an opportunity as valid, spectacular and effective as any other action in the match (Herráez, 2003). At the high levels of competition, when you reach a stage when there's not much difference between teams and defences are very well organised, then set plays become a vital weapon (*Fédération Internationale de Football Association [FIFA]*, 2018). In this way, the study of set play actions in competition has shown marked development over time (Loureiro, Teixeira, Costa, Prudente & Sequeira, 2014).

In addition, several researchers began to study patterns of goals scored in World Cup matches due to the importance that this event has for world football (Marques Jr., 2012), being the most important level of football and serving as a parameter for the more varied researches related to football (Silva & Campos Jr., 2006). Thus, the aim of this study is to analyze the importance of set plays for high performance football, verifying the incidence of goals scored through this action during the 2018 FIFA World Cup. Our hypothesis was that set plays represent an important element tactic of the match, resulting in a considerable amount of goals.

## MATERIAL AND METHODS

### Sample

169 goals scored in 64 matches played at the 2018 Russia World Cup were analysed. The data were obtained from the database of the FIFA website ([www.fifa.com](http://www.fifa.com)), through technical report and videos of the goals scored. The scored goals were analysed, obtaining the sequence of actions from the moment of recovery of ball possession. When it was not possible to clearly identify the origin of the play that resulted in a scored goal, the full video of the matches was used. All the evaluated videos were obtained through the Footballia website ([www.footballia.net](http://www.footballia.net)).

### Method

The methodology used for this study was observational descriptive or match analysis. The use of match analysis in football is justified by the importance of understanding the behavioural patterns related to the dynamics of the sport, as well as to subsidize the planning of training and competition processes, aiming at maximum individual and collective performance (Hughes & Franks, 2005). An objective assessment derived from video analysis offers analytical, realistic, and more accurate information, illustrating the performance profile of the team and players in real match conditions (Hohmann & Rommel, 1994).

### Definition of parameters

In order to increase the reliability of the observation, we defined the concepts that support this inquiry.

**Open play:** characterized as all actions in which the objective is to unbalance the opponent's defence, usually through pre-established concepts and match patterns.

**Counterattack:** situations in which the team was on defence and, after regaining ball possession, reached the opponent's goal dynamically.

**Set plays:** situations of penalties, free-kicks, corners and throw-ins. For all actions of corners, indirect free-kicks and throw-ins, a goal from set play was considered when the ball was touched, at most, up to three times during the action (including the restart shot).

- **Penalty:** occurs when the team is being attacked commits an infraction within the penal area. A direct free kick is awarded to the opposing team.
- **Corner:** consists of the restart of the match from a kick in the ball of the corner area, using one of the feet.
- **Direct free-kick:** free kick kicked directly to the goal.
- **Indirect free-kick:** following a free-kick, trying to find another player better positioned for finalization.
- **Throw in:** consists of restarting the match, throwing the ball from the sideline of the field, using both hands.
- **Own goal<sup>1</sup>:** some own goals were counted in this category, because, even though it was not the defender's intention, they originated from set plays actions (example: figure 1).

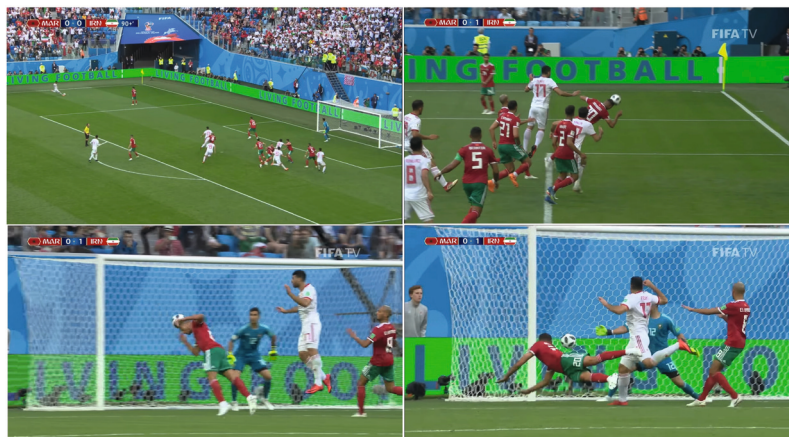


Figure 1. Own goal originating from set play (Morocco 1 vs. 0 Iran)

<sup>1</sup>This is the same methodology adopted by FIFA. In the technical report of the tournament, the entity counts own goals originating from set plays in this category (goals scored in set plays).

### ***Data analysis***

For the presentation of the results we used descriptive statistics, consisting of frequency distribution. Statistical data were reproduced with Absolute Frequency (number of goals) and the Relative Frequency (percentage of goals).

### **RESULTS**

Table 1 shows the type of play that goals were scored during the tournament. Of the 169 goals scored, 81 goals were scored through open play; 68 goals were scored in plays originating from set play actions; 16 goals were scored in counterattack actions; and 4 goals were own goals.

**Table 1.** Number of goals scored, divided by type of play.

Goal type	Goals
Open play	81
Counter attack	16
Set play	68
Own goal	4

Table 2 shows how the set play goals were scored. Of the 68 goals scored, 22 goals were scored through penalties; 19 were scored through plays from corners; 7 goals were scored in direct free-kick; 11 goals were scored in indirect free-kick; 1 goal was scored in a throw-in; and 8 goals were own goals in actions originating from set plays.

**Table 2.** Number of goals scored originating from set plays, divided by set play action.

Set play	Goals
Penalty	22
Corner	19
Direct free-kick	7
Indirect free-kick	11
Throw-in	1
Own goal	8

### **DISCUSSION**

The aim of this study was to make an analysis of the actions that occurred from the recovery of ball possession to the achievement of the goal scored by elite national teams; checking the incidence and importance of goals scored through set plays during the 2018 Russia World Cup.

The results of this study show that 68 (40.2%) goals, of all 169 goals scored in the tournament, originated through set plays. This result shows that there is a great importance of these actions for high performance football.

The analysis of relevant studies about goals scored in a national team tournament, since the beginning of the 21st century (2001-20), shows the importance of actions originating from set plays in the main football competitions (table 3).

**Table 3.** Football tournaments and number of goals scored from set play actions (GSP), absolute and relative frequency.

Tournament	GSP
2002 World Cup (FIFA, 2002)	45 (28%)
Euro 2004 (Yiannakos & Armatas, 2006)	27 (35.6%)
2006 World Cup (Armatas & Yiannakos, 2010)	48 (36.2%)
Euro 2008 (UEFA, 2008)	16 (20.8%)
2010 World Cup (FIFA, 2010)	35 (24.1%)
Euro 2012 (Leite, 2013b)	22 (29%)
2014 World Cup (FIFA, 2014)	38 (22.2%)
Euro 2016 (UEFA, 2016)	32 (29.6%)

As noted, the analysis of these studies shows ranges ranging from 20.8% to 36.2%. Thus, the present study presents a result higher than the interval observed in previous studies. Such a result may be due only to a punctual finding or a consequence of an evolutionary trend in football, caused mainly by 2 aspects:

i) *greater training and tactical improvement*: realizing the importance of dead balls for modern high-performance football, teams may be increasing the training sessions of these actions, seeking to improve collective efficiency and increase the probability of victory;

ii) *Video Assistant Referee (VAR)*: the insertion of VAR technology in football allows important decisions by referees to be reviewed and corrected. In this way, it also contributed to the increase in the number of goals scored in set play actions, considering that the number of penalties awarded in the group stage significantly increased from previous editions, partly due to the presence of VAR (FIFA, 2018).

Apart from penalties, the biggest change at this year's tournament in terms of set plays concerned corners. At the 2018 World Cup, one in every 29 corners led to a goal, whereas the figure was 61 at South Africa 2010 and 36 at Brazil 2014. This trend of superior effectiveness continued through the knockout stage in Russia, where teams scored from one in every 31 corners compared to every 41 in Brazil (FIFA, 2018).

Gaining more and more importance in today's football, the training of set plays is essential (Herráez, 2003), being considered one of the most important aspects in modern football (Dunn, 2009). According to Mombaerts (2000), goals arising from set plays are becoming increasingly decisive and can determine the outcome of a match between teams of the same level often being crucial to winning matches in a World Cup tournament (Rumpf, Silva, Hertzog, Farooq & Nassis, 2017).

At the 2018 World Cup many matches were won in set play situations. Final champions France offered a prime example of the importance of set plays at this tournament, notably in the semi-final against Belgium and then again in the final. Indeed, their first two goals in the final came from set plays: a free kick and a penalty. When a match is tight, set plays can make all the difference and win trophies (FIFA, 2018).

## CONCLUSION

According to results of this study, the actions of set plays have become increasingly important for high performance football, as a considerable number of goals are scored through these actions. These actions can be an important means of determining victory in a dispute between teams of the same level, in an important tournament. Among the main reasons to explain the results, we can suggest: greater training and tactical improvement, causing a better collective efficiency of the teams in the execution of these actions; and the insertion of VAR technology, mainly causing a greater number of penalties.

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## ZNAČAJ POSTAVKE IGRAČA U VRHUNSKOM FUDBALU

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**Sažetak:** Konstantno beleženje i ocenjivanje karakteristika postizanja golova je važno i može predstavljati promene i evolucione trendove u fudbalu. Cilj ovog istraživanja bio je analizirati važnost postavke igrača za vrhunski fudbal, provjeravajući učestalost postignutih golova kroz ove akcije tijekom Svjetskog prvenstva u fudbalu 2018. godine. Analizirano je 169 postignutih golova u 64 odigrane utakmice. Podaci su dobijeni iz baze podataka FIFA web stranice, službenih zapisnika i video zapisa postignutih golova. Prema rezultatima, postignuto je 68 golova (40,2%) u radnjama koje proizilaze iz postavljene igre. Ovaj veliki broj postignutih golova pokazuje da ove akcije mogu biti važno sredstvo za određivanje pobjede u fudbalskim utakmicama visokih performansi, posebno između timova istog nivoa. Među glavnim razlozima za objašnjenje rezultata možemo navesti: veću obuku i taktičko unapređenje, što će rezultirati boljom kolektivnom efikasnošću timova u izvođenju ovih akcija; i postavljanje VAR tehnologije, uglavnom uzrokuje veći broj penala.

**Ključne reči:** video analiza, analiza meča, Svetsko prvenstvo u Rusiji, fudbal

# THE IMPORTANCE OF LOWER BODY STRENGTH AND POWER FOR FUTURE SUCCESS IN PROFESSIONAL MEN'S BASKETBALL

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**Abstract:** Heavy resistance exercise is often prescribed for collegiate basketball players to enhance game performance, but few data are available concerning the transference of lower body strength and power to the opportunity to play professionally after college. This study investigated if lower body muscular power and strength measures obtained during the barbell squat are related to future professional playing opportunities. The data was collected over a seven year period from a collegiate men's basketball program ( $n=37$ ;  $X\pm SD$ , age=20.0 $\pm$ 1.4 yrs, hgt=1.98 $\pm$ 0.09 m, bw=94.5 $\pm$ 11.8 kg). Lower body strength was determined from 1 repetition maximum (1RM) tests of the parallel high-bar squat. Maximum lower body squat power was determined from speed squat testing across a load spectrum (30-90% 1RM) while an external tethered dynamometer or a 3-D video motion capture system quantified barbell power. Repeated measures ANOVA with Tukey's HSD post hoc, Spearman  $\rho$  correlations, and Cohen's  $D$  effect sizes were used to analyze the results. Subjects who subsequently played in the NBA or in professional leagues elsewhere had greater lower body strength and power. This was mainly attributed to their greater body mass, since strength and power relative to body mass was not different between the groups. Even without statistically significant differences, effect sizes consistently indicated moderate to large differences between the NBA and other professional groups when compared to those who did not play professionally. Regardless, lower body strength and power were related to post-collegiate playing opportunities, with greater values related to higher levels of professional play.

**Key words:** player evaluation, sport, assessment, sports testing, college sports.

## INTRODUCTION

In the modern world, basketball is one of the most popular and internationally played sports. A large number of participants, especially young adults, contemplate and work towards achieving a goal of playing at various levels of professional basketball competition. While many foreign countries host various well established and successful professional basketball teams allied with multiple international basketball federations, the National Basketball League (NBA) is still considered the highest level of competition.

Basketball is a sport that involves continuous repetitive numbers of sprints with short recovery times and requires players to possess high levels of agility, strength, anaerobic and aerobic conditioning in order to satisfy all physiological demands (Hoffman, 2003). Previous research revealed that a professional basketball player during a competitive game in duration of 48 minutes changes movement 997  $\pm$  183 times with a direction change every 2 seconds (McInnes, Carlson, Jones, McKenna, 1995). Considering that during a regulation game period an average player performs approximately 105  $\pm$  52 high-intensity sprints, we can conclude that 15% of game time is spent at a high-intensity level (McInnes, Carlson, Jones, McKenna, 1995). Sport specific and sport performance coaches are always in search of any variable that can serve as a reliable and valid indicator for the overall sport performance. For a long time, development of athlete strength characteristics, especially lower body, was believed to be highly correlated with improvement in overall athletic performance. While it is beneficial for basketball players to possess certain levels of upper body strength, exponential improvements in squat 1RM performance demonstrated superior

relationship with maximal vertical jump, speed and agility variables when compared to improvements in 1RM bench press (Hoffman, Tenenbaum, Maresh, Kraemer, 1996). Besides direction changes (i.e., agility), ability to quickly cover the distance and rapidly accelerate can be highly beneficial during fast break opportunities. Considering that a length of an NBA basketball court is 28.65m, the ability to beat the defender and gain an initial sprint advantage can lead to a potential scoring opportunity. When studying a cohort of elite basketball players, researchers found that 5m and 10m sprint performances were highly correlated with lower body 1RM squat values, which emphasized the importance of incorporating squat as one of the most fundamental lower body exercises in a typical strength and conditioning program for basketball players (Chouchani, Brughelli, Chamari, Levin, Abdelkrim, Laurencille, Castagna, 2009). Furthermore, while lower body strength is highly related to change of direction performance, eccentric maximal strength by itself can serve as a reliable indicator of change of direction ability (Spiteri, Nimphius, Hart, Specos, Sheppard, Newton, 2014). A recent meta-analysis demonstrated the importance of lower body resistance training and strength transfer for sprint performance improvements up to 3.11% (Seitz, Reyes, Tran, deVillarreal, Haff, 2014). Other research has emphasized the importance of sport performance tests that are highly applicable to the nature of the sport and playing position. It is suggested that 5m and 10m sprint ability combined with agility tests such as a T-test or 5-0-5 test, should be incorporated into power-related testing since they highly correlate with on-court basketball performance (Wen, Dalbo, Burgos, Pyne, Scanian, 2018). Based on previously reported data, we can recognize the importance of properly designed strength and conditioning programs focused on enhancing in-game basketball performance requirements.

In the game of basketball, there are five distinct playing positions: point-guard, shooting-guard, small-forward, power-forward and center. It is important to consider that anthropometric differences and on-court tasks are not identical and are highly dependent on playing position which can greatly influence physiological demands. Previous research has revealed significant differences in anthropometric characteristics between playing positions even though these differences were not significant selection criteria for professional levels of play (Sallet, Perrier, Ferret, Vitelli, Baverel, 2005; Delextrat, Cohen, 2009). When Wingate anaerobic tests, suicide runs, T-tests and single leg jump tests were administered to national caliber female basketball players, it was found that guards possess superior peak and mean power outputs compared to forwards for each of these tests (Delextrat, Cohen, 2009). A similar study focusing on professional male basketball players found that T-test, 10m and 30m sprint performance were superior for forwards and guards when compared to centers, however centers exhibited greater lower body leg flexor strength (Koklu, Alemdaroglu, Kocak, Erol, Findikoglu, 2011). It has also been reported that  $\text{VO}_2$  max capacities for male basketball players can range between 42-59  $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  and indicated that despite non-significant differences guards tend to have higher  $\text{VO}_2$  max values on both professional and collegiate levels of competition (Hoffman, 2003; Sallet, Perrier, Ferret, Vitelli, Baverel, 2005). However, basketball players need to rely on aerobic capacity, and research indicates that anaerobic capacity is a greater predictor for level of competition than aerobic capacity (Hoffman, 2003; Sallet, Perrier, Ferret, Vitelli, Baverel, 2005). Additionally, basketball shooting performance is highly correlated with anaerobic capacity and explosive power (Pojskic, Sisic, Separovic, Sekulic, 2018). Besides differences in playing position, training regimen and anaerobic capacity, Gonzales and colleagues found that starters at the collegiate basketball level of competition were more likely to have higher vertical jump power outputs compared to non-starters. Similarly, starters at the NBA level of competition had greater capability to increase vertical jump power even though squat power values were not significantly different from non-starters (Gonzales, Hoffman, Rogowski, Burgos, Manalo, Weise, Fragala, Stout, 2013; Gonzales, Hoffman, Scallin-Perez, Stout, Fragala, 2012).

Each year, basketball players have a chance to participate in the NBA draft combine where each basketball player demonstrates their performance capabilities. When body size, power-quickness and upper-body strength were observed, surprisingly body size was one of the most significant positive markers for determining successful future basketball performance, while power-quickness did not reach significance (Teramoto, Cross, Rieger, Maak, Willick, 2018). The findings of this study are contrary to our expectations and the previously mentioned research emphasizing the importance of power-quickness characteristics. In addition, it is important to mention that the NBA possesses a specific playing style where a major emphasis is placed on scoring. Even though steals, and offensive and defensive rebounds play critical roles in the overall quality of a player, the ability to score is an important skill for future success. Furthermore, it was reported that the ability to score during a collegiate career is positively related to future NBA draft positions (Berri, Brook, Fenn, 2011).

It is interesting to note that lower body strength testing is not integrated into NBA draft combine procedures. Based on the previously presented research we can assume that there is a potential positive relationship between lower body strength and power and on-court playing performance. Even though physical and performance testing at the NBA draft combine have been effective for many years, we also realize that additional forms of athlete testing of collegiate basketball players may potentially help identify important performance characteristics that contribute to later professional capabilities. Hence, the purpose of this study was to determine the qualities of lower body strength and power for male collegiate basketball players who subsequently play professional basketball. Our hypothesis was that lower body muscular strength and power measures obtained during barbell squat testing may serve as good indicators for prospective drafting success and the ability to compete in various professional basketball leagues.

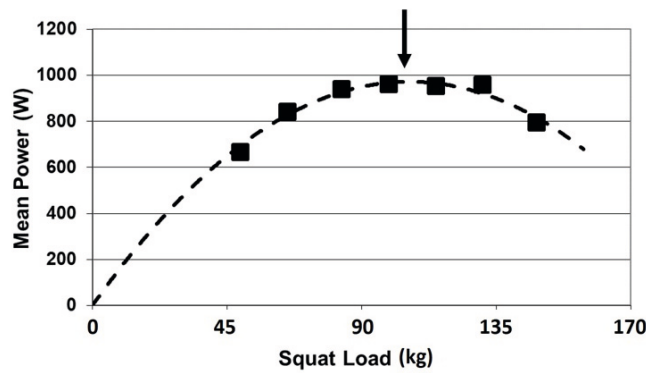
## METHODS

Members of an NCAA Division-I collegiate men's basketball team over a seven year period were subjects for this study ( $n=37$ ;  $X\pm SD$ , age= $20.0\pm 1.4$  years, height= $1.98\pm 0.09$  m, body weight= $94.5\pm 11.8$  kg). Data were analyzed for each player who had completed his collegiate playing career. This was either due to using all years of their playing eligibility (4 or 5 years) according to NCAA regulations, or due to becoming a professional player before their eligibility was completed. Players were divided into three groups; one group who continued playing basketball professionally in the National Basketball Association (NBA;  $n=10$ ), another group who played professionally in the other basketball leagues around the world (Pro;  $n=8$ ), and the final group who did not continue to play basketball after their collegiate careers were completed (Non-Pro;  $n=19$ ).

Maximal parallel barbell squat strength (1 repetition maximum; 1RM) was determined during a regular weight room training session, from which loads were determined for each subject at 30%, 40%, 50%, 60%, 70%, 80% and 90% 1RM. Squat power testing was performed during a training session approximately two weeks later. After a brief warm-up, each subject was instructed to perform 1-3 maximal effort speed-squats at each intensity, with increasing loads for each set. As the load increased, subjects were allowed to perform fewer repetitions per set with the minimum being one repetition at the highest load. Each subject descended at a volitionally controlled velocity, followed by a maximal velocity ascension from the bottom position. Proper depth for each squat was determined by one or more members of the testing team. Acceptable squat depth in this study was set as the posterior thigh parallel to the ground. Repetitions that did not descend to appropriate squat depth were not recorded.

Squat mean powers for the barbell were determined in one of two manners. Initially, an external dynamometer (Tendo, Fitrodyne, Bratislava, Slovakia) was attached by a nylon tether to the end of the barbell (Eleiko, Halmstad, Sweden) to determine mean barbell power. Barbell loads to the nearest kg (no body mass) were entered into the external dynamometer, so the results represent external barbell power. Results were monitored for each load to determine when power began to decrease with increasingly heavier loads. In the event that the mean power recorded had not begun to decrease at the highest intensity, additional heavier loads (5-7% increases) were lifted until mean power exhibited a decrease. Data collected in the later stages of the study were collected using a 3-D camera motion capture system that monitored barbell movements (EliteForm, Lincoln, NE). This system sampled data at 30 Hz, and calculated kinetic and kinematic variables of interest in a manner similar to the Tendo unit. Agreement between these devices for mean power during the barbell squat exercise at all measured relative intensities was consistently within the 95% CI and exhibited a mean difference between the testing modalities of 17.5 W (unpublished data).

The repetition with the greatest mean concentric bar power for each relative load was used for data analysis. For each subject, a 2<sup>nd</sup> order polynomial regression, forced through the origin, was calculated to find the line of best fit for the bar power-load relationship. The peak of each subject's bar power-load curve was identified as the individual's maximum squat bar power. An example curve with the resulting maximum power is shown in Figure 1.



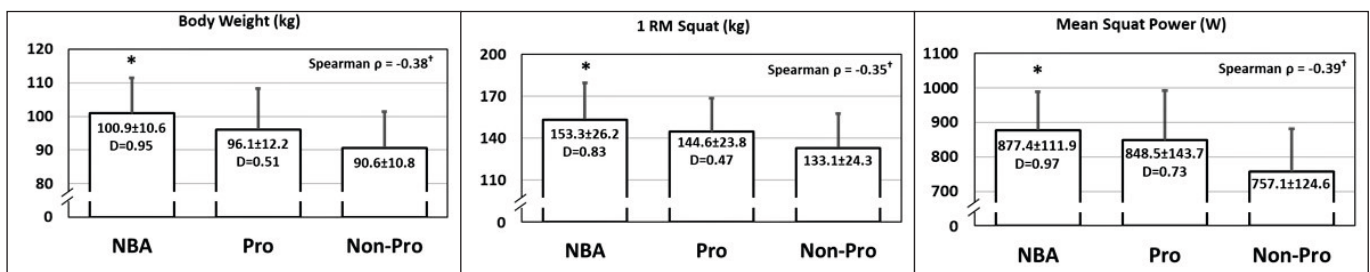
**Figure 1.** Example curve for a squat bar power-load curve as used in the present study.  
 A 2<sup>nd</sup> order polynomial curve that was fitted to the data and forced through the origin.  
 The maximum bar power is indicated by the arrow.

**Statistical Analyses**

Results are reported as X±SD. A 1 x 3 ANOVA was used to determine differences between the three groups of subjects, with significant main effects further examined with Tukey HSD post hoc analyses. Additionally, Cohen’s D effect sizes using pooled group standard deviations were used to compare group data as compared to the Non-Pro group. Spearman rho (ρ) correlations identified relationships between subject groups and maximum squat power. Additionally, a X<sup>2</sup> analysis was used to determine if each of the player positions (i.e., centers, forwards, guards) were similarly represented in each subject group (NBA, Pro or Non-Pro). The resulting data for each subject was analyzed using SPSS statistical software (Version 25, SPSS Inc. Chicago, IL, USA). Due to the exploratory nature of this project, significance levels were set at p<0.10.

**RESULTS**

Results of the group comparisons indicate significant differences between the NBA and the Non-Pro groups for body weight, 1RM squat strength, and maximum squat bar power (p<0.10; see Figure 2). When squat strength and bar power were adjusted for body weight, no differences between groups were observed (data not shown). Spearman ρ correlation coefficients between the player groups and body weight, 1RM squat strength, and maximum squat bar-bell power were all significant (p<0.05). Additionally, effect sizes for the NBA group compared to the Non-Pro group were large for every variable (D= 0.83-0.97), and moderate to moderately-large for the Pro group (D= 0.47-0.73). A X<sup>2</sup> analysis indicated there were no differences between groups for player position distributions (p<0.05).



**Figure 2.** Group comparisons (X±SD) for body weight, 1 RM squat strength, and maximum squat bar power.

NBA (n=10) are players drafted by the NBA, Pro (n=8) are players who signed contracts with other professional leagues, and Non-Pro (n=19) are players who did not play after college. \*p<0.10 different from Non-Pro †p<0.05 for Spearman ρ correlations.

## DISCUSSION

Based on our findings, high levels of lower body strength and power of collegiate basketball players are associated with the future ability to compete at professional levels of competition. The barbell squat is one of the most fundamental lower body exercises, and is often incorporated into resistance training regimens of basketball players. With the development of technology designed to measure and record resistance exercise kinetic and kinematic data during individual training sessions and over long training phases, we are now capable of quantifying important variables that may be associated with future performances and the ability to compete at the highest level of basketball competition, the NBA.

There are number of previous reports across a broad spectrum of sports that demonstrated strong relationships between weight room performances and sport performances (*Kraemer, Ratamess, Fry, Triplett-Mcbride, Koziris, Bauer, Lynch, Fleck, 2000; Lucero, Fry, LeRoux, Hermes, 2019; Fry, Honnold, Hudy, Roberts, Gallagher, Vardiman, Dellasega, 2011, Fry, Kraemer, Weseman, Conroy, Gordon, Hoffman, Maresh, 1991*). Furthermore, one of the studies reported differences in performance characteristics between three American football divisions of the National Collegiate Athletic Association (NCAA) level of play, and found that tests such as vertical jump, sprint ability and power cleans were significantly different among the groups (*Fry, Kraemer, 1991*). The cohort of basketball players analyzed in the present study was purposely recruited by the coaching staff to play at one of the highest ranked basketball programs in NCAA Division-I level. It is assumed that their performance and basketball playing skills were highly superior compared to many of their peers, thus, attracting interests of the basketball coaches and resulting in the opportunity to compete at this level of competition. Even within this elite cohort of basketball players, however, individual differences in performance variables were obvious. Our subject pool included all basketball players that were eligible to compete within the span of seven basketball seasons. This time frame also included high level prospects that pursued an NBA career upon completion of just one year of playing eligibility at the collegiate level. Regardless of their length of stay at the collegiate level of competition, our results indicate that as long as player's lower body strength and power may have contributed to their ability to secure playing position at the NBA level of competition or other professional levels.

In addition, when physical performance variables were observed between three professional divisions in a European professional basketball league, Korkmaz et al. found that the major factors that could potentially be used to distinguish between an individual's ability to play at their particular level of competition were vertical jump performance and lean body mass (*Korkmaz, Karahan, 2012*). Even though vertical jump was not measured in the present study, it is well-established that improvements in 1RM squat strength is positively related with improvements in vertical jump performance (*Comfort, Stewart, Bloom, Clarkson, 2014; Channell, Barfield, 2008; Wisloff, Castagna, Helgerund, Jones, Hoff, 2004*). Therefore, we may assume that our observations of statistically significant differences between the NBA players and the other groups are related to the findings of the Korkmaz et al. (*Korkmaz, Karahan, 2012*). In addition, since heavy squats are consistently being performed in the weight lifting room, we can potentially use these already collected data as valid and reliable measures in additions to other assessments such as vertical jump testing. With performance monitoring devices such as used in this study, we may be able to decrease testing times and establish supplementary variables of interest that can provide us with a better understanding of individual athletic performance potential.

A recently published article indicated that the average height for all the players participating in the NBA in 2008 was 195.6cm, which is slightly lower when compared to the 198cm average height of the players participating in this study (Davidson, 2011). It has been reported that body size is one of the most important factors for selection success in the NBA draft (*Teramoto, Cross, Reiger, Maak, Willick, 2018*). Based on our data, we can conclude that lower body strength and power, as examined in this study, might provide an additional insight besides body size that would aid in determining prospects for the future NBA draft potential. Future research should focus on determining how weight room performance variables translate to competition performances in other sports, and which other kinetic and kinematic variables should be incorporated.

## CONCLUSION

In conclusion, these data supports the importance of lower body strength and power for enhanced opportunities to play at the professional level in men's basketball. Lower body strength and power were related to post-collegiate

playing opportunities, with greater values being related to higher levels of professional play. Each of these variables are readily enhanced with a properly designed strength and conditioning program, suggesting that including exercises that enhance muscle hypertrophy as well as strength and power such as squats and power cleans should be included in a regular training program for this sport.

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# BODY MASS INDEX AND MOTOR STATUS OF PRESCHOOL CHILDREN

# INDEKS TELESNE MASE I MOTORIČKI STATUS PREDŠKOLSKE DECE

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**Abstract:** The purpose of this study is to establish the existence of gender differences in motor skills in the preschool period as well as to check their nutritional status. The classification of their nutritional status has been performed based on their body mass index (BMI), based on the percentile values according to Centers for Disease Control and Prevention, (2000). Total sample consisted of 188 examinees with average values of body height (BH=124.59 cm±5.76) and body weight (BW=24.32 kg±3.11) with average age of 6.39±0.44 years, out which boys (N=107) and girls (N=81). Non-experimental research design, ex post facto correlation research plan, has been used. The battery with seven motor tests according to Bala and Popović (2007), has been used in this research. The study results show that the prevalence of malnourished children is 10.64%, well nourished 72.34%, tending to become obese 9.57% and obese children 7.44%, also with the existing gender difference in motor abilities in favour of better average values of boys in coordination, explosive and repetitive strength. The research results show that there is the satisfying percentage of normally nourished children and that the linearity of their nutritional status is in accordance with their motor status, growth and development. On the other hand, the perceived gender difference are present due to differentiation of motor abilities that occurs at this age. The authors point out that greater differences and variability regarding the level of nourishment and motor abilities of children can be expected only in prepuberty period, which will happen in the next phase.

**Keywords:** body mass index, motor skills, preschool age, differences.

**Apstrakt:** Cilj studije bio je utvrditi postojanje polnih razlika u predškolskom uzrastu u motoričkim sposobnostima i proveriti stanje njihove uhranjenosti. Klasifikacija hranjivog statusa izvršena je prema indeksu telesne mase (ITM), na osnovu percentilnih vrednosti prema Centers for Disease Control and Prevention, (2000). Ukupan uzorak sastojao se od 188 ispitanika sa prosečnim vrednostima telesne visine (TV=124,59 cm±5,76) i telesne težine (TM=24,32 kg±3,11), prosečne starosti 6,39±0,44 godine od kojih dečaka (N=107) i devojčica (N=81). Korišćen je neeksperimentalni istraživački dizajn, ex post facto korelacijski nacrt istraživanja. U istraživanju je korišćena baterija od sedam motornih testova prema Bala i Popović (2007). Rezultati studije pokazuju da je prevalenca neuhranjene dece 10,64%, normalno uhranjene 72,34%, rizično gojazne 9,57% i gojazne 7,44%, kao i da postoje polne razlike u motoričkim sposobnostima u korist boljih prosečnih vrednosti dečaka u koordinaciji, eksplozivnoj i repetitivnoj snazi. Rezultati istraživanja pokazuju da postoji zadovoljavajući procenat normalno uhranjene dece i da je linearnost njihovog nutritivnog statusa u skladu sa njihovim motoričkim statusom, rastom i razvojem. S druge strane, uočene polne razlike su prisutne zbog diferencijacije motoričkih sposobnosti koja nastaje u ovom periodu. Autori ističu da se veće razlike i varijabilnosti u pogledu stanja uhranjenosti i motoričkih sposobnosti dece mogu očekivati tek u prepubertetskom periodu.

**Ključne reči:** indeks telesne mase, motoričke veštine, predškolski uzrast, razlike.

## INTRODUCTION

If physical activity is considered to be a phenomenon, even the basic type of physical activity, not programmed and planned cycle, is undoubtedly of great importance for the health of human population. Apart from prevention and a decrease of children's overweight and obesity, which a decade ago included about 22 million of children all over the world (WHO, 2008), physical activity is also connected in a positive way with cardiovascular status, muscular strength and endurance, decrease of depression and anxiety (Stron et al, 2005). Ever since then, a lot of attention has been paid to insufficient physical activity, so WHO (2000) classifies it as a risk factor and makes it as equal as risk which hypertension and obesity had back then (Pelemiš et al., 2015). The problem of physical (in)activity had been identified long time ago by National Association for Sport and Physical Education (NASPE, 2002), which published a guide for children, who need at least 60 minutes of planned physical activity on a daily basis.

On the other hand, the acquired motor skills and developed motor abilities are fundamental factor of children's motor competence, that is aptitude (Stamatović, Sekeljić, Martinović & Pelemiš, 2019) based on which it is possible to monitor the compliance and deviation of children's development. The level of development of children's motor abilities influence to a great degree on their regular further growth and development (Pelemiš, Branković & Banović, 2016). When it comes to preschool children, motor abilities have their distinctiveness. Throughout that period, motor abilities are characterized by significant variability, not fully built and inadequately defined motor structures which are still closely interconnected (Pelemiš et al., 2019a). The development of motor abilities moves in accordance with certain laws and is similar to ontogenetic body development (Pelemiš & Džinović-Kojić, 2018), and main features of that development are: heterochrony (intense development at different ages), synphasy (development of abilities matches), rhythm (occurrence in certain, relatively regular rhythm) and sensibility (sensitivity of organism to physical activity). Because of that, children who are overweight are prone to lower practice of physical activity and worse motor index (Planinsec & Matejek, 2004). Therefore, insufficient physical activity can be connected to the increase of obesity with children, as indicated in research of Mendonac & Anjos, (2004).

After discoveries on the results of previous researches, the flaw which has so far appeared in the the studies of similar character is the insufficient number of findings which point to facts on constant monitoring of motor abilities with preschool children, before enrolling school, at ex-

## Uvod

Ako se fizička aktivnost smatra fenomenom, pa čak i osnovnim oblikom fizičke aktivnosti, a ne programiranim i planiranim ciklusom, njegova je važnost za zdravlje ljudske populacije nesumnjiva. Osim prevencije i smanjenja dečje prekomerne težine i gojaznosti, koja je pre deceniju uključivala oko 22 miliona dece širom sveta (WHO, 2008), fizička aktivnost je takođe pozitivno povezana s kardiovaskularnim statusom, mišićnom snagom i izdržljivošću, smanjenjem depresije i anksioznosti (Strong et al., 2005). Otada se mnogo pažnje posvećuje nedovoljnoj fizičkoj aktivnosti, te je WHO (2000) klasifikuje kao faktor rizika i izjednačava je sa rizikom koji su do tada imali hipertenzija i gojaznost (Pelemiš et al., 2015). Problem fizičke (ne)aktivnosti dugo je identifikovan od strane National Association for Sport and Physical Education (NASPE, 2002) koji je izdao vodič za decu za koje je potrebno najmanje 60 minuta planirane fizičke aktivnosti dnevno.

Sa druge strane, stečene motoričke veštine i razvijene motoričke sposobnosti su fundamentalni faktori dečje motoričke kompetencije, odnosno spremnosti (Stamatović, Šekeljić, Martinović i Pelemiš, 2019), na temelju kojih je moguće pratiti sklad i odstupanja dečjeg razvoja. Step en razvijenosti motoričkih sposobnosti dece uveliko zavisi o njihovom daljnjem pravilnom rastu i razvoju (Pelemiš, Branković i Banović, 2016). Kada su u pitanju predškolci, motoričke sposobnosti imaju svoje specifičnosti. Tokom tog perioda motoričke sposobnosti karakterišu značajna varijabilnost, nepotpuno izgrađene i neadekvatno definisane motoričke strukture koje su još uvek usko međusobno povezane (Pelemiš et al., 2019a). Razvoj motoričkih sposobnosti protiče u skladu sa određenim zakonitostima i sličan je ontogenetski razvoju organizma (Pelemiš i Džinović-Kojić, 2018), a glavne karakteristike razvoja su: heterohronost (intenzivan razvoj u različitim razdobljima), sinfaznost (razvoj sposobnosti se poklapa), ritmičnost (javljanje u određenom relativno pravilnom ritmu) i senzibilnost (osetljivost organizma na fizičku aktivnost). Zbog toga deca s preteranom telesnom težinom sklona su manjem upražnjavanju fizičkih aktivnosti i imaju lošiji motorički indeks (Planinsec i Matejek, 2004). Iz tih razloga nedovoljnu fizičku aktivnost možemo povezati s povećanjem gojaznosti kod dece, na što ukazuju istraživanja Mendonca i Anjos, (2004).

Nakon saznanja o nalazima dosadašnjih istraživanja, nedostatak koji je do sada proveden u studijama sličnog karaktera bi se ogledao u nedovoljnom broju nalaza koji ukazuju na činjenice o konstantnom praćenju motoričkih sposobnosti kod predškolske dece pre upisa

actly this age. Therefore, this study should give answers to questions if there are some significant gender differences, if they are in accordance with most findings got at a pre-school age, as well as to compare BMI values with the referent values for this age.

The purpose of this research was to establish the existence of gender differences with children of preschool age in motor abilities, and then establish their BMI values.

## MATERIAL AND METHOD

The research was of transversal character. The plan of non-experimental research, to be more precise *ex post facto*, was used. According to character of scientific research, for the purpose of the applied methods, empirical method was used, while according to the knowledge connected to this problem, an affirmative method was used. According to the level of control, half-field method was used. Total sample consisted of 188 examinees, at the age of  $6.39 \pm 0.44$ , out of which 107 boys (56,91%), at average age of  $6.44 \pm 0.50$  years and the following values:  $BH = 124.42 \pm 5.66$  cm;  $BM = 24.77 \pm 2.82$  kg and  $BMI = 16.03 \pm 1.72$  kg/m<sup>2</sup>, and 81 girls (43.09%) from total sample, at the average age of  $6.34 \pm 0.35$  years,  $BM = 124.77 \pm 5.87$  cm;  $BM = 23.88 \pm 3.35$  kg and  $BMI = 15.35 \pm 1.93$  kg/m<sup>2</sup>, who attended preschool institution Čukarica in Belgrade (The Republic of Serbia). Children's parents got a survey questionnaire before the research, where study deadline and the process itself were marked, so they approved the research on their children by giving their signature (Declaration of Helsinki, 2013).

As a sample of the measuring instrument the following anthropometrical measures were chosen: I For estimation of skeleton longitude dimensionality 1) *Body height* (cm) – it was measured with the help of anthropometer by Martin; II For estimation of body mass and volume 2) *Body mass* (0.1 kg) – it was measured by decimal medical scales. Based on those two measured variables we calculated 3) *Body Mass Index* (kg/m<sup>2</sup>), in accordance with the classification regulated by National Institutes of Health (1998). The examinees were then grouped based on their reference values of BMI, and based on the percentile values regulated by Centers for Disease Control and Prevention (2000) to the following subsamples: 1)  $\leq 5$  percentiles-malnourished; 2) from 5-85 well nourished 3) from 85.01-95 tending to become obese and 4) 95.01 obese.

$$BMI = BM/(BM)^2$$

**Legend:** *BMI* – Body Mass Index; *BM* – Body Mass; *BH* – Body Height

u školu, upravo u ovom uzrasnom periodu. S toga bi ova studija trebala dati odgovore na pitanja da li postoje značajne polne razlike, te da li su u skladu sa većinom nalaza dobijenih na ovom predškolskom uzrastu, kao i uporediti vrednosti ITM sa referentnim vrednostima za ovaj uzrast.

Cilj istraživanje bio je utvrditi postojanje polnih razlika dece predškolskog uzrasta u motoričkim sposobnostima, te utvrditi njihove vrednosti ITM.

## MATERIJAL I METOD

Istraživanje je bilo transverzalnog karaktera. Koristio se nacrt neeksperimentalnih istraživanja, tačnije *ex post facto* nacrt. Prema prirodi naučnih istraživanja, u svrhu primenjenih metoda korištena je empirijska metoda, dok se prema znanju problema koristila potvrdna metoda. Prema stepenu kontrole primenjena je polu-terenska metoda. Ukupak uzorak sačinjavalo je 188 ispitanika  $6,39 \pm 0,44$  godina. Od toga 107 dečaka (56,91%) ukupnog uzorka, prosečnog uzrasta  $6,44 \pm 0,50$  godina sa vrednostima  $TV = 124,42 \pm 5,66$  cm;  $TM = 24,77 \pm 2,82$  kg i  $ITM = 16,03 \pm 1,72$  kg/m<sup>2</sup>, te 81 devojčice (43,09%) ukupnog uzorka, prosečne starosti  $6,34 \pm 0,35$  godina  $TV = 124,77 \pm 5,87$  cm;  $TM = 23,88 \pm 3,35$  kg i  $ITM = 15,35 \pm 1,93$  kg/m<sup>2</sup>, koji su bili polaznici predškolske ustanove PU Čukarica u Beogradu (Republika Srbija). Roditelji dece dobili su anketni upitnik pre ankete, u kome je bio naznačen plan i tok studije, te su svojim potpisima odobrili istraživanje na njihovoj deci (Declaration of Helsinki, 2013).

Kao uzorak mernih instrumenata izabrane su osnovne antropometrijske mere: I Za procenu longitudinalne dimenzionalnosti skeleta 1) *Telesna visina* (cm) – bila je izmerena uz pomoć antropometra po Martinu; II Za procenu volumena i mase tele 2) *Telesna masa* (0,1 kg) – bila je izmerena pomoću decimalne medicinske vage. Na osnovu te dve izmerene varijable izračunat je 3) *Indeks telesne mase* (kg/m<sup>2</sup>), sagledan prema klasifikaciji koju propisuje National Institutes of Health (1998). Ispitanici su dalje grupisani na osnovu referentnih vrednosti ITM, a prema percentilnim vrednostima koji su propisani od strane Centers for Disease Control and Prevention, (2000) na sledeće subuzorke: 1)  $\leq 5$  percentila-pothranjeni; 2) od 5-85 normalno uhranjeni 3) od 85,01-95 rizično gojazni i 4) 95,01 gojazni.

$$ITM = TM/(TV)^2$$

**Legenda:** *ITM* – Indeks telesne mase; *TM* – Telesna masa; *TV* – Telesna visina.

Body height was measured with anthropometer by Martin. Examinee was without shoes, standing on the flat surface, with heels pulled together, head in the position of „Frankfurt horizontal“. We measured the distance from the ground surface to the top of the head. The result is expressed in the values of 0.1 cm. Body Mass was measured by decimal medical scales. The examinee was standing on the device, wearing only underwear. The result is expressed in the values of 0.1 kg.

As a sample of measuring instruments for estimation of motor abilities with children of preschool age, standardized motor tests with good metric performances (validity, reliability, representiveness and homogeneity) have been used, based on the reduced theoretical model of Kurelić, Momirović, Stojanović, Šturm, Radojević & Viskić-Štalec, (1975) and Gredelj, Metikos, Hosek & Momirović, (1975) applied in the research of (Bala & Popović, 2007) checked on a big sample of the examinees, applying the following test battery: I For estimation of movement structuring factor: 1) *Backwards polygon* (0.1s); II For estimation of factor of excitement intensity of motor units: 2) *Long jump* (cm), 3) *Running 20 m from a high start* (0.1 s); III) For estimation of factor of functional synergy and muscular tonus: 4) *Hand tapping* (frec.), 5) *Bending with spread legs in a seating position* (cm); IV For estimation of duration factor with excitement of motor units; 6) *Sit-ups in 30 s* (frec.), 7) *Endurance in pull-ups* (0.1 s).

Out of all measuring instruments which are used for testing motor abilities, the following have been used in this research: stopwatch Polar C 112, frequency tapping board, whistle, colourful sticky bands, carpet with marked centimeters, springboard, metal measure tape, plastic table, sponge and chalk.

For statistical processing of data, statistical program SPSS Statistics for Windows, version 20, has been used. For all acquired data, calculation of basic parameters of descriptive statistics was performed: from measures of central tendency (M)–arithmetic mean; from measures of variability (S)–standard deviation. Testing normality of distribution has been performed applying Kolmogorov-Smirnov (KS) test. Then, based on percentile values, the examinees have been classified into four categories as follows: malnourished; well nourished; tending to become obese and obese. For establishing gender differences in the overall motor space, multi-variable variance analysis (Manova) has been used, and for establishing individual differences, One-Way Anova.

Telesna visina merena je antropometrom po Martinu. Ispitanik je bio bez cipela. Stajao je na ravnoj površini, pete skupljene, glava u položaju „frankfurtske horizontale“. Merila se udaljenost od podloge do teme na glave. Rezultat je izražen u vrednostima od 0,1cm. Telesna masa je izmerena pomoću decimalne medicinske vage. Ispitanik je stajao na uređaju odeven samo u donjem vešu. Rezultat je izražen u vrednostima od 0,1kg.

Kao uzorak mernih instrumenata za procenu motoričkih sposobnosti kod dece predškolskog uzrasta korišteni su standardizirani motorički testovi s dobrim metrijskim karakteristikama (valjanost, pouzdanost, reprezentativnost i homogenost), po redukovanom teoretskom modelu Kurelića, Momirovića, Stojanovića, Šturma, Radojevića, i Viskić-Štalcove, (1975) i Gredelja, Metikoš, Hošek i Momirović, (1975) primenjenom u istraživanju (Bala i Popović, 2007) proverenom na velikom uzorku ispitanika, te se primenjivala sledeća baterija testova: I Za procenu faktora strukturiranja kretanja: 1) *Poligon natraške* (0,1 s); II Za procenu faktora intenziteta ekscitacije motoričkih jedinica: 2) *Skok udalj iz mesta* (cm), 3) *Trčanje 20 m iz visokog starta* (0,1 s); III Za procenu faktora funkcionalne sinergije i regulacije tonusa: 4) *Taping rukom* (frec.), 5) *Preklon u sedu raznožno* (cm); IV Za procenu faktora trajanja ekscitacije motoričkih jedinica: 6) *Podizanje trupa za 30 s* (frec.), 7) *Izdržaj u zgibu podhvata* (0,1 s).

Od mernih instrumenata koji se koriste za ispitivanje motoričkih sposobnosti bili su korišćeni: štoperica Polar C 112, frekvenciona ploča za taping, pištaljka, obojene lepljive trake, tepih sa izvučenim centimetrima, odskočna daska, metalna merna traka, plastični stočić, sunder za brisanje i kreda.

Za statističku obradu podataka koristio se statistički program SPSS Statistics for Windows, version 20. Za sve dobijene podatke urađeno je izračunavanje osnovnih parametara deskriptivne statistike: od mera centralne tendencije (M) -aritmetička sredina; od mera varijabilnosti (S)-standardno odstupanje. Ispitivanje normalnosti distribucije provedeno je primenom testa Kolmogorov-Smirnov (KS). Dalje su ispitanici na temelju percentilnih vrednosti podeljeni u četiri kategorije i to: pothranjeni; normalno uhranjeni; rizične gojazni i gojazni. Za utvrđivanje polnih razlika u celokupnom motoričkom prostoru korištena je multivarijantna analiza varijance (Manova), a za određivanje pojedinačnih razlika One-Way Anova.

## RESULTS

Based on the coefficient values of *Body Mass Index* (BMI) table 1 shows the performed classification of subsamples which are further grouped according to percentile values into the following subsamples: 1)  $\leq 5$  percentiles-malnourished; 2) from 5-85 percentiles, the examinees of normal level of nourishment; 3) from 85,01–95 percentiles, tending to become obese 4) over 95,01 percentiles, obese.

Research results show that prevalence of malnourished children in total sample is 10,64%; well nourished 72,34%; tending to become obese 9,57% and obese 7,44%. After classification of total sample according to gender, it can be said there was 9,35% of malnourished boys, 71,03% of

## REZULTATI

Na osnovu vrednosti koeficijena *Indeksa telesne mase* (ITM) u tabeli 1, prikazano je i izvršeno razvrstavanje subuzoraka koji su dalje grupisani po percentilnim vrednostima u sledeće poduzorake: 1)  $\leq 5$  percentila-pothranjeni; 2) od 5-85 percentila ispitanici s normalnim stanjem uhranjenosti; 3) od 85,01–95 percentila s rizikom od gojaznosti 4) više od 95,01 percentila gojazni.

Rezultati istraživanja pokazuju da je prevalenca pothranjene dece u ukupnom uzorku 10,64%; normalno uhranjene 72,34%; rizično gojazne 9,57% i gojazne 7,44%. Nakon podele celog uzorka prema polu, može se reći da je pothranjenih dečaka bilo 9,35%, normalno

Table 1. Nourishment status within the sample / Tabela 1. Stanje uhranjenosti u uzorku

Nourishment Status Stanje uhranjenosti	Percentile BMI values Percentilne vrednosti ITM	Boys (kg/m <sup>2</sup> ) Dečaci (kg/m <sup>2</sup> )	Girls (kg/m <sup>2</sup> ) Devojčice (kg/m <sup>2</sup> )
Malnourished / Pothranjeni	<5	<13.78 (N=10 – 9.35%)	<13.50 (N=10 -12.35%)
Well Nourished / Normalno uhranjani	5-85	od 13.79 do 17.20 (N=76 – 71.03%)	od 13.51 do 17.40 (N=60 – 74.07%)
Tending to become obese / Rizično gojazni	85.01-95	Od 17.21 do 18.80 (N=13 – 12.15%)	Od 17.41 do 19.40 (N=5 – 6.17%)
Obese / Gojazni	<95.01	>18.81 (N=8 – 7.47%)	>19.41 (N=6 – 7.41%)

Table 2. Descriptive statistics and gender differences / Tabela 2. Deskriptivni statistici i polne razlike

Variable / Varijabla	Gender / Pol	AS	S	KSp	f	p
Backwards polygon (0.1s) / Poligon natraške (0.1 s)	Boys / Dečaci	197.42	45.47	0.01	4.09	0.04
	Girls / Devojčice	211.85	52.14	0.20		
Long jump (cm) / Skok udalj iz mesta (cm)	Boys / Dečaci	118.45	15.26	0.07	5.04	0.03
	Girls / Devojčice	113.33	15.80	0.01		
Running 20 m from a high start (0.1s) / Trčanje 20 m iz visokog starta (0.1 s)	Boys / Dečaci	51.31	4.40	0.01	3.68	0.06
	Girls / Devojčice	52.30	3.79	0.00		
Hand tapping (frec.) / Taping rukom (frek.)	Boys / Dečaci	18.57	3.48	0.00	0.02	0.90
	Girls / Devojčice	18.58	3.54	0.01		
Bending with spread legs in a sitting position(cm) / Pretklon u sedu raznožno (cm)	Boys / Dečaci	42.50	3.85	0.00	7.10	0.01
	Girls / Devojčice	44.46	4.52	0.05		
Sit-ups 30s (frec.) / Podizanje trupa 30s (frek.)	Boys / Dečaci	18.98	6.62	0.12	0.24	0.62
	Girls / Devojčice	18.47	6.73	0.01		
Endurance in pull-ups (0.1s) / Izdržaj u zgibu pothvatom (0.1 s)	Boys / Dečaci	145.67	101.29	0.00	1.10	0.30
	Girls / Devojčice	131.22	92.82	0.00		

$F=2.61$ ;  $P=0.01$

**Legend:** AS – arithmetic mean, S – standard deviation, KSp – level of statistical significance of Kolmogorov Smirnov coefficient f – univariant f test; p – level of statistical significance of f test; F – multivariant Wilks F test; P – statistical significance of multivariant F test.

**Legenda:** AS - aritmetička sredina, S - standardna devijacija, KSp - nivo statističke značajnosti Kolmogorov Smirnovljevog koeficijenta f – univarijantni f test; p – nivo statističke značajnosti f testa; F – multivarijantni Wilksov F test; P – statistička značajnost multivarijantnog F testa.

well nourished, 12,15% of the ones tending to become obese, and only 7,47% of obese boys. When it comes to girls, the percentage of malnourished girls is somewhat higher than the one with boys, which is 12,35%, well nourished are also slightly higher, which is 74,07%, girls tending to become obese are less when compared to boys, which is 6,17% and the percentage of obese is exactly the same, 7,41%.

Taking into account the values of multi-variant Wilks' F test and its significance presented in Table 2, it can be concluded that there is statistically significant difference between the samples of different genders, regarding their motor abilities, considering the overall system of the applied variables. These differences, from case to case, have been identified in variables for estimation of coordination, explosive strength of legs, in favour of boys and in variables for estimation of flexibility, in favour of girls.

## DISCUSSION

Observing study findings, directed at the establishment of gender differences among children of preschool period in their motor abilities and their BMI values, some significant differences can be noticed.

It needs to be pointed out that the study had 10.64% of malnourished children in total, and those data could not be fully connected with shortage of food in the previous period of life, but this fact could be connected to some seasonal variations and changes, and the way of eating. The opposite findings with one year younger sample of preschool children are set forth by Pelemiš, Branković & Banović (2016), pointing out to extremely high level of malnourished children, even 31.76% of total sample. Namely, children nowadays, and their way of eating in this part of Europe, do not deviate from the findings acquired in other developed countries, where it must be taken into account some age characteristics of children and periods of growth and development. Recent survey on the territory of Serbia, which analyzed the period of ten years, indicated the trend of increase in body height and decrease of BMI parameters (Pavlica, Rakić & Šironjić, 2017), which can be a consequence of migrations in this region, but also of the way of eating and partly of practicing some physical activity. The countries with the highest prevalence of obesity are Micronesia and Polynesia, where more than 38% of men and over 50% of women are obese (Radić, 2016). There is a growing obesity trend around the world, and in developed countries like the USA and Great Britain, the number of overweight people is higher than the number of people of normal body weight (NCD Risk factor collaboration, 2016.), which complies with the findings of this research. To be more specific, recent findings of the research in Serbia also show that the boys who are 7 years old are not much different than the

uhranjenih 71,03%, rizično gojaznih 12,15%, a gojaznih samo 7,47%. Kada se sagledaju devojčice, napominje se da je postotak pothranjenih devojčica nešto viši od dečaka i iznosio je 12,35%, normalno uhranjenih takođe neznatno više i iznosio je 74,07%, rizično gojaznih znatno manje kada se upoređi sa dečacima 6,17% i gojaznih gotovo isto 7,41%.

Uzimajući u obzir vrednosti multivarijantnog Wilksovog F testa i njegovu značajnost prikazanu u tabeli 2, zaključuje se da postoji statistički značajna razlika između uzoraka različitog pola u pogledu njihovih motoričkih sposobnosti, uzimajući u obzir celokupni sistem primenjenih varijabli. Ove razlike, od slučaja do slučaja, identifikovane su u varijablama za procenu koordinacije, eksplozivne snage nogu u korist dečaka i u varijabli za procenu fleksibilnosti u korist devojčica.

## DISKUSIJA

Gledajući nalaze studije usmerene na utvrđivanje polnih razlika dece predškolskog uzrasta u motoričkim sposobnostima i njihove vrednosti ITM, može se primetiti da se opažaju neke značajne razlike.

Treba naglasiti da je studija imala ukupno 10,64% pothranjene dece, a ti podaci se nisu u potpunosti mogli povezati s nedostatkom u ishrani u prethodnom periodu života, ali ova činjenica može biti povezana s nekim sezonskim varijacijama i promenama i načinu ishrane. Suprotne nalaze na godinu dana mlađem uzorku predškolske dece iznose Pelemiš, Branković & Banović (2016), te ukazuju na izrazito visok nivo pothranjene dece čak 31,76% ukupnog uzorka. Naime, današnja deca i njihov način ishrane u ovom delu Europe ne odstupaju od nalaza dobivenih u drugim razvijenim zemljama, pri čemu se moraju uzeti u obzir uzrasne karakteristike dece i periodičnosti rasta i razvoja. Nedavno istraživanje na području Srbije, koje je analiziralo period od deset godina, ukazalo je na trend povećanja telesne visine i smanjenja parametara ITM (Pavlica, Rakić & Šironjić, 2017), što može biti posledica migracija u ovoj regiji, ali i načina ishrane i jednim delom upražnjavanja fizičke aktivnosti. Zemlje sa najvećom prevalencom gojaznosti su Mikronezija i Polinezija, u kojima je više od 38% muškaraca i preko 50% žena gojazno (Radić, 2016). U svetu raste trend gojaznosti, a u razvijenim zemljama poput Sjedinjenih Američkih Država i Velike Britanije broj ljudi s prekomernom telesnom težinom veći je od broja ljudi s optimalnom telesnom težinom (NCD Risk factor collaboration, 2016.), što se ne podudara s nalazima iz ovog istraživanja. Konkretno, nedavni nalazi istraživanja u Srbiji takođe pokazuju da se dečaci stari 7 godina ne razlikuju značajno od

girls of the same age regarding BMI and body fat (Madić, Trajković, Popović, Radanović & Sporiš, 2017), which was not really the case in this research. In other parts of the world, Japan for example, with children of the same age (6 and 7), there is a lower percentage of fat tissue found with girls of preschool period, which is explained by the beginning phase of the early development. Namely, the cells are filled with fat before the phase of intense growth, later dominated by longitudinal dimensionality of skeleton, that is, the growth of bones in length. That is the signal for faster entrance into puberty phase with girls. Comparing these findings with the research of Pelemiš et al., (2019b) of some older sample of children from Serbia ( $7.27 \pm 0.43$  years of age), a higher percentage of malnourished children (3.87%) can be noticed, which points out the increase of percentage of malnourished children at preschool age, but also a usual phase of growth and development for this age, where the number of malnourished children decreases in years, as the ratio of fat and muscle tissue significantly changes.

The existence of significant differences in motor behaviour of children of different gender, which is confirmed in this research, is in accordance with the previous researches of Pavlović & Marinković (2013). The authors point to a significantly higher level of coordination and strength with boys. Better coordination with boys of preschool age on the same tests, in the same developing period is confirmed by Bala, Jakšić & Popović (2009). Furthermore, recent researches performed by Ujsasi, Bulatović & Kerić, (2014) show the domination of boys in coordination and strength. It is very interesting to notice the opposite findings, which do not support the results of this research, named by Aćimović (2013), and which point to a better coordination and flexibility with girls, and strength and preciseness with boys. Justification of the existing differences acquired in this study is connected with more versatile movement of boys and greater activity during this growing up. Better motor control of movement with boys can be result of more versatile moves. Therefore, it is, first and foremost, about the biotic motor knowledge, which speeds up work of central nervous system (CNS), coordination of moves, and achieve better inner and intermuscular coordination, which is expressed in better coordination of moves and higher explosive strength than the opposite sex examinees. Better performances of boys in the explosive strength can be explained with greater body activity, including greater presence and diversity of moves, especially „rough physical games“ (rough-and-tumble play) (Lindsey & Mize, 2001). Based on this, it can be concluded that motor functioning of children, especially boys, is still and in a great degree influenced by the mechanism for movement structuring, and that coordination, together with strength can be singled out and

devojkica iste dobi u smislu ITM i telesne masti (Madić, Trajković, Popović, Radanović & Sporiš, 2017), što u ovom istraživanju i nije bio slučaj. U drugim delovima sveta, na primer, u Japanu, kod dece u istoj uzrasnoj dobi (6 i 7 godina) manji je postotak masnog tkiva pronađen kod devojkica predškolskog uzrasta, što se objašnjava početkom faze ranog sazrevanja. Naime, ćelije se napune masnoćom pre faze intenzivnog rasta, kojom kasnije dominira longitudinalna dimenzionalnost kostura, tj. rast kostiju u dužinu. To je signal za brži ulazak u pubertet-sku fazu kod devojkica. Uspoređujući ove nalaze s istraživanjem Pelemiša i sar., (2019b) nešto starijeg uzorka dece iz Srbije ( $7.27 \pm 0.43$  godine), može se primetiti veći postotak pothranjene dece (3,87%), što ukazuje na porast postotka pothranjene dece u predškolskoj dobi, ali i uobičajenu fazu rasta i razvoja za ovaj uzrast, gde se broj pothranjene dece smanjuje sa godinama kako se omer masnog i mišićnog tkiva značajno menja.

Postojanje značajnih razlika u motoričkom ponašanju dece različitog pola, što je i potvrđeno u ovom istraživanju, u skladu je s dosadašnjim istraživanjima Pavlovića i Marinkovića (2013). Autori ukazuju na znatno viši nivo koordinacije i snage izražene kod dečaka. Bolja koordinacija dečaka predškolskog uzrasta na istim testovima u istom razvojnom periodu potvrđuju Bala, Jakšić i Popović (2009). Takođe, nedavna istraživanja koja su sprovedili (Ujsasi, Bulatović i Kerić, 2014) pokazuju dominaciju dečaka u koordinaciji i snazi. Vrlo je zanimljivo primetiti suprotne nalaze, koji ne podržavaju rezultate ovog istraživanja, koje je naveo Aćimović (2013), a koji ukazuju na bolju koordinaciju i fleksibilnost kod devojkica te snagu i preciznost kod dečaka. Opravdanje postojanja razlika dobijenih u ovoj studiji, povezano je s bogatijim kretanjem dečaka i većom aktivnošću tokom ovog odrastanja. Bolja motorička kontrola kretanja dečaka može proizlaziti iz raznolikih pokreta. Dakle, pre svega se radi o biotičkim motoričkim znanjima, koje ubrzavaju rad centralnog nervnog sistema (CNS), koordiniraju izvođenje pokreta, postižu bolju unutrašnju i intermuskularnu koordinaciju, što se ispoljava boljom koordinacijom pokreta i većom eksplozivnom snagom od ispitanika suprotnog pola. Bolje performanse dečaka u eksplozivnoj snazi mogu se objasniti većom telesnom aktivnošću, uključujući veću zastupljenost i raznolikost pokreta, posebno „grubih fizičkih igara“ (rough-and-tumble play) (Lindsey & Mize, 2001). Iz ovoga se zaključuje da na motoričko funkcionisanje dece, posebno dečaka, još uvek i u velikoj meri utiče mehanizam za strukturiranje kretanja, te da se koordinacija, zajedno sa snagom, može izdvojiti i prepoznati kao dominantna. Postoje različita istraživanja sa sličnim

identified as dominant. There are different researches with similar findings which point to the fact that coordination at this preschool age can be isolated as a general motor factor as well. Research points out to findings of general motor factor and motor behaviour of small children (Bala & Nicin, 1997; Pelemiš 2016), whereas there are different findings on differentiation of motor abilities in motor behaviour of children (Rajtmajer & Proje, 1990; Planinsec, 1995), and also by Russian authors (Popeska, Georgiev & Mitevski, 2009) and Ivanović in Serbia (2007).

Practical value of this paper is reflected in the initial evaluation of motor abilities and the nourishment status of children of preschool age, whereby we got a starting base for monitoring of their anthropological features. Therefore, such condition, achieved by transversal section of research, will considerably change in the following year, since those children will enter the phase of intensive growth, that girls' BMI values already show, and which is slightly lower compared to boys'. That is also confirmed by slightly higher values of body height in comparison to boys. Moreover, it needs to be pointed out that the acquired findings indicate to the fact that with girls, some additional treatment of physical activities, based on the development of coordination and in a great degree improvement of biotic motor skills, could be conducted.

Based on all above mentioned and the acquired research results, it can be concluded that there are significant differences in motor space of boys and girls in favour of better average values of boy in coordination, explosive and repetitive strength. Study results show that there is a satisfying percentage of well nourished children of both genders and that there is a linearity between their nourishment statuses, which is in accordance with their motor status, growth and development. The authors recommend some additional work with girls in the field of improvement of biotic motor skills and such programmes of kinesiology activities based on the development of coordination.

#### **Announcemet**

*We announce that the authors have equally contributed to this paper.*

#### **Conflict of interests**

*There is no conflict of interests among the authors themselves.*

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nalazima koji ukazuju na to da se koordinacija u ovom predškolskom uzrastu može izolovati i kao generalni motorički faktor. O nalazima generalnog motoričkog faktora i motoričkog ponašanja male dece ukazuju istraživanja (Bala i Nićin, 1997; Pelemiš, 2016), dok postoje različiti nalazi o diferencijaciji motoričkih sposobnosti u motoričkom ponašanju dece (Rajtmajer i Proje, 1990; Planinsec, 1995), zatim (Popeska, Georgiev i Mitevski, 2009) i u Srbiji Ivanović (2007).

Praktična vrednost rada ogleda se u inicijalnoj evaluaciji motoričkih sposobnosti i stanju uhranjenosti dece predškolskog uzrasta čime se dobila polazna osnova za praćenje njihovih antropoloških obeležja. Dakle ovo stanje dobiveno transversalnim presekom istraživanja će se znatno promeniti u narednoj godini jer će deca ući u fazu intenzivnog rasta na što već ukazuju vrednosti ITM kod devojčica, koji je nešto niži u odnosu na dečake. To takođe potvrđuju i neznatno veće vrednostima telesne visine devojčica u odnosu na dečake. Takođe treba istaći da dobijeni nalazi ukazuju na činjenicu da bi se sa devojčicama mogao sprovesti dodatni tretman fizičkih aktivnosti koji bi bio koncipiran na razvoju koordinacije i dobrim delom usavršavanjem biotičkih motoričkih znanja.

Na temelju svega navedenog i dobijenih rezultata istraživanja, može se zaključiti da postoje značajne razlike u motoričkom prostoru dečaka i devojčica u korist boljih prosečnih vrednosti dečaka u koordinaciji, eksplozivnoj i repetitivnoj snazi. Rezultati studije pokazuju da je zadovoljavajući postotak normalno uhranjene dece oba pola i da postoji linearnost između njihovog stanja uhranjenosti, koji je u skladu sa njihovim motoričkim statusom, te rastom i razvojem. Autori preporučuju dodatni rad sa devojčicama na polju unapređenja biotičkih motoričkih znanja i takve programe kinezioloških aktivnosti koji bi se temeljili na razvoju koordinacije.

#### **Izjava**

*Izjavljujemo da su autori podjednako doprineli radu.*

#### **Konflikt interesa**

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## INFLUENCE OF BASIC-MOTOR ABILITIES ON EFFICIENCY OF REALIZATION OF SPECIFIC MOTOR TASKS IN SWIMMING

## UTICAJ BAZIČNO-MOTORIČKIH SPOSOBNOSTI NA EFIKASNOST REALIZACIJE SPECIFIČNIH MOTORIČKIH ZADATAKA U PLIVANJU

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**Abstract:** The research was conducted on a sample of 70 respondents-swimmers aged 13-15 years of swimming clubs from Sarajevo Canton/Federation of B&H, with the aim of determining the significance and magnitude of the impact of selected basic motor skills on the implementation of specific motor tasks in swimming (navigability in place, sliding length with reflection from water, start from starting block, parallel). The study used 10 variables to assess basic motor skills, which were the input or predictor set of variables, and three variables to assess the efficiency of specific motor tasks in swimming as a criterion, each variable from the battery of specific motor tasks was considered as a criterion on the predictor set of basic-motor variables.

Three mini regression analyzes were applied to determine the statistical significance and relative influence of basic motor skills on the realization of specific motor tasks in swimming (buoyancy in place, length of sliding with reflection from water, start from the starting block, parallel). The results of regression analyzes indicate that the greatest influence on the overall efficiency in the implementation of specific motor tests in swimming, looking at all criterion variables together, from the set of basic-motor variables, as a predictor set, show the following variables: stick twist-MFLISK MFLPRK, plantar flexion-MFLPL, long jump from place-MFESDM, agility on the ground-MKOKNT and shelter in lying-MRCZTL.

The results obtained in this research can be useful for teachers and swimming trainers who work with younger age categories for the purpose of better programming of training work and selection of training content.

**Keywords:** efficiency, basic motor skills, young swimmers, specific motor tasks, regression analysis.

**Apstrakt:** Istraživanje je provedeno na uzorku od 70 ispitanika-plivača uzrasta 13 – 15 godina plivačkih klubova iz Kantona Sarajevo/Federacija BiH, s ciljem utvrđivanja značaja i veličine uticaja odabranih bazično-motoričkih sposobnosti na realizaciju specifičnih motoričkih zadataka u plivanju (plovnost u mjestu, dužina kliženja sa odrazom iz vode, start sa startnog bloka, paralelni). U istraživanju je primijenjeno 10 varijabli za procjenu bazično-motoričkih sposobnosti koje su predstavljale ulazni ili prediktorski skup varijabli i tri varijable za procjenu efikasnosti realizacije specifičnih motoričkih zadataka u plivanju kao kriterija pri čemu je svaka varijabla iz baterije specifičnih motoričkih zadataka posmatrana kao kriterij na prediktorski skup bazično-motoričkih varijabli.

Za utvrđivanje statističke značajnosti i relativnog uticaja bazično-motoričkih sposobnosti na realizaciju specifičnih motoričkih zadataka u plivanju (plovnost u mjestu, dužina kliženja sa odrazom iz vode, start sa startnog bloka, paralelni) primijenjene su tri mini regresione analize.

Rezultati regresionih analiza ukazuju da najveći uticaj na ukupnu efikasnost u realizaciji specifičnih motoričkih testova u plivanju, posmatrajući sve kriterijske varijable zajedno, iz seta bazično-motoričkih varijabli, kao prediktorskog seta, pokazuju sljedeće varijable: iskret sa palicom-MFLISK, duboki pretklon na klupici-MFLPRK, plantarna fleksija-MFLPL, skok u dalj iz mjesta-MFESDM, okretnost na tlu-MKOKNT i zaklon u ležanju-MRCZTL.

Dobijeni rezultati u ovom istraživanju mogu biti od koristi nastavnicima i trenerima u plivanju koji rade sa mlađim uzrasnim kategorijama u svrhu kvalitetnijeg programiranja trenažnog rada i izbora trenažnih sadržaja.

**Gljučne reči:** efikasnost, bazično-motoričke sposobnosti, mladi plivači, specifični motorički zadaci, regresiona analiza.

## INTRODUCTION

Knowledge of the influence of certain anthropological abilities on the efficiency in the realization of specific tasks in a certain sports discipline and achieving high sports results is the starting point for quality programming and implementation of both teaching and training process. If it is known which anthropological abilities participate in achieving high efficiency in a sport, and if it is known how much each dimension and tests of these abilities can contribute to the assessment of fitness, then it is possible to establish such a system of programmed work (teaching or training) that will affect to improve precisely those abilities that will most contribute to the achievement of that success (Platonov, 1997). The influence of basic motor skills on the realization of specific motor tasks in different sports disciplines has been a research problem of many researchers (Katić, Maleš & Miletić, 2002; Metikoš et al., 1982; Momirović et al., 1984; Otte, 1999; Popo, 2010; Mirvić et al., 2018). Motor abilities are those human abilities that participate in solving motor tasks and condition successful movement, regardless of whether they were acquired through training or not (Malacko & Rađo, 2004). Motor skills are very complex, with different birth rates and different possibilities for their improvement in different periods of children's development. Some motor skills are genetically conditioned with a high innate coefficient (speed, explosive power, coordination, balance, precision), and some with a lower innate coefficient (endurance, repetitive and static power). The development of motor abilities is uneven, because some motor abilities in a certain age period can be influenced more by their improvement, and some less. All this indicates their complexity, and at the same time caution when programming training work with children of different ages (Nićin, 2000).

Swimming as a sport discipline is characterized by a monostructural movement of the cyclic type, which takes place in a specific environment, so that learning this activity is conditioned by the properties of water. The swimmer performs his physical activity in an aquatic environment, in which the body is in an unstable position, which means without a firm support. In such circumstances, a large number of different movements are used, so that in water there is movement of those parts of the body and in those joints that are less active on dry land, which positively affects the development of certain organs and organ systems (Kazazović, 2008; Bajrić et al., 2014).

The effect of swimming on the body has a positive effect on the body as a whole. Considering the environment

## Uvod

Poznavanje uticaja određenih antropoloških sposobnosti na efikasnost u realizaciji specifičnih zadataka u određenoj sportskoj disciplini i postizanje visokih sportskih rezultata predstavlja polaznu osnovu kvalitetnog programiranja i sprovođenja, kako nastavnog tako i trenažnog procesa. Ako je poznato koje antropološke sposobnosti učestvuju u ostvarivanju visoke efikasnosti u nekoj sportskoj disciplini, i ako se zna koliki može biti doprinos svake dimenzije i testova tih sposobnosti u ocjenie fikasnosti, onda je moguće uspostaviti takav sistem programiranog rada (nastavnog ili trenažnog) koji će uticati na poboljšanje upravo onih sposobnosti koji će u najvećoj mjeri doprinijeti ostvarivanju tog uspjeha (Platonov, 1997.). Uticaj bazičnih motoričkih sposobnosti na realizaciju specifičnih motoričkih zadataka u različitim sportskim disciplinama bio je problem istraživanja mnogih istraživača (Katić, Maleš & Miletić, 2002; Metikoš i sar., 1982; Momirović i sar., 1984; Otte, 1999; Popo, 2010; Mirvić i sar., 2018.). Motoričkim sposobnostima nazivaju se one sposobnosti čovjeka koje učestvuju u rješavanju motoričkih zadataka i uslovljavaju uspješno kretanje, bez obzira da li su stečene treningom ili ne (Malacko & Rađo, 2004). Motoričke sposobnosti su veoma kompleksne i složene, sa različitim koeficijentom urođenosti i različitim mogućnostima za njihovo poboljšanje u različitim periodima razvoja djece. Neke motoričke sposobnosti su genetski uslovljene sa visokim koeficijentom urođenosti (brzina, eksplozivna snaga, koordinacija, ravnoteža, preciznost), a neke sa manjim koeficijentom urođenosti (izdržljivost, repetitivna i statička snaga). Razvoj motoričkih sposobnosti je neravnomjeran, jer se na neke motoričke sposobnosti u određenom uzrasnom periodu može više uticati na njihovo poboljšanje, a na neke manje. Sve to ukazuje na njihovu složenost, a ujedno i opreznost prilikom programiranja trenažnog rada sa djecom različite uzrasne dobi (Nićin, 2000).

Plivanje kao sportsku disciplinu karakteriše monostrukturno kretanje cikličnog tipa, koje se odvija u specifičnoj sredini, tako da je učenje te aktivnosti uslovljeno svojstvima vode. Plivač obavlja svoju tjelesnu aktivnost u vodenoj sredini, u kojoj se tijelo nalazi u nestabilnom položaju, što znači bez čvrstog oslonca. U takvim okolnostima koristi se veći broj različitih pokreta, tako da u vodi dolazi do kretanja i onih dijelova tijela i u onim zglobovima koji su na suvom malo aktivni, što pozitivno utiče na razvoj određenih organa i organskih sistema (Kazazović, 2008; Bajrić i sar., 2014.).

Djelovanje plivanja na organizam ima pozitivan uticaj na organizam u cjelini. Sobzirom na sredinu u kojoj

in which the swimmer performs the movement, that movement has a general bodily character, that is, during swimming the entire musculature and all organs and organ systems are activated (Madić et al., 2007; Marković, 2017).

Swimming and other activities in the water serve as a means of strengthening primarily the locomotor, cardiovascular and respiratory systems, as well as all other systems (Marković, 2017).

Swimming is an activity that implies the ability of a person to stay in place or to move on the surface of the water in a horizontal position with the movements of his own locomotion. Similar to other types of physical exercise, swimming has its own characteristics, which affect the morphological, functional, motor, psychological and intellectual development of a person. (Volčanšek, 1979).

The influence of a wider range of motor abilities on different swimming disciplines has been determined on the efficiency of realization of specific motor tasks in swimming, which is why it is necessary to develop a separate model for each of them, in relation to age, gender and discipline (Zenić et al. 2007). The parameters monitored in all age categories are mainly related to morphological characteristics and motor abilities (Leko, 2001; Dimitrić and Srđić, 2010).

The main goal of this research is to determine the significance and magnitude of the influence of selected basic motor skills on the realization of specific motor tasks in swimming (buoyancy in place, length of sliding with reflection from water, start from the starting block, parallel).

## RESEARCH METHODOLOGY

### *Sample of respondents*

The study included 70 male swimmers aged 13-15 years, and the study included only those subjects who were completely healthy at the time of measurement. Prior to testing the subjects, the written consent of the parents/guardians was obtained in accordance with the ethical principles for biomedical research on humans - Declaration of Helsinki (2013). After obtaining the consent of the parents/guardians, an assessment of the basic motor skills and efficiency of performing situational-motor tasks in swimming was performed, which was realized during regular training with appropriate conditions necessary for testing.

### *Sample variables*

A set of 10 variables for the assessment of basic motor abilities as a predictor set and 3 variables for the assessment of situational-motor abilities as a criterion set

plivač vrši kretanje, to kretanje ima opšti tjelesni karakter, to jeste da se za vrijeme plivanja aktivira cijelokupna muskulatura i svi organi i organski sistemi (Madić i sar., 2007; Marković, 2017.).

Plivanje i druge aktivnosti u vodi služe kao sredstvo za jačanje prije svega lokomotornog, kardiovaskularnog i respiratornog sistema, kao i svih ostalih sistema (Marković, 2017.).

Plivanje je aktivnost koja podrazumijeva sposobnost čovjeka da se održi na mjestu ili da se kreće po površini vode u horizontalnom položaju pokretima sopstvene lokomocije. Slično drugim vidovima fizičkog vježbanja i plivanje ima svoje karakteristike, kojima utiče na morfološki, funkcionalni, motorički, psihološki i intelektualni razvoj ličnosti. (Volčanšek, 1979.).

Na efikasnot realizacije specifičnih motoričkih zadataka u plivanju utvrđen je uticaj šireg spektra motoričkih sposobnosti na različite plivačke discipline, zbog čega je potrebno za svaku od njih izraditi poseban model, i to u odnosu na uzrast, pol i disciplinu (Zenić i sar. 2007.). Parametri koji se prate u svim uzrasnim kategorijama uglavnom su vezani za morfološke karakteristike i motoričke sposobnosti (Leko, 2001; Dimitrić i Srđić, 2010.).

Osnovni cilj ovog istraživanja je utvrđivanje značaja i veličine uticaja odabranih bazično-motoričkih sposobnosti na realizaciju specifičnih motoričkih zadataka u plivanju (plovnost u mjestu, dužina kliženja sa odrazom iz vode, start sa startnog bloka, paralelni).

## METODOLOGIJA ISTRAŽIVANJA

### *Uzorak ispitanika*

Istraživanjem je obuhvaćeno 70 plivača muškog pola uzrasta 13-15 godina, a ispitivanjem su obuhvaćeni samo oni ispitanici koji su za vrijeme mjerenja bili potpuno zdrav. Prije testiranja ispitanika dobivena je pismena saglasnost roditelja/staratelja u skladu sa etičkim principima za biomedicinska istraživanja na ljudima - Declaration of Helsinki (2013). Nakon dobivenih saglasnosti od strane roditelja/staratelja izvršena je procjena bazičnih motoričkih sposobnosti i efikasnosti izvođenja situaciono-motoričkih zadataka u plivanju koje je realizovano za vrijeme redovnih treninga uz odgovarajuće uslove potrebne za testiranje.

### *Uzorak varijabli*

U istraživanju je primijenjen skup od 10 varijabli za procjenu bazičnih motoričkih sposobnosti kao prediktor-ski skup i 3 varijable za procjenu situaciono-motoričkih sposobnosti kao kriterijski skup varijabli.

of variables were used in the research.

### **Variables for the assessment of basic motor skills (predictor set of variables)**

Determining the level of basic motor skills was performed using measuring instruments recommended by (Kurelić et al., 1975; Mikić, 1999):

Variables for assessing flexibility:

1. Spin with a stick..... (MFLISK)
2. Deep bend on the bench..... (MFLPRK)
3. Plantar flexion..... (MFLPLF)

Variables for estimating explosive power:

4. Long jump from the place..... (MFESDM)
5. Throwing the medic from a lying position (MFEBML)

Variables for estimating repetitive power

6. Push-ups..... (MRESKL)
7. Lifting the torso from lying on the back (MRCDTL)
8. Lying shelter ..... (MRCZTL)

Coordination assessment variables:

9. Agility on the ground..... (MKOKNT)
10. Agility with a stick..... (MKTOSP)

### **Variables for assessing situational-motor abilities in swimming (criterion set of variables):**

1. Buoyancy in place..... (SMPLOV)
2. Slip length with reflection from water... (SMDKOV)
3. Start from the starting block (parallel)..... (SMSTPA)

### **Data processing methods**

In order to determine the influence of basic motor skills defined as a predictor set of variables on the efficiency of realization of specific motor tasks in swimming defined as a criterion set of variables, multiple regression analysis was applied.

## **RESULTS AND DISCUSSION**

### **Regression analysis of basic motor abilities and criterion variables - buoyancy in place (SMPLOV)**

Regression analysis of the applied sets of variables (Tables 1 and 2) established a statistically significant correlation between basic motor skills, as a predictor system and buoyancy in place, as a criterion variable.

The multiple correlation coefficient is relatively high 58% ( $R = .582$ ), with a total explained variability of about 35% ( $R \text{ Square} = .351$ ) at a statistically significant level of  $\text{Sig.} = .009$ . Based on these indicators, it can be concluded that the applied variables of basic motor skills participate in the prediction of navigability in a place with 35% participation, while

### **Varijable za procjenu bazično-motoričkih sposobnosti (prediktorski skup varijabli)**

Utvrđivanje nivoa bazičnih motoričkih sposobnosti izvršeno je pomoću mjernih instrumenata koje preporučuju (Kurelić i sar., 1975; Mikić, 1999.):

Varijable za procjenu fleksibilnosti:

1. Iskret s palicom ..... (MFLISK)
2. Duboki pretklon na klupi..... (MFLPRK)
3. Plantarna fleksija ..... (MFLPLF)

Varijable za procjenu eksplozivne snage

4. Skok u dalj iz mjesta ..... (MFESDM)
5. Bacanje medicine iz ležećeg položaja .. (MFEBML)

Varijable za procjenu repetitivne snage

6. Sklekovi..... (MRESKL)
7. Dizanje trupa iz ležanja na leđima ..... (MRCDTL)
8. Zaklon u ležanju ..... (MRCZTL)

Varijable za procjenu koordinacije

9. Okretnost na tlu ..... (MKOKNT)
10. Okretnost s palicom..... (MKTOSP)

### **Varijable za procjenu situaciono-motoričkih sposobnosti u plivanju (kriterijski skup varijabli)**

1. Plovnost u mjestu ..... (SMPLOV)
2. Dužina kliženja sa odrazom iz vode..... (SMDKOV)
3. Start sa startnog bloka (paralelni)..... (SMSTPA)

### **Metode obrade podataka**

U cilju utvrđivanja uticaja bazičnih-motoričkih sposobnosti definisane kao prediktorske skup varijabli na efikasnost realizacije specifičnih motoričke zadataka u plivanju definisane kao kriterijski skup varijabli primjenjena je multipla regresiona analiza

## **REZULTATI I DISKUSIJA**

### **Regresiona analiza bazično-motoričkih sposobnosti i kriterijske varijable - plovnosti u mjestu (SMPLOV)**

Regresionom analizom primijenjenih skupova varijabli (tabela 1 i 2) utvrđena je statistički značajna povezanost između bazično-motoričkih sposobnosti, kao prediktorskog sistema i plovnosti u mjestu, kao kriterijske varijable.

Koeficijent multiple korelacije iznosi, relativno visokih 58% ( $R = .582$ ), sa ukupno obješnjanim varijabilitetom od oko 35% ( $R \text{ Square} = .351$ ) na statistički značajnom nivou od  $\text{Sig.} = .009$ . Na osnovu navedenih pokazatelja može se konstatovati da primijenjene varijable bazično-motoričkih sposobnosti učestvuju u predikciji plovnosti u mjestu sa 35% učešća, dok preostali dio

the remaining 65% of the variance belongs to other anthropological dimensions and other factors not applied in this study.

The partial influence of individual variables of basic motor abilities on buoyancy in place was selected into two variables with statistical significance (Table 3). The following statistically significant influence of predictor variables on the criterion variable was achieved by the following variables: deep torso tilt (MFLPRK), whose value of partial coefficient BETA is .411 (Sig = .012) and agility on the ground (MKOKNT), whose value of partial coefficient is .691 (Sig = .000).

Based on the obtained results, it can be concluded that the in-flight navigability (SMPLOV) is dominated by the MFLPRK-deep forward slope flexibility assessment test for which the synergistic and tone regulation mechanism is responsible and the ICCPT-soil agility coordination test for which responsible mechanism for structuring the movement, which suggests that a high level of hull flexibility and agility is required to perform buoyancy effectively in place.

**Regression analysis of motor abilities and criterion variables - sliding length from water reflection (SMDKOV)**

Regression analysis (Tables 4 and 5) determined a statistically significant correlation between motor abilities,

varijanse od 65% pripada drugim antropološkim dimenzijama i drugim faktorima koji nisu primijenjeni u ovom istraživanju.

Parcijalni uticaj pojedinačnih varijabli bazično-motoričkih sposobnosti na plovnost u mjestu selekcionisan je na dvije varijable sa statističkim značajem (tabela 3). Parcijalni statistički značajan uticaj prediktorskih varijabli na kriterijsku varijablu ostvarile su sljedeće varijable: *duboki pretklon trupom (MFLPRK)*, čija vrijednost parcijalnog koeficijenta BETA iznosi .411 (Sig = .012) i *okretnost na tlu (MKOKNT)*, čija vrijednost parcijalnog koeficijenta BETA iznosi .691 (Sig = .000).

Na osnovu dobijenih rezultata može se konstatovati da na *plivnost u mjestu (SMPLOV)* dominantnu ulogu ima test za procjenu fleksibilnosti MFLPRK-duboki pretklon za koju je odgovoran mehanizam za sinergijsku regulaciju i regulaciju tonusa i test za procjenu koordinacije MKOKNT –okretnost na tlu za koju je odgovoran mehanizam za strukturiranje kretanja, što upućuje na zaključak da je za efikasno izvođenje plovnosti u mjestu potreban je visok nivo fleksibilnosti trupa i okretnosti.

**Regresiona analiza motoričkih sposobnosti i kriterijske varijable - dužina kliženja odrazom iz vode (SMDKOV)**

Regresionom analizom (tabela 4 i 5) utvrđena je statistički značajna povezanost između motoričkih sposobno-

*Table 1. Regression analysis of the criterion variable of buoyancy in place (SMPLOV) / Tabela 1. Regresiona analiza kriterijske varijable plovnosti u mjestu (SMPLOV)*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.582a	.351	.248	.858

a. Predictors: (Constant): MFLISK, MFLPRK, MFLPLF, MFESDM, MFEBML, MRESKL, MRCDTL, MRCZTL, MKOKNT, MKTOSP

*Table 2. Analysis of multiple regression variance / Tabela 2. Analiza varijanse multiple regresije*

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	23.688	10	2.359		
Residual	40.282	55	.741	3.231	.009a
Total	63.918	69			

a. Predictors: (Constant): MFLISK, MFLPRK, MFLPLF, MFESDM, MFEBML, MRESKL, MRCDTL, MRCZTL, MKOKNT, MKTOSP.

b. Dependent Variable: SMPLOV

**Table 3.** Partial influence of individual variables of basic motor abilities on in-air navigability (SMPLOV)  
**Tabela 3.** Parcijalni uticaj pojedinačnih varijabli bazično-motoričkih sposobnosti na plovnost u mjestu (SMPLOV)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	2.792	1.930		1.466	.148
MFLISK	.002	.001	.187	1.393	.143
MFLPRK	.004	.003	.411	1.822	.012
MFLPLF	-.001	.022	-.009	-.044	.833
MFESDM	-.002	.001	-.352	-1.025	.072
MFEBML	.002	.001	.004	.032	.845
MRESKL	.003	.006	.055	.466	.543
MRCDTL	-.019	.016	-.216	-1.241	.217
MRCZTL	.003	.006	.056	.462	.522
MKOKNT	.473	.102	.691	4.125	.000
MKTOSP	-.125	.111	-.245	-1.055	.088

a. Dependent Variable: SMPLOV

**Legend:** R-coefficient of multiple correlation between criterion variable and system of predictor variables., R-square-coefficient of explained variability, Std. Error of the Estimate-standard error of forecast of criterion variable based on system of predictor variables, Regression-valid variance df-degrees of freedom of the calculated F test, F-test which determines the significance of the multiple correlation coefficient, t-contribution of each predictor variable to that part of the criterion variance, which can be estimated based on the whole system of variables, Sig.-probability of some critical ratio if the value of the standardized regression coefficient is 0, calculated on the basis of the F distribution, B – non-standardized regression coefficients, Beta – standardized regression coefficients

**Legenda:** R-koeficijent multiple korelacije između kriterijske varijable i sistema prediktorskih varijabli., R-square-koeficijent objašnjenog varijabiliteta, Std. Error of the Estimate-standardna greška prognoze kriterijske varijable na osnovu sistema prediktorskih varijabli, Regression-valjana varijanca, Residual-neobjašnjena varijansa, df-stepeni slobode izračunatog F testa, F-test kojim se određuje značajnost koeficijenta multiple korelacije, t-doprinos svake prediktorske varijable onom dijelu kriterijske varijance, koji se može procjeniti na osnovu čitavog sistema varijabli, Sig.-vjerovatnoća da se neki kritički omjer pojavi ako je vrijednost standardiziranog regresionog koeficijenta 0, izračunat na osnovu F distribucije, B–nestandardizovani regresioni koeficijenti, Beta– standardizovani regresioni koeficijenti

as a predictor system, and sliding length with reflection from water, as a criterion variable. The multiple correlation coefficient is, relatively high 63% (R = .632), with a total explained variability of about 39% (R Square = .386) at the statistically most stringent level of Sig. = .000.

The obtained indicators indicate that the applied variables of basic motor abilities in the prediction of the length of gliding from the water participate with 39% participation, while the remaining part of the variance of 61% belongs to other anthropological dimensions and other factors not applied in this study.

The partial influence of individual variables of basic motor abilities on the length of sliding with reflection from water was selected into three variables with statistical significance (Table 6). The highest predictive value on the length of sliding with reflection

sti, kao prediktorskog sistema i dužine kliženja sa odrazom iz vode, kao kriterijske varijable. Koeficijent multiple korelacije iznosi, relativno visokih 63% (R=.632 ), sa ukupno obješnjanim varijabilitetom od oko 39% (R Square = .386) na statistički najstrožijem nivou od Sig. = .000.

Dobijeni pokazatelja ukazuju da primijenjene varijable bazičnih motoričkih sposobnosti u predikciji dužine kliženja odrazom iz vode učestvuju sa 39% učesća, dok preostali dio varijanse od 61% pripada drugim antropološkim dimenzijama i drugim faktorima koji nisu primijenjeni u ovom istraživanju.

Parcijalni uticaj pojedinačnih varijabli bazično-motoričkih sposobnosti na dužinu kliženja sa odrazom iz vode selekcionisan je na tri varijable sa statističkim značajem (tabela 6). Najveću prediktivnu vrijednost na dužinu kliženja sa odrazom iz vode ostvarile su sljede-

from water was achieved by the following variables: *twist with a stick* (MFLISK), whose value of partial coefficient BETA is .492 (Sig. = .008), *plantar foot flexion* (MFLPLF), whose value of partial coefficient BETA amounts to .464 (Sig. = .012), *torso shelter* (MRCZTL), whose value of the partial coefficient BETA is .465 (Sig. = .010).

The obtained results suggest that the sliding length of reflection from water (SMDKOV) is dominated by tests to assess the flexibility of MFLISK-stick stick and MFLPLF-plantar flexion of the feet for which the mechanism for synergistic regulation and regulation of tone is responsi-

će varijable: *iskret sa palicom* (MFLISK), čija vrijednost parcijalnog koeficijenta BETA iznosi .492 (Sig. =.008), *plantarna fleksija stopala* (MFLPLF), čija vrijednost parcijalnog koeficijenta BETA iznosi iznosi .464 (Sig. =.012), *zaklon trupom u ležanju* (MRCZTL), čija vrijednost parcijalnog koeficijenta BETA iznosi iznosi .465 (Sig. =.010).

Dobijeni rezultati upućuju na konstataciju da na **dužinu kliženja odrazom iz vode (SMDKOV)** dominantnu ulogu imaju testovi za procjenu fleksibilnosti MFLISK-iskret s palicom i MFLPLF-plantarna fleksija stopala za koje je odgovoran mehanizam za sinergijsku regulaci-

**Table 4.** Regression analysis of the criterion variable slip length by reflection from water (SMDKOV) / **Tabela 4.** Regresiona analiza kriterijske varijable dužina kliženja odrazom iz vode (SMDKOV)

Model	R	R Square	Adjusted R Square	Std.Error of the Estimate
1	.632a	.386	.268	1355.272

a. Predictors: (Constant): MFLISK, MFLPRK, MFLPLF, MFESDM, MFEBML, MRESKL, MRCDTL, MRCZTL, MKOKNT, MKTOSP

**Table 5.** Analysis of multiple regression variance / **Tabela 5.** Analiza varijanse multiple regresije

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	61655215	10	6273322.443	3.483	.000a
Residual	99576183	55	1823455.933		
Total	155E+06	69			

a. Predictors: (Constant): MFLISK, MFLPRK, MFLPLF, MFESDM, MFEBML, MRESKL, MRCDTL, MRCZTL, MKOKNT, MKTOSP. b. Dependent Variable: SMDKOV

**Table 6.** Partial influence of individual variables of basic motor abilities on the length of sliding by reflection from water (SMDKOV) / **Tabela 6.** Parcijalni uticaj pojedinačnih varijabli bazično-motoričkih sposobnosti na dužinu kliženja odrazom iz vode (SMDKOV)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std.Error	Beta		
1 (Constant)	-262.764	3241.266		-.086	.946
MFLISK	62.305	24.563	.492	2.866	.008
MFLPRK	-.335	2.658	-.119	1.050	.108
MFLPLF	66.405	25.663	.464	2.551	.012
MFESDM	-1.085	1.220	-.126	-.686	.355
MFEBML	-6.520	9.313	-.082	-.655	.386
MRESKL	-3.525	2.943	-.169	-.913	.361
MRCDTL	1.705	1.087	.222	1.566	.108
MRCZTL	69.355	26.663	.465	2.630	.010
MKOKNT	-257.684	192.687	-.318	-1.947	.080
MKTOSP	326.457	171.347	.286	1.222	.096

a. Dependent Variable: SMDKOV



ble, and test to assess repetitive MRCZTL forces for which the excitation duration mechanism is responsible. A high level of flexibility in the shoulder joint and flexibility of the foot, as well as repetitive strength of the torso, is required for efficient sliding with reflection from the water.

**Regression analysis of motor abilities and criterion variables start from the starting block-parallel (SMSTPA)**

Regression analysis (Tables 7. and 8.) determined a statistically significant correlation between motor abilities, as a predictor system, and starting from the starting block-parallel (SMSTPA), as criterion variables. The multiple correlation coefficient is relatively high 64% (R = .641), with a total explained variability of about 42% (R Square = .422) at a statistically significant level of Sig. = .001. Based on the obtained indicators, it can be concluded that the applied variables of basic motor abilities participate in the prediction of starting from the starting block-parallel with 42% participation, while the remaining 58% variance belongs to other anthropological dimensions and other factors not applied in this research. The partial influence of individual variables of basic motor abilities on the start from the starting block - parallel, was selected into three variables with statistical significance (Table 9). The highest predictive value at the start from the starting block-parallel was expressed by the following variables: *jump from a place* (MFESDM), whose value of partial coefficient BETA is .489 (Sig. = .000), *agility on the ground* (MKOKNT), whose value of partial coefficient BETA is .345 (Sig. = .048), *plantar flexion of the foot* (MFLPLF), whose value of the partial coefficient BETA is .466 (Sig. = .006) and *bending with a stick* (MFLISK) whose value of the partial coefficient BETA is .355 . = .056)

Based on the obtained results, it can be stated that flexibility tests have a dominant role in the efficiency of the start from the starting block-parallel (SMSTPA): MFLISK-twist with a stick, MFLPLF-plantar flexion for which the mechanism for synergistic regulation and tone regulation is responsible, explosive power test MFESDM-long jump from the place for which the mechanism for regulating the inten-

ju i regulaciju tonusa, te test za procjenu repetitivne snage MRCZTL za koje je odgovoran mehanizam za trajanja ekscitacije. Za efikasno izvođenje kliženja odrazom iz vode potreban je visok nivo fleksibilnosti u zglobu ramena i fleksibilnosti stopala, te repetitivne snage trupa.

**Regresiona analiza motoričkih sposobnosti i kriterijske varijable start sa startnog bloka-paralelni (SMSTPA)**

Regresionom analizom (tabela 7 i 8) utvrđena je statistički značajna povezanost između motoričkih sposobnosti, kao prediktorskog sistema, i starta sa startnog bloka-paralelni (SMSTPA), kao kriterijske varijable. Koeficijent multiple korelacije iznosi, relativno visokih 64% ( R=.641 ), sa ukupno obješnjanim varijabilitetom od oko 42% (R Square = .422) na statistički značajnom nivou od Sig. = .001. Na osnovu dobijenih pokazatelja može se konstatovati da primijenjene varijable bazičnih motoričkih sposobnosti učestvuju u predikciji starta sa startnog bloka-paralelni sa 42% učešća, dok preostali dio varijanse od 58% pripada drugim antropološkim dimenzijama i drugim faktorima koji nisu primijenjeni u ovom istraživanju. Parcijalni uticaj pojedinačnih varijabli bazično-motoričkih sposobnosti na start sa startnog bloka-paralelni, selekcionisan je na tri varijable sa statističkim značajem (tabela 9). Najveću prediktivnu vrijednost na start sa startnog bloka-paralelni ispoljile su sljedeće varijable: *skok udalj iz mjesta* (MFESDM), čija vrijednost parcijalnog koeficijenta BETA iznosi .489 (Sig. =.000), *okretnost na tlu* (MKOKNT), čija vrijednost parcijalnog koeficijenta BETA iznosi .345 (Sig. =.048), *plantarna fleksija stopala* (MFLPLF), čija vrijednost parcijalnog koeficijenta BETA iznosi .466 (Sig. =.006) i *iskret palicom* (MFLISK) čija vrijednost parcijalnog koeficijenta BETA iznosi .355 (Sig. =.056)

Na osnovu dobijenih rezultata može se konstatovati da na **efikasnost starta sa startnog bloka-paralelni (SMSTPA)** dominantnu ulogu imaju testovi fleksibilnosti: MFLISK-iskret sa palicom, MFLPLF-plantarna fleksija za koje je odgovoran mehanizam za sinergijsku regulaciju i regulaciju tonusa, test eksplozivne snage MFE-SDM-skok u dalj iz mjesta za koje je odgovoran meha-

**Table 7. Regression analysis of the criterion variable start from the starting block-parallel (SMSTPA) /  
 Tabela 7. Regresiona analiza kriterijske varijable start sa startnog bloka-paralelni (SMSTPA)**

Model	R	R Square	Adjusted R Square	Std.Error of the Estimate
1	.641a	.422	.314	.54410

a. Predictors: (Constant): MFLISK, MFLPRK, MFLPLF, MFESDM, MFEBML, MRESKL, MRCDTL, MRCZTL, MKOKNT, MKTOSP

**Table 8.** Analysis of multiple regression variance / **Tabela 8.** Analiza varijanse multiple regresije

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	11.822	10	1.166	3.853	.001a
Residual	16.688	55	.313		
Total	28.613	69			

a. Predictors: (Constant): MFLISK, MFLPRK, MFLPLF, MFESDM, MFEBML, MRESKL, MRCDTL, MRCZTL, MKOKNT, MKTOSP

b. Dependent Variable: SMSTPA

**Table 9.** Partial influence of individual variables of basic motor abilities on the start from the starting block-parallel (SMSTPA)

**Tabela 9.** Parcijalni uticaj pojedinačnih varijabli bazično-motoričkih sposobnosti na start sa startnog bloka-paralelni (SMSTPA)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	5.121	1.225		3.968	.001
MFLISK	.000	.001	.335	1.985	.056
MFLPRK	-.002	.003	-.216	-1.366	.165
MFLPLF	.018	.006	.466	3.922	.006
MFESDM	.008	.016	.489	4.055	.000
MFEBML	.003	.010	-.055	-.325	.645
MRESKL	.002	.001	.082	.448	.420
MRCDTL	.005	.010	.066	.421	.432
MRCZTL	.006	.004	-.065	-.428	.535
MKOKNT	.018	.068	.345	2.008	.048
MKTOSP	.023	.066	.058	.326	.621

a. Dependent Variable: SMSTPA

sity of excitation is responsible, and the coordination test MKOKNT-agility on the ground for which the mechanism for structuring the movement is responsible. These results suggest that a high level of flexibility in the shoulder joint and flexibility of the foot, as well as a high level of jumping and agility are especially important for efficient starting from the starting block-parallel.

The need to know the legality of relations and influences between motor and some other dimensions is especially emphasized because complex motor abilities can be manifested only through the executive subsystem, which is largely determined by the basic-motor structure of the entity. In research of this nature, which sought to determine the impact of basic motor skills on the efficiency of performing situational-motor tasks in various kinesiological activities, the emphasis is mainly to determine their hierarchical structure of participation for efficient performance of situational-motor tasks. It was this research that aimed to determine the influence of selected basic motor skills as a predictor system of variables on the efficiency of performing situational-motor tasks in swimming as a criterion.

nizam za regulaciju intenziteta ekscitacije, te test koordinacije MKOKNT-okretnost na tlu za koje je odgovoran mehanizam za strukturiranje kretanja. Ovakvi rezultati upućuju na zaključak da je za efikasno izvođenje starta sa startnog bloka-paralelni posebno značajan visok nivo fleksibilnosti u zglobu ramena i fleksibilnosti stopala, kao i visok nivo skočnosti i okretnosti.

Potreba poznavanja zakonitosti relacija i uticaja između motoričkih i nekih drugih dimenzija posebno se ističe zbog toga što je složene motoričke sposobnosti moguće manifestovati jedino preko izvršnog podsistema koji je u velikoj mjeri determinisan bazično-motoričkom strukturom entiteta. U istraživanjima ovakvog karaktera koja su nastojala da se utvrdi uticaj bazičnih motoričkih sposobnosti na efikasnost izvođenja situaciono-motoričkih zadataka u različitim kineziološkim aktivnostima uglavnom je naglasak da se utvrdi njihova hijerarhijska struktura učesća za efikasno izvođenje situaciono-motoričkih zadataka. Upravo je ovo istraživanje imalo za cilj da utvrdi uticaj odabranih bazičnih motoričkih sposobnosti kao prediktorskog sistema varijabli na efikasnost izvođenja situaciono-motoričkih zadataka u plivanju kao kriterija.

The results of this research indicate that the selected set of variables of basic motor skills is a significant predictor of the efficiency of performing situational motor tasks in swimming related to navigability in place, the length of sliding with reflection from the water and parallel start from the starting block. In general, based on the results obtained in this study, it can be concluded that the applied basic motor tests definitely significantly affect the efficiency of specific motor tasks in swimming observed through the efficiency of performing buoyancy in place, sliding length with reflection from water and parallel start from the starting block.

The largest and statistically most significant influence of the selected basic motor abilities was achieved in the situational-motor test start from the starting block-parallel (SMSTPA), followed by the length of sliding with reflection from water (SMDKOV) and buoyancy in place (SMPLOV).

The analysis of the influence of individual variables from the set of basic motor abilities can be seen that the statistically most significant influence on all three situational-motor tasks in swimming (buoyancy in place) (SMPLOV), sliding length with reflection from water (SMDKOV) and parallel start from the starting block (SMSTPA) achieved variables for flexibility assessment, rod twist-MFLISK, deep bench forward-MFLPRK, plantar flexion-MFLPL, for which the mechanism for synergistic regulation and regulation of tone is responsible, which is based on the process of referentation and regulation of individual tone groups. and the mechanism for muscle relaxation of antagonists when performing all cyclic movements (Mikić, 1995). Slightly lower but statistically significant influence was achieved by variables for estimating explosive-MFESDM and repetitive strength-MRCZTL, and coordination, agility on the ground- intensity regulation, ie the mechanism for excitation duration and the structuring mechanism is movement. The results of this research do not deviate from previous research (Marković, 2004; Tereš, 1982; Mirvić et al., 2018), which indicate the importance of the mechanism for regulating the duration of excitation which, in addition to regulating the number of activated motor units, controls the intensity of muscle action. activation of individual motor units. The authors also emphasize the great importance of this regulation on generating force of explosive character, but also in generating force of small muscle groups, such as hand muscles (which in addition to regulating the number of activated motor units control the intensity of muscle action by regulating the frequency of activation of individual motor units).

Rezultati ovog istraživanja ukazuju da odabrani skup varijabli bazično-motoričkih sposobnosti predstavlja značajan prediktor na efikasnost izvođenja situaciono-motoričkih zadataka u plivanju koji se odnose na plovnost u mjestu, dužinu kliženja sa odrazom iz vode i paralelni start sa startnog bloka. Generalno, na osnovu dobijenih rezultata u ovom istraživanju može se konstatovati da primijenjeni bazično-motorički testovi definitivno značajno utiču na efikasnost izvođenja specifičnih motoričkih zadataka u plivanju posmatrane kroz efikasnost izvođenja plovnosti u mjestu, dužine kliženja sa odrazom iz vode i paralelni start sa startnog bloka.

Najveći i statistički najznačajniji uticaj odabranih bazičnih motoričkih sposobnosti ostvaren je kod situaciono-motoričkog testa start sa startnog bloka-paralelni (SMSTPA), a zatim slijede dužina kliženja sa odrazom iz vode (SMDKOV) i plovnost u mjestu (SMPLOV).

Analizom uticaja pojedinačnih varijabli iz skupa bazičnih motoričkih sposobnosti može se vidjeti da su statistički najznačajniji uticaj na sva tri situaciono-motorička zadatka u plivanju (plovnost u mjestu (SMPLOV), dužina kliženja sa odrazom iz vode (SMDKOV) i paralelni start sa startnog bloka (SMSTPA) ostvarile varijable za procjenu fleksibilnosti, iskret sa palicom-MFLISK, duboki pretklon na klupici-MFLPRK, plantarna fleksija-MFLPL, za koje je odgovoran mehanizam za sinergijsku regulaciju i regulaciju tonusa, koji je zasnovan na procesu reaferencije i regulaciji tonusa pojedinih mišićnih grupa i mehanizma za relaksaciju mišića antagonista prilikom izvođenja svih cikličnih pokreta (Mikić, 1995.). Nešto niži ali statistički značajan uticaj ostvarile su varijable za procjenu eksplozivne-MFESDM i repetitivne snage-MRCZTL, te koordinacije, okretnost na tlu- MKOKNT koje pripadaju mehanizmu za regulaciju intenziteta, odnosno mehanizmu za trajanja ekscitacije i mehanizmu za strukturiranje kretanja. Rezultati ovog istraživanja ne odstupaju od dosadašnjih istraživanja (Marković, 2004; Tereš, 1982; Mirvić i sar., 2018.) kojima više ukazuju na značaj mehanizma za regulaciju trajanja ekscitacije koji osim regulacije broja aktiviranih motoričkih jedinica upravlja i intenzitetom mišićne akcije putem regulacije frekvencije aktiviranja pojedinih motoričkih jedinica. Autori takođe ističu veliku važnost ove regulacije na generisanje sile eksplozivnog karaktera, ali i kod generisanja sile malih mišićnih grupa, kao naprimjer, mišići šake (koji osim regulacije broja aktiviranih motoričkih jedinica upravlja i intenzitetom mišićne akcije putem regulacije frekvencije aktiviranja pojedinih motoričkih jedinica).

Based on the results of this research, it can be concluded that all mechanisms together, significantly contribute to the more efficient performance of specific motor tasks in swimming in subjects aged 13 to 15 years.

As all previous research (Kazazović, 1984; Leko, 2011; Bajrić and Bajrić, S., 2016; Mirvić et al., 2018) has indicated a significant impact of basic motor skills on the efficiency of performing specific motor tasks in swimming, this requires that special attention is paid to the development of motor skills when planning and programming the training process in swimming. It must be borne in mind that children aged 13-15 years still go through a phase of intensive growth and development and that intense changes within the morphological space are reflected in changes within motor skills (Madić, 2001; Leko, 2011; Faigenbaum AD, 2000). In this sense, the specialization of swimmers should begin after a period of intensive growth and development that characterizes the completion of biological maturation (Volčanšek, 2002; Popo, 2010). After this period, the scope and intensity of training should be significantly increased and the specialization of swimmers according to a certain swimming technique and swimming section should begin. During this period, it is necessary to intensify work on dry land, which is dominated by work with weights in order to increase muscle strength. This work must be based on the assumption that the intensive growth of bones, especially in length, has ended and that the connective and muscular tissue has been strengthened enough to be able to withstand heavy loads (Medved et al., 1989). In the end, it can be concluded that it would be best to wait for the completion of intensive growth and development of the treated sample of subjects and only then start with high-intensity anaerobic training in water and high loads on dry land.

## CONCLUSION

The main goal of this research was to determine the influence of basic motor skills on the efficiency of realization of specific motor tasks in swimming for swimmers aged 13-15. The research was conducted on a sample of 70 swimmers aged 13-15 years from the swimming clubs of Sarajevo Canton, F/BiH, which are in a continuous training process. The study used 10 variables to assess basic motor skills, which represented a predictor set of variables, and three variables to assess situational motor abilities as criteria, with each variable from the battery of situational motor abilities viewed as a criterion for a predictor set of basic motor variables. The results of regression analyzes show that the basic motor skills applied in this study had a statistically significant impact on each individual specific motor task as a criterion.

Na osnovu rezultata ovog istraživanja može se konstatovati da svi mahanizmi zajedno, značajno doprinose efikasnijem izvođenju specifičnih motoričkih zadataka u plivanju kod ispitanika uzrasne dobi 13 do 15 godina.

Kako su sva dosadašnja istraživanja (Kazazović, 1984; Leko, 2011; Bajrić i Bajrić, S., 2016; Mirvić i sar., 2018.) ukazala na značajan uticaj bazičnih motoričkih sposobnosti na efikasnost izvođenja specifičnih motoričkih zadataka u plivanju, to zahtijeva da se razvoju motoričkih sposobnosti posveti posebna pažnja prilikom planiranja i programiranja trenažnog procesa u plivanju. Pri tome se mora imati u vidu da djeca uzrasta 13-15 godina još uvijek prolaze fazu intenzivnog rasta i razvoja i da intenzivne promjene unutar morfološkog prostora imaju odraza i na promjene unutar motoričkih sposobnosti (Madić, 2001; Leko, 2011; Faigenbaum A.D., 2000). U tom smislu, specijalizacija plivača bi trebala početi poslije perioda intenzivnog rasta i razvoja koji karakteriše završetak biološkog sazrijevanja (Volčanšek, 2002; Popo, 2010). Poslije tog perioda bi se trebao značajno povećati obim i intenzitet treninga te započeti specijalizaciju plivača prema određenoj tehnici plivanja i dionici plivanja. U tom periodu potrebno je intenzivirati rad na suhom u kojem dominira rad sa utezima s ciljem povećavanja mišićne jakosti. Ovakav rad mora počivati na pretpostavci da je intenzivan rast kostiju, naročito u dužinu, završio i da je vezivno i mišićno tkivo dovoljno ojačalo da bi moglo izdržati velika opterećenja (Medved i sar., 1989). Na kraju se može zaključiti da bi najbolje bilo pričekati završetak intenzivnog rasta i razvoja tretiranog uzorka ispitanika i tek tada započeti sa visokointenzivnim anaerobnim treninzima u vodi i velikim opterećenjima na suhom.

## ZAKLJUČAK

Osnovni cilj ovog istraživanja odnosio se na utvrđivanje uticaja bazičnih motoričkih sposobnosti na efikasnost realizacije specifičnih motoričkih zadataka u plivanju plivača uzrasta od 13-15 godina. Istraživanje je provedeno na uzorku od 70 plivača uzrasta 13-15 godina iz plivačkih klubova Kantona Sarajevo, F/BiH koji se nalaze u kontinuiranom trenažnom procesu. U istraživanju je primijenjeno 10 varijabli za procjenu bazičnih motoričkih sposobnosti koje su predstavljale prediktorski skup varijabli i tri varijable za procjenu situaciono-motoričkih sposobnosti kao kriterija pri čemu je svaka varijabla iz baterije situaciono-motoričkih sposobnosti posmatrana kao kriterij na prediktorski skup bazično-motoričkih varijabli. Rezultati regresionih analiza pokazuju da su bazično-motoričke sposobnosti primijenjene u ovom istraživanju ostvarile statistički značajan uticaj na svaki

The generalization of the results obtained by this research is primarily possible in those populations that have the same or similar characteristics as the respondents in this paper, ie swimmers aged 13-15 years who are subjected to a continuous training process.

A more complete insight into the magnitude of the influence of basic motor skills on the efficiency of performing specific motor tasks in swimming should be given by some further research on a larger sample of respondents from other swimming clubs and a larger set of predictor (basic motor) variables.

The results obtained in this research can be useful for teachers and swimming trainers who work with younger age categories for the purpose of better programming of training work and selection of training content. The obtained results can also contribute to a better orientation in the selection of young swimmers.

pojedinačni specifični motorički zadatak kao kriterij.

Generalizacija rezultata dobijenih ovim istraživanjem prije svega je moguća na onim populacijama koje imaju ista ili slična obilježja kao ispitanici u ovom radu, odnosno na plivače uzrasta 13-15 godina koji su podvrgnuti kontinuiranom trenažnom procesu.

Potpuniji uvid u veličinu uticaja bazično-motoričkih sposobnosti na efikasnost izvođenja specifičnih motoričkih zadataka u plivanju trebala bi dati neka naredna istraživanja na većem uzorku ispitanika drugih plivačkih klubova i većim skupom prediktorskih (bazično-motoričkih) varijabli.

Dobijeni rezultati u ovom istraživanju mogu biti od koristi nastavnicima i trenerima u plivanju koji rade sa mlađim uzrasnim kategorijama u svrhu kvalitetnijeg programiranja trenažnog rada i izbora trenažnih sadržaja. Takođe, dobijeni rezultati mogu doprinijeti boljoj orijentaciji u selekciji mladih plivača.

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## CURRENT LEGAL REGULATIONS AS A FACTOR OF MANAGEMENT OF SPORTS ORGANISATION

## POZITIVNO PRAVNA REGULATIVA KAO ČINILAC UPRAVLJANJA SPORTSKOM ORGANIZACIJOM

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**Abstract:** Management of sports organisations, viewed in the context of their legality and legitimacy, predominantly relies on the filed of current legal regulations in sport. This could be, relatively speaking, considered as the existence of the “sports legislation” within a specific social environment, encompassing the set of laws and legal regulations, which govern the relations, procedures and operation of sports organisations. The issues concerning the current legal regulating of the relations in sport call attention to the following legal documents in a state: constitution, laws, subordinate legislation and internal (organisation’s) legal documents. From the point of view of sport (as a social phenomenon and practical activity), the concept of the current law must be treated through its determination that relates to all rules of social behaviour accepted and valid in a specific state. All stakeholders and participants in the sport process (stakeholders in the sports system) need to be informed about basic aspects of the legal norms constituting the substance of the current law. This paper, basically, deals with theoretical explication of the relevance of the current legal regulations as an important factor in the management of sports organisations. The context of the respective considerations is oriented towards the sports system environment in the Republic of Serbia.

**Keywords:** sport, current law, legal regulations.

### INTRODUCTION

The conceptual determination of the current law is defined through the context of application within a social environment, and is related to the treatment of the law, which is currently applied. This means the law(s) and subordinate legislation, which are currently in force. Also, it is known in the legal science that almost all legal regulations have their “life cycle”, namely “they are born, live, and die” subject to the volition of their legislators (Kremenović, 2015). Therefore, it is necessary

**Apstrakt:** Upravljanje sportskim organizacijama, posmatrano kroz kontekst njihovog legaliteta i legitimiteta, dominantno se oslanja na područje pozitivno pravne regulative u sportu, što se uslovno može smatrati egzistencijom „sportskog zakonodavstva“ u određenom društvenom okruženju. Njime je obuhvaćen skup zakona i pravnih regulativa koji upravljaju odnosima, postupcima i funkcionisanju sportskih organizacija. Pitanja pozitivno pravnog regulisanja odnosa u sportu usmeravaju pažnju na sledeće pravne akte u državi: ustav, zakone, podzakonska normativna akta i interna (organizacijska) pravna akta. Posmatrano iz ugla sporta (kao društvene pojave i prakse) pojam pozitivnog prava se mora tretirati kroz njegovu determinisanost koja se odnosi na sva pravila društvenog ponašanja koja su prihvaćena i važe u određenoj državi. Svi akteri i učesnici sportskog procesa (stejkholderi sportskog sistema) neophodno je da budu informisani o osnovnim aspektima pravnih normi koje tvore biće pozitivnog prava. Rad se, u osnovi, bavi teorijskom eksplikacijom značaja pozitivno pravne regulative kao bitnog činioca upravljanja u sportskim organizacijama. Kontekst predmetnog razmatranja usmeren je na okruženje sportskog sistema u Republici Srbiji.

**Ključne reči:** sport, pozitivno pravo, zakonska regulativa.

### Uvod

Pojmovno određenje pozitivnog prava definisano je kroz kontekst primene u okviru društvenog okruženja, a odnosi se na tretman prava koje se trenutno primenjuje. Odnosno, koji zakon(i) i podzakonski propisi su trenutno na snazi. Takođe, u pravnoj nauci je poznato da gotovo svi pravni propisi imaju svoj „životni ciklus“ odnosno „rađaju se, žive i umiru“ voljom njihovih donosilaca (Kremenović, 2015). Zbog toga je neophodno da svi subjekti na koje se odnose aktivnosti obavezne pri-

that all entities, engaged in activities with compulsory application of a particular regulation (or a group of regulations) should know „what is currently in force“ and/or what legal document “expired“. This, certainly, applies also to sports organisations.

From the point of view of sport (as a social phenomenon and practical activity), the concept of the current law must be treated through its determination that relates to all rules of social behaviour, which are accepted and valid in a specific state. All stakeholders and participants in the sport process, i.e., stakeholders in the sports system, need to be informed about basic aspects of legal norms that constitute the substance of current law. Therefore, the legal norm should be understood, through its terminological determination, as a proper behaviour of people, which is protected by the state apparatus by repression (Mitrović, 2007). It is not particularly relevant to the character of the legal norm by whom it is enacted (either by the state or society), since predominant relevance is rather attributed to those that take care of its application (the state). In this regard, a failure to observe the current law and its norms is consequently linked to the application of appropriate sanctions by the state (Kutlešić, 2005).

As far as the application of the current legislation in sport is concerned, it is necessary to bear in mind that in any state exists the application not only of the national (as imperative), but also of international legislation. The international legislation gains its legal force only upon ratification by the government authorities of the specific state (parliament). In this way, it can be said that the legislation is hierarchically organized, regarding both enactment and application of legal documents (Popović, 2010). This has great importance to business activities in the sports industry, in particular with respect to management structures in the sports systems, in view of the fact that the hierarchy in the law implies such a mutual relation between legal documents in which any lower-level document is “subordinated” to the higher-level one, and must be in conformity with the latter (otherwise, it must be repealed). This fully corresponds with the general physiognomy of the structure of the sports system, in which the subordination relation prevails.

The concept of sports law can be considered through two forms: (a) as a separate branch of the law, which encompasses a systematic set of regulations governing the sports system and sport-related business activities, and (b) as a sports law science, oriented towards studying of legal concepts about sport, sports organisations, sport-related business activities, sports activities, athletes, sports infrastructure, and also about legal proceedings connected to exercising rights in sport (Šuput, 2010). Within the legal system of the Republic of Serbia, the sports law has been only recently

mened određenog propisa (ili grupe propisa) znaju „šta je trenutno na snazi“, odnosno kojem zakonskom aktu je prošao „rok trajanja“. To se svakako odnosi i na sportske organizacije.

Posmatrano iz ugla sporta (kao društvene pojave i prakse) pojam pozitivnog prava se mora tretirati kroz njegovu determinisanost koja se odnosi na sva pravila društvenog ponašanja koja su prihvaćena i važe u određenoj državi. Svi akteri i učesnici sportskog procesa, odnosno stejkholderi sportskog sistema, neophodno je da budu informisani o osnovnim aspektima pravnih normi koje tvore biće pozitivnog prava, tako da je neophodno da se pravna norma poima kroz njeno terminološko određenje kao pravilo ponašanja ljudi koje je zaštićeno državnim aparatom prinude (Mitrović, 2007). Za karakter pravne norme nije posebno značajno od strane koga je ona doneta (država ili društvo), već se dominantan značaj pridaje onome ko se stara o njenoj primeni (država). U tom smislu nepoštovanje pozitivnog prava i njegovih normi posledično je povezano sa primenom odgovarajuće državne sankcije (Kutlešić, 2005).

Kada se radi o primeni pozitivno-pravnog zakonodavstva u sportu mora se imati u vidu da u svakoj državi egzistira primena kako domaćeg (kao imperativnog), tako i međunarodnog zakonodavstva. Međunarodno zakonodavstvo postiže svoju pravnu snagu tek nakon ratifikovanja od strane organa vlasti konkretne države (parlamenta). U tom smislu može se govoriti o hijerarhijskoj uređenosti zakonodavstva, kako u pogledu donošenja pravnih akata, tako i u njihovoj primeni (Popović, 2010). Za poslovne aktivnosti u sportskoj delatnosti to je od velike važnosti, posebno kod rukovodnih struktura u sportskim sistemima, obzirom da hijerarhija u pravu podrazumeva takav međusobni odnos pravnih akata gde je niži akt „potčinjen“ višem i mora biti u saglasnosti sa njime (u suprotnom se mora ukinuti). Ovo je sasvim korespondentno sa opštom fizionomijom strukture sportskog sistema u kojem je dominantan odnos subordinacije.

Pojam sportskog prava se može posmatrati kroz dva oblika: (a) kao posebna grana prava kojim je obuhvaćen sistematičan skup propisa o sportskom sistemu i sportskim delatnostima, i (b) kao nauka sportskog prava koja je usmerena ka proučavanju pravnih pojmova o sportu, sportskim organizacijama, sportskim delatnostima, sportskim aktivnostima, sportistima, sportskoj infrastrukturi, kao i pravnim postupcima povezanim sa ostvarivanjem prava u sportu (Šuput, 2010). U okviru pravnog sistema Republike Srbije sportsko pravo se tek u novije vreme profilisalo kao nova pravna grana. U



profiled as a new branch of law. As related to the respective systematics, it is specific for its mixed features, since it is based on basic principles and specific normative solutions, which are contained in other branches of law (constitutional, civil, criminal, administrative, law of obligations, and so on). Such an approach is conditioned, first of all, upon the needs of the sporting practice, taking into account that the contemporary sport has become a highly profitable business activity (in particular in the sphere of professional sports or high-performance sports). Namely, business activities in sport (carried out mainly by sports organisations) can be freely considered as traditional service industry. Such trends in sport business industry, which predominantly extend into the domain of constitutional law, open a number of practical issues (and require answers thereto) in the fields of relations stemming from contract and torts, of commercial agreements, labour law, specific regulation of criminal liability and liability for damages, etc. What makes sport different from casual physical activities of people (what makes it a socially acceptable type of activity) is the level of legal regulation of relations in sport, which allows exercising and preserving the basic values, upon which sport is based (Šegvić, 2011). These are, in the first instance, reflected in the principles of fair play and free competition (Kačer, 2009), so that this approach takes into account the connection between sport and law. These two phenomena have had separate development pathways, but in recent times, through their interaction, the conditions have been created for laying a foundation for the development of the sports law as a separate law branch.

In order to understand more clearly the context of sports law against the determinants of management of sports organisations, it is necessary to bear in mind the distinction between the concepts of sports activity and sport business industry. The legal terminological determination (The Law on Sports, 2016; Art. 3) of the sport business industry defines it as the industry, which provides conditions for the performance of sports activities and/or enables their performance, in particular: organising of participation and carrying out of sports competitions, including international competitions, training for engaging in sports activities, and planning and managing of sports activities; activities of referees and umpires; organising of training sessions and sporting events; provision and management of sports equipment and facilities; professional education, training, improvement and information in the field of sport; research and study, and research and development activities in sport; advertising and marketing in sport; consulting and professional services in sport; intermediation in sport, organising of business activities of organisations in the field of sport. On the other

odnosu na predmetnu sistematiku karakteristično je po mešovitom obeležju obzirom da se bazira na osnovnim načelima i određenim normativnim rešenjima koja se nalaze u drugim granama prva (ustavnom, građanskom, krivičnom, upravnom, obligacionom, i sl.). Uslovljenost ovakvog pristupa leži, pre svega, u potrebama sportske prakse obzirom da je savremeni sport postao visokoprofitabilna poslovna aktivnost (posebno u sferi profesionlanog, ili sporta visokih performansi). Odnosno, poslovne aktivnosti u sportu (prvenstveno sportskih organizacija) mogu se slobodno smatrati klasičnim uslužnim sektorom. Ovakve tendencije sportske delatnosti, koje dominantno zadiru u domen ustavnog prava, otvaraju brojna praktična pitanja (i traže odgovore) u oblastima obligacionih odnosa, privrednih ugovora, radnog prava, specifično regulisanje krivične i odštetne odgovornosti, itd. Ono što sport razlikuje od stihijskih fizičkih aktivnosti ljudi (što ga čini društveno prihvatljivim vidom delatnosti) jeste nivo pravne uređenosti sportskih odnosa koji omogućavaju ostvarivanje i očuvanje osnovnih vrednosti na kojima se sport zasniva (Šegvić, 2011). One se, pre svega, ogledaju u načelima fer pleja (poštene igre) i slobodnog takmičenja (Kačer, 2009), tako da se u ovom pristupu posmatra povezanost sporta i prava. Razvojni put ova dva fenomena je tekao odvojeno, ali su se njihovom interakcijom u novije vreme stvorili uslovi za uspostavljanje temelja za razvoj sportskog prava kao posebne grana prava.

Da bi se jasnije mogao shvatiti kontekst sportskog prava u odnosu na determinante upravljanja sportskim organizacijama neophodno je imati u vidu distinkciju pojmova sportske aktivnosti i sportske delatnosti. Zakonska terminološka određenost (Zakon o sportu, 2016; čl. 3) sportske delatnosti određuje kao delatnosti kojima se obezbeđuju uslovi za obavljanje sportskih aktivnosti, odnosno omogućava njihovo obavljanje, a naročito: organizovanje učešća i vođenje sportskih takmičenja, uključujući i međunarodna takmičenja, obučavanje za bavljenje sportskim aktivnostima i planiranje i vođenje sportskih aktivnosti; sportsko suđenje; organizovanje sportskih priprema i sportskih priredaba; obezbeđenje i upravljanje sportskom opremom i objektima; stručno obrazovanje, osposobljavanje, usavršavanje i informisanje u oblasti sporta; naučnoistraživački i istraživačko-razvojni rad u sportu; propaganda i marketing u sportu; savetodavne i stručne usluge u sportu; sportsko posredovanje, organizovanje poslovanja organizacija u oblasti sporta. Sa druge strane sportskim aktivnostima se smatraju svi oblici fizičke i umne aktivnosti koji, kroz neorganizovano ili organizovano učešće, imaju za cilj izražavanje ili

hand, sports activities encompass any forms of physical and mental activities which are, through either non-organised or organised participation, aimed to express or improve physical fitness and mental wellness, establish social relations, or achieve results in competitions at all levels.

The current legal regulations in sport, in particular if analysed in the context of management of sports organisations, can be practically considered also as the „sports legislation“. That is, as the existence of the set of laws and legal regulations governing the relations, procedures and operation of sports organisations (as a base for the existence of sport), i.e., the entire sports system (in a specific state). Likewise in other social spheres, in sport this issue also calls attention to the following legal documents of a state: (a) constitution (as the basic law of the state, governing the most important issues concerning the social and political structure, provided that any other regulations enacted by the government authorities must be compliant with it), (b) laws (as written sources having the supreme legal power that must be observed/applied by all legal entities and natural persons), (c) subordinate legislation (legal documents stemming from laws and being a base for full enforcement thereof; such documents are, in addition to the government authorities, also passed by other administrative organisations), and (d) internal bylaws (passed by the head of a relevant administrative body, as well as by managing bodies of business entities; in this context – managing bodies of sports organisations).

### **SPORT AS AN AREA FOR THE EXISTENCE OF SPORTS LAW**

Modern understandings of sport take the view that sport is today a very important public activity (the most widely accepted and also intensively publicly followed in a society), so that the management processes in the sports system require professional knowledge, responsibility and business ethics. Furthermore, it has become an industry in which are engaged numerous organisations, institutions and individuals, a social life sphere having also its own scientific validity. Sport plays a very prominent social role, which arises out of its essentially multidisciplinary nature. Hence, regarding the interpretation of its social dimension, two approaches exist: the first one, attributing to sport mainly the role which to the largest extent corresponds to the interests of a specific society, leading social ideology or political goals (for instance, adherents of existentialism represent sport as a way of self-affirmation of a human personality which, in the global post-industrial society where people are greatly subjected to manipulation, has become one of the main instruments for self-realization of a person) (Tomić, 2007); the other one is based on the compensation theory

poboljšanje fizičke spremnosti i duhovnog blagostanja, stvaranje društvenih odnosa ili postizanje rezultata na takmičenjima svih nivoa.

Pozitivno pravna regulativa u sportu, posebno kada se posmatra kroz kontekst upravljanja sportskim organizacijama, može se aplikativno posmatrati i kao „sportsko zakonodavstvo“. Odnosno kao egzistencija skupa zakona i pravnih regulativa koje upravljaju odnosima, postupcima i funkcionisanju sportskih organizacija (kao osnove egzistencije sporta), odnosno sportskim sistemom u selini (u određenoj državi). Kao i u drugim društvenim sferama, tako i u sportu ovo pitanje usmerava pažnju na sledeće pravne akte u državi: (a) ustav (kao osnovni zakon države kojim se uređuju najvažnija pitanja društveno-političkog uređenja, a svi drugi propisi koje donose državni organi moraju biti usklađeni sa njim), (b) zakoni (kao pisani izvori koji imaju najvišu pravnu snagu i moraju biti poštovani/primenjivani od strane svih pravnih i fizičkih lica), (c) podzakonski normativni akti (pravni akti koji proizilaze iz zakona i osnova su njegovog sadržajnog izvršenja; ove akte, osim državnih organa, donose i druge upravne organizacije), i (d) interna akta (donose ih starešine nadležnog organa uprave, kao i upravni organi poslovnih subjekata; u ovom kontekstu – upravni organi sportskih organizacija).

### **SPORT KAO PODRUČJE ZA EGZISTENCIJU SPORTSKOG PRAVA**

Savremena shvatanja sporta stoje na stanovištu da je on danas vrlo značajna javna delatnost (najšire prihvaćena, ali i intenzivno javno praćena u društvu) tako da upravljački procesi u sistemu sporta zahtevaju stručno znanje, odgovornost i poslovnu etičnost. Takođe, postao je i delatnost kojom se bave brojne organizacije, institucije i pojedinci, oblast socijalnog života koji ima i svoju naučnu zasnovanost. Sport poseduje veoma izraženu socijalnu ulogu koja proizilazi iz njegove suštinske multidisciplinarnosti, tako da u pogledu tumačenja njegove društvene dimenzije egzistiraju dva pristupa: prvi, gde se sportu uglavnom pripisuje uloga koja u najvećoj meri odgovara interesima određenog društva, vodećoj društvenoj ideologiji ili političkim ciljevima (npr. zastupnici egzistencijalizma sport predstavljaju kao način samopotvrđivanja ljudske ličnosti koji u globalnom postindustrijskom društvu, gde se uglavnom manipuliše ljudima, postaje jedno do osnovnih sredstava samorealizacije čoveka) (Tomić, 2007); drugi, koji se zasniva na Teoriji kompenzacije i polazi od poistovećivanja društvenog razvoja sa tehničkim progresom (tumačenje čoveka i njegovog razvoja sa-

and proceeds from equating the social development with technical progress (interpretation of an individual and of his/her development is perceived through absolutisation of his/her natural conditionality/natural substance, while social changes are represented only as a result of the development of natural determinants) (Nešić, 2008a).

With its functions and comprehensiveness, sport is an important factor for shaping and creating of a social ambient. The social character of sport is specifically indicative in the processes which affect the changes in particular human relations, which is specifically reflected in developing of friendship, fellowship, social contacts, business communication, and so forth. Or, to put it another way, the sport industry, as an important factor of the "social superstructure", with its public character, is a significant development factor of every society. In addition to general social values, sport has also become an inevitable factor of the economic ambient over the past decades. Many business arrangements are stipulated within particular sporting events and activities, while entire communication systems operate by way of sport (Nešić, 2018).

Irrespective of various theoretical approaches in interpretation of the concept and essence of sport, in particular within its sociological context, sport must be universally treated through its three basic characteristics (in the context of direct stakeholders in sporting activities): (1) competition, (2) achievement of maximum (sporting) scores, and (3) intense psycho-physical load. The essence of competition is illustrated by efforts made by an individual or group (teams, crews) to achieve better or faster the same goal that the others also strive for. Competition in itself also contains specific formative values, which are reflected in the fact that an individual, over the course of time, becomes better, stronger, more capable, healthier, and constantly tends to exceed his/her level of development achieved. This, further, leads to generating a strong tendency to achieve maximum, measurable sports performance. However, to achieve increasingly higher performance implies that one has to continuously increase one's own physical and mental efforts, which should be adequately dosed and controlled (Nešić & Lolić, 2008).

When considering the topic of sport in a wider sociological context, the attention is, in the first instance, paid to its dimensions of entertainment, recreation, physical achievements of athletes embodied in the sports performance, and so forth. However, the attention of a narrower segment of scientific and practical approach to sport, as a complex phenomenon, is represented with a relatively small circle of researchers (mostly those who "originate" from sports or who have substantially understood latent dimensions of sport). Within this scope, there is a continuous "search" for

gledava se kroz apsolutizovanje njegove prirodne uslovljenosti/prirodne suštine, dok se društvene promene predstavljaju isključivo kao rezultat razvoja prirodnih determinanti) (Nešić, 2008a).

Sport sa svojim funkcijama i obuhvatnošću bitan je faktor oblikovanja i stvaranja socijalnog ambijenta. Društveni karakter sporta naročito je indikativan u procesima koji utiču na promene u pojedinim međuljudskim odnosima, što se naročito ogleda u razvijanju prijateljstva, drugarstva, socijalnih kontakata, poslovne komunikacije i sl. Drugim rečima, sportska delatnost kao bitan činilac „društvene nadgradnje“ svojim javnim karakterom je značajan razvojni faktor svakog društva. Pored opšte društvenih vrednosti sport poslednjih decenija postaje i nezaobilazan činilac ekonomskog ambijenta. Mnogi se poslovni aranžmani sklapaju u uslovima pojedinih sportskih događaja i aktivnosti, a čitavi sistemi komunikacije se ostvaruju posredstvom sporta (Nešić, 2008).

Bez obzira na različite teorijske pristupe u tumačenju pojma i suštine sporta, posebno u njegovom sociološkom kontekstu, sport se mora univerzalno tretirati kroz svoje tri osnovne karakteristike (u kontekstu neporednih aktera sportskih aktivnosti): (1) takmičenje, (2) postizanja maksimalnog (sportskog) rezultata i (3) intenzivno psihofizičko opterećenje. Suštinu takmičenja odlikava nastojanje pojedinca ili grupe (timova, ekipa) da bolje ili brže postignu isti cilj kome teže i drugi. Takmičenje u sebi sadrži i specifične vaspitne vrednosti koje se ogledaju u tome da čovek vremenom postaje bolji, jači, sposobniji, zdraviji i da stalno teži ka prevaziženju dostignutog nivoa svoga razvoja. Ovo, nadalje, dovodi do stvaranja snažne težnje za postizanjem maksimalnog, sportski merljivog rezultata. Međutim, postizanje sve većeg rezultata podrazumeva i stalno povećanje čovekovih telesnih i mentalnih napora, koji bi trebalo da budu adekvatno dozirani i kontrolisani (Nešić & Lolić, 2008).

Kada se tematika sporta razmatra u širem sociološkom kontekstu u prvom redu se usmerava pažnja na njegove dimenzije zabave, razonode, fizičkih postignuća sportista personificiranih u sportskom rezultatu, i sl. Međutim, pažnja užeg segmenta naučno-praktičnog pristupa sportu kao kompleksnom fenomenu zastupljena je u relativno malom krugu istraživača (uglavnom onih koji su "potekli" iz sporta ili su suštinski shvatili latentne dimenzije sporta). U tom obuhvatu egzistira stalna "potraga" za linijom koja deli sport na, uslovno, dva područja: (1) deo koji je krucijalan kulturni element društva, i (2) deo koji obuhvata značajnu ekonomsku aktivnost (Bačić & Bačić, 2011). Bez obzira na to o

a line dividing sport into, conditionally, two sections: (1) a part crucial to the cultural element of a society, and (2) a part encompassing a substantial economic activity (Bačić & Bačić, 2011). Irrespective of which "line" of studying and perceiving of sport is in question, legal determinants are the components binding upon all of its stakeholders. The current legal regulations have equal implications not only for the approach to sport through its socially positive categories (health; achievement; morality; participation in sports performance, resulting from discipline, motivation, team work, etc.; and/or opportunities which sports activities, as a dynamic dimension of sport, open for development of permanent human values), but also, even more, for its negative reflections (emphasizing the significance of victory; absolutisation of money awards as a main purpose for going in for sports; influence of power groups from the world of business, which tend to shape sports in accordance with their own interests and goals; disaffirmation of inherent values of fair-play; abuse of sports for money laundering; use of doping; politicization of sporting events; etc.)

The sports law, as already pointed up, constitutes quite a new branch of the legal system, which is formatted on the respective systematics with mixed features. It includes basic principles, but also specific normative solutions that belong the spheres of certain traditional branches of law (constitutional, civil, criminal, administrative, law of obligation, labour law, etc.). The integration in a separate systemic unit resulted from practical needs identified in recent years in current trends in the development of modern sport. This has been in particular intensified though a clear understanding of sport as a highly profitable business activity. This has opened a number of issues interfering with domains of various types of law. Sporting activities often take place outside state borders, whereby becomes evident also their dimension of international legal responsibility, thus influencing an increasingly fast development of the specific legal regulations which accompany and direct the specific sport-related legal practice. Therefore, the current legal regulations with respect to sport can be considered from the point of view of different areas of the scientific (and also practical) approach, which are encompassed by academic studies<sup>1</sup>: (a) constitutional base of sports law, (b) administrative, organisational and financial law in sport; (c) contract law in sport, (d) tort law, (e) criminal liability in sport, (f) international sports law, (g) European Union sports law, (h) labour law, etc.

### SPORTS ORGANISATION AS A MANAGED SYSTEM

The sports activities organised in modern days constitute a complex system, which exists in a statutory deter-

kojoj se "liniji" proučavanja i sagladavanja sporta radi, zakonske determinante su obavezujuća komponenta za sve njegove aktere. Pozitivno pravna regulativa je podjednako implicitna kako na pristup sportu kroz njegove društveno pozitivne kategorije (zdravlje; postignuće; moralnost; participacija u sportskim rezultatima koji su posledica discipline, motivisanosti, timskog rada i sl.; odnosno mogućnostima koje sportske aktivnosti, kao dinamička dimenzija sporta, otvaraju za razvoj trajnih ljudskih vrednosti), tako još više na njegove negativne refleksije (naglašavanje značaja pobeđe; apsolutizovanje novčanih nagrada kao dominantnog smisla bavljenja sportom; uticaja moćnih grupa iz sveta biznisa koje sport nastoje da uobliče prema sopstvenim interesima i ciljevima; negacija inherentnih vrednosti fer pleja; zloupotreba sporta u „pranju“ novca; korišćenje dopinga; politizacija sportskih događaja; itd.)

Sportsko pravo, kako je već naglašeno, predstavlja noviju granu pravnog sistema koja je formatirana na predmetnoj sistematici sa mešovitim obeležjima. Obuhvata osnovna načela, ali i konkretna normativna rešenja koja pripadaju sferama pojedinih klasičnih grana prava (ustavno, građansko, krivično, upravno, obligaciono, radno, itd.). Objedinjavanje u zasebnu sistemsku celinu bilo je uslovljeno praktičnim potrebama koje su identifikovane poslednjih godina u aktelnim tendencijama razvoja savremenog sporta. To se naročito intenziviralo kroz jasnu spoznaju današnjeg sporta kao visoko profitabilne poslovne aktivnosti. To je otvorilo brojna pitanja koja zadiru u domene različitih vrsta prava. Sportske aktivnosti se često odvijaju izvan državnih granica, pri čemu dolazi do izražaja i njihova međunarodno pravna dimenzija, što utiče na sve brži razvoj posebne pravne regule koja prati i usmerava specifičnu sportsko-pravnu praksu. Stoga se o pozitivno pravnoj regulativi u sportu može govoriti iz ugla različitih prostora naučnog (ali i praktičnog) pristupa koji su obuhvaćeni akademskim izučavanjem<sup>1</sup>: (a) ustavne osnove sportskog prava, (b) administrativno, organizaciono i finansijsko pravo u sportu; (c) ugovorno pravo u sportu, (d) odštetno pravo, (e) krivično pravna odgovornost u sportu, (f) međunarodno sportsko pravo, (g) sportsko pravo Evropske unije, (h) radno pravo, itd.

### SPORTSKA ORGANIZACIJA KAO SISTEM KOJIM SE UPRAVLJA

Savremeno organizovane sportske aktivnosti predstavljaju kompleksan sistem koji egzistira u zakonski određenoj i pravno uobličenoj organizacionoj formi.

<sup>1</sup> <https://www.uns.ac.rs/index.php/c-clanice/centri/acimsi>

<sup>1</sup> <https://www.uns.ac.rs/index.php/c-clanice/centri/acimsi>

mined and legally shaped organisational form. The specific sports organisations are, in the broadest term, institutionalized through sports clubs. By its nature, these are in the most number of cases formed as associations (a system of grouping all persons who have organized themselves for the purpose of physical workout, training and competing, as a common purpose and/or goal) (Nešić & Nešić, 2012).

Although regarding the organisational physiognomy and form of the formal and legal determination of sports organisations there is a wide range of various options for their expression, their common characteristic is that the organisation is not a goal in itself, but rather one of the general sporting strategies for reaching the set goal. This means that a sports organisation implies the regulation, coordination and direction of all parts of the unit (functions, processes and relations therein) for the purpose of achieving the set athletic goals (Tomić, 2007). Therefore, the system approach to the way of forming a sports organisation provides for a purposeful theoretical framework for solving the issue of selection of the type of organising appropriate for realistic, constantly changing circumstances relevant to sports activities. A well-designed organisational system is the first and most important instrument for successful management of a sports organisation (Raič, 1999).

The existence of several mutually dependent subsystems is typical of the structural functioning of a sports organisation. Taking into account the size, orientation and mission of a specific sports organization, the subsystems can be created as: training process, management, marketing, sporting facilities and infrastructure, finance, etc. Each of the subsystems implies certain characteristics and properties that may characterize it also as a relatively independent part of the sports organisation, separated (conditionally) from other subsystems in it (Nešić, 2014). This can be particularly noticed in the training process, which constitutes the central part of every sports organisation. Therefore, the system approach in structuring a sports organisation is the determinant for an appropriate theoretical, but also a practical framework which solves the issue of selection of the type of organising appropriate for the realistic environment in which sports activities take place. A well-designed organisational system is the first and most important instrument for successful management of a sports organisation (Nešić, 2017).

Any sports organisation is fundamentally based on three "pillars": structure, functions and processes. Although these organisational components are interconnected and interactively determined, from the point of view of internal specificity of sport and its values, the organisational functions must be recognised in the professional scope

Konkretne sportske organizacije su, u najširem obliku, institucionalizovane kroz sportske klubove. Oni su po svom karakteru, u najvećem broju slučajeva, formirani kao udruženja (sistem grupisanja lica koja su se organizovala radi fizičkog vežbanja, treniranja i takmičenja, kao zajedničke svrhe, odnosno cilja) (Nešić & Nešić, 2012).

Mada u pogledu organizacione fizionomije i oblika formalno-pravne determinisanosti kod sportskih organizacija postoji širok spektar različitih mogućnosti njihovog ispoljavanja, zajednička karakteristika im je da organizacija nije sama sebi cilj, već jedna od opštih sportskih strategija dolaženja do postavljenog cilja. To znači da sportska organizacija podrazumeva uređivanje, koordinaciju i vođenje svih delova celine (funkcije, procese i odnose u njima) radi ostvarivanja postavljenih sportskih ciljeva (Tomić, 2007). Stoga sistemski pristup oblikovanja sportske organizacije daje svrsishodan teorijski okvir za rešavanje problema izbora tipa organizovanja primerenog realnim, stalno promenljivim okolnostima sportskih aktivnosti. Dobro projektivani organizacioni sistem je prvi i najvažniji instrument uspešnog menadžmenta sportske organizacije (Raič, 1999).

Strukturno funkcionisanje sportske organizacije karakteristično je po egzistenciji više međusobno zavisnih podsistema. U odnosu na veličinu, usmerenost i misiju konkretne sportske organizacije, podsystemi mogu biti kreirani kao: trenažni proces, upravljanje, marketing, sportski objekti i infrastruktura, finansije, itd. Svaki od podsistema podrazumeva određene karakteristike i svojstva koja ga mogu karakterisati i kao relativno nezavisan deo sportske organizacije, odvojen (uslovno) od drugih podsistema u njoj (Nešić, 2014). To se posebno može uočiti kod trenažnog procesa koji predstavlja centralni deo svake sportske organizacije. Zbog toga je sistemski pristup u strukturiranju sportske organizacije determinanta za odgovarajući teorijski, ali i praktični okvir, kojim se rešava problem izbora tipa organizovanja primerenog realnom okruženju u kojem se odvijaju sportskih aktivnosti. Dobro projektovani organizacioni sistem je prvi i najvažniji instrument uspešnog menadžmenta sportske organizacije (Nešić, 2017).

Sušinski se sportska organizacija temelji na tri "stuba": strukturi, funkcijama i procesima. Mada su ove organizacijske komponente međusobno povezane i interaktivno determinisane, sa aspekta unutrašnje osobenosti sporta i njegovih vrednosti, organizacione funkcije moraju biti prepoznate u stručnom opsegu svih pojedinačnih subjekata sportskog procesa. U sportskoj praksi se najče-

of all individual entities in the sport process. In the sporting practice is most commonly used (as a basic model) the functional structuring of club organisation through: 1) sports function (sports-functional subsystem), and 2) business function (business subsystem). Through the sports-functional subsystem of a club are included, according to the principle of interactive relation, the following parts (functions): training, competition, professional and pedagogic work, selection, training technology development, scientific and research activity, and so forth. As business functions of a club (business subsystem), the following may exist: marketing, finance, employment division, facilities and equipment, investment and innovation, division of operations and profit, etc. (Nešić, 2008).

In the sport business industry nowadays prevails an entrepreneurship attitude according to which the competitive advantage of a sports organisation (as a multi-dimensional system) is not primarily based on the fact "what it has" (that others don't have), but rather on "what the organisation can and may do better than others" (Nešić, 2014:105). In the light of sports management, organising refers to the processes, which enable an adequate division of labour at a sports institution into individual tasks and groups of interdependent jobs, to which the managers assign responsibilities within specific groups of activities, including their mutual relations. Any efficient management must take care of the most rational forms of work of the club, which is one of the basic roles of organising as a management function. The organisational structure of a sports institution may significantly affect the ways in which the business processes and operational activities are conducted in it. If anyone wishes to reach as high level of success of a sports organization as possible, and/or upgrade the quality of services provided to the clients, then its structural elements should be created observing, at the same time, the relevance of the organizational design, the task of which is to ensure a smooth generating and use of new knowledge and method of operation within the sports system (Nešić & Fratrić, 2013). Implementation of modern methods for improvement of score performances of a sports organisation has become a synonym for success of its business activity. Constant improvement and innovation in the activities of a sports organisation, in particular in the training process and organisational subsystems associated therewith, which lead to continuous improvements of all business activity segments, constitutes the best and the most efficient way to satisfy the organisation members, as well as related stakeholders (new prospective service clients, spectators and fans, investors, shareholders, sponsors, etc.) (Nešić, 2014).

šće može sresti (kao osnovni model) funkcionalno strukturiranje organizacije kluba kroz: 1) sportsku funkciju (sportsko-funkcionalni podsistem) i 2) poslovnu funkciju (poslovni podsistem). Kroz sportsko-funkcionalni podsistem kluba obuhvaćeni su, po principu interaktivnog odnosa, sledeći delovi (funkcije): trening, takmičenje, stručno-pedagoški rad, selekcija, razvoj trenažne tehnologije, naučno-istraživačka delatnost, i sl. Kao poslovne funkcije kluba (poslovni podsistem) mogu da egzistiraju: marketing, finansije, kadrovska služba, objekti i oprema, investicije i inovacije, poslovno-profitni sektor, itd. (Nešić, 2008).

U sportskoj delatnosti danas postoji dominantan preduzetnički stav da se konkurentska prednost sportske organizacije (kao višedimenzionalnog organizacionog sistema) ne zasniva primarno na činjenici "šta ona ima" (a druga nema), već na osnovu toga "šta organizacija ume i može da uradi bolje od drugih" (Nešić, 2014: 105). U svetlu sportskog menadžmenta, organizovanje se odnosi na procese koji omogućavaju adekvatnu podelu rada u sportskoj instituciji na pojedinačne zadatke i grupe međuzavisnih poslova, kojima menadžeri određuju odgovornosti u okviru pojedinih grupacija aktivnosti, kao i njihove međusobne odnose. Efikasan menadžment mora da vodi računa o najracionalnijim oblicima rada kluba, što je jedna od osnovnih uloga organizovanja kao menadžment funkcije. Organizaciona struktura sportske institucije može bitno da utiče na načine kojima se u njoj odvijaju poslovni procesi i radne aktivnosti. Ukoliko se želi dostići što viši nivo uspešnosti sportske organizacije, odnosno podići kvalitet usluga koje pruža korisnicima, tada bi se njeni strukturni elementi trebali kreirati uz uvažavanje značaja organizacionog dizajna, čiji je zadatak obezbeđivanje nesmetanog generisanja i korišćenja novih znanja i metoda rada u sportskom sistemu (Nešić & Fratrić, 2013). Implementacija savremenih metoda za poboljšanje rezultatskih performansi sportske organizacije postao je sinonim za uspešnost njenog poslovanja. Konstantno usavršavanje i inovativnost u aktivnostima sportske organizacije, posebno u trenažnom procesu i sa njime povezanih organizacionih podsistema, koji dovode do kontinuiranih poboljšanja svih segmenata poslovanja, predstavljaju najbolji i najbrži put do zadovoljnih članova organizacije, kao i povezanih stejkholdera (novih potencijalnih korisnika usluga, sportske publike, ulagača, deoničara, sponzora, itd.) (Nešić, 2014).

Upravljačke performanse sportske organizacije uslovljene su, pre svega, organizacionim modelom koji je koherentan sa njenim ciljevima, misijom i kapaciteti-

The management performances of a sports organisation are conditioned, first of all, upon the organisational model which is coherent to its goals, mission and capacities, as well as upon specific features of the sports branch it belongs to. However, the starting point in all activities lies in the application of the legal regulations, which are oriented not only towards the issues of establishing and commencement of operation of a sports organisation, but also towards the obligations of the management structures during its "life". The legal soundness is defined through the Law on Sports (2016) by an explicit definition of the rights and obligations of all entities within the sports system of the Republic of Serbia, such as: legal status; organisation and registration of organisation in the field of sport; general interest, needs and citizen interests in the field of sport; funding; categorisations in the field of sport; national sports development strategy in the Republic of Serbia; school and university sports and physical education of pre-school children; sporting facilities; organising of sporting events; national recognitions and awards for special contribution to the development and affirmation of sport; record-keeping and supervision of the operations of organisations in the field of sport (Art. 1).

### SPORTS ORGANISATIONS AND LEGAL REGULATIONS

The legal systems in the majority of European states recognize and respect the sports law, as well as the regulations complementary thereto, which make it a social reality. The content of the currently existing applicable legal regulations, governing the field of sports in the Republic of Serbia, evidences the efforts made by the state to protect in sport (sports activities and sport business industry) the positive values it holds and promotes. Taking into account that the law constitutes a set of norms of human behaviour (which are prescribed and sanctioned coercively by the sovereign state authorities), it is logical that sports activities (as a type of human activity/behaviour) also fall within the competence of the state and its legal structure. Furthermore, the role of the state is to enable and uphold exercising of social functions of sport, which is possible only if the sports system is operating and if the sports activities are organised and carried out in accordance with the rules prescribed in advance, which rules enjoy the protection of the state apparatus of institutionalized coercion (Šegvić, 2011: 777).

How the state will regulate the relations in sport, i.e., legal protection measures it provides to sports entities, depends on the selection of the model of legal regulation of sport. In practice, two of them prevail: (1) interventionist (when the major part of the sports system is legally regu-

ma, kao i specifičnostima sportske grane kojoj pripada. Međutim, polazište u svim aktivnostima leži u primeni zakonske regulative, koja je usmerena, kako na pitanja osnivanja i početka rada sportske organizacije, tako i na obaveze upravljačkih struktura tokom njenog „života“. Pravna utemeljenost kroz Zakon o sportu (2016) definisana je eksplicitnim određenjem prava i obaveza svih subjekata u sistemu sporta Republike Srbije, kao što su: pravni položaj; organizacija i registracija organizacije u oblasti sporta; opšti interes, potrebe i interesi građana u oblasti sporta; finansiranje; kategorizacije u oblasti sporta; nacionalna strategija razvoja sporta u Republici Srbiji; školski i univerzitetski sport i fizičko vaspitanje dece predškolskog uzrasta; sportski objekti; organizovanje sportskih priredaba; nacionalna priznanja i nagrade za poseban doprinos razvoju i afirmaciji sporta; vođenje evidencija i nadzor nad radom organizacija u oblasti sporta (čl. 1).

### SPORTSKE ORGANIZACIJE I PRAVNA REGULATIVA

Pravni sistemi u većini evropskih država prepoznaju i uvažavaju sportsko pravo, kao i njemu komplementarne propise koji ga čine društvenom realnošću. Sadržaj trenutno postojeće pozitivno pravne regulative koja uređuju oblast sporta u Republici Srbiji govori o nastojanjima države da u sportu (sportskim aktivnostima i delatnostima) zaštite pozitivne vrednosti koje on nosi i promoviše. Obzirom da pravo predstavlja skup normi o ljudskom ponašanju (koje propisuje i prinudom sankcioniše suverena državna vlast), logično je da se i sportske aktivnosti (kao vid ljudske delatnosti/ponašanja) nalaze u nadležnosti države i njenog pravnog poretk. Takođe, uloga države je da omogući i podrži ostvarivanje socijalnih funkcija sporta, što je moguće samo ako sportski sistem funkcioniše, a sportske aktivnosti se organizuju i sprovode po unapred propisanim pravilima koja uživaju zaštitu državnog aparata institucionalizovane prinude (Šegvić, 2011: 777).

Kako će država regulisati odnose u sportu, odnosno mere pravne zaštite koje pruža sportskim subjektima, zavisi od izbora modela zakonskog uređenja sporta. U praksi dominiraju dva: (1) intervenistički (kada država najveći deo sportskog sistema pravno reguliše posebnim zakonom/Zakonom o sportu<sup>2</sup>), i (2) neintervenistički (gde je pravna zaštita sportskih odnosa parcijalna; pravne norme koje se odnose na sport su raspo-

<sup>2</sup> Na ovaj način se šalje jasna "poruka" građanima da je sport društvena delatnost koja je pod eksplicitnom pravnom zaštitom, čime se afirmišu njegove društvene vrednosti.

lated by the state by a separate law/the Law on Sports<sup>2</sup>), and (2) non-interventionist (where the legal protection of sports relations is partial; the legal norms relating to sport are distributed in a large number of regulations governing the performance in other areas of human activities – e.g. health and social protection, pensions insurance, culture, education, employment protection, citizen associations, etc.). Irrespective of the theoretical model in question, for practitioners in sport, i.e., persons managing sports organisations, it is of primary importance to be aware of (and to accept) the dictum that “ignorance of the law excuses no one”.

The Law on Sports (2016; Art. 2) defines sport as the activity of special importance to the Republic of Serbia. The legal entities in the sports system are formed as sports organisations, having this status if set up for the purpose of carrying out sports activities and sport-related business activity, pursuant to the law (Art. 3). From the point of view of the existence of sport organisation as a managed system (legal entity) and activities carried out in it, which are relevant to the management structures, the Law (2016) provides for (Art. 33) that for the purpose of carrying out sport-related business activities, a sport organisation can be set up as an association (sport association) or as a company (sport company). To any issues not regulated by this law, the general regulations governing associations and/or companies shall apply. The provision that is essential, which is to be directly implicated and implemented “in consciousness” of people who manage a sports organisation, is related to the basic conditions required regarding the legality of operation. To this end, Article 35 of the Law explicitly determines that a sport organisation may carry out sports activities and be engaged in the sport business industry if, in accordance with this law and sports rules, it has: (1) athletes who are its members or who are hired under contract; (2) engaged sport experts, depending on the type of activity; (3) ensured an appropriate space, i.e., sporting facilities and sporting equipment; (4) appropriate internal organisation and funds, if takes part in sporting competitions; (5) ensured safety of the athletes and other participants in carrying out sports activities and sport-related business activity.

So, this legal solution clearly sets determinants for the rights and obligations of human resources in the management part of a sports organisation, and implicitly directs the areas for legal responsibility in line with the legal regulations of the environment in which the business activity is carried out. This is irrespective of whether a sports organisation in the form of association (voluntary non-profit or-

<sup>2</sup>In this way, a clear message” is sent to citizens that sport is a social activity, which is under the explicit legal protection, whereby its social values are affirmed.

ređene u većem broju propisa koji regulišu obavljanje drugih područja ljudskih delatnosti – npr. zdravstvena i socijalna zaštita, penzijsko osiguranje, kultura, obrazovanje, radnopravna zaštita, udruženja građana, itd.). Bez obzira o kojem je teorijskom modelu reč, za praktičare u sportu, odnosno ljude koji upravljaju sportskim organizacijama, od prvenstvenog je značaja poznavanje (i prihvatanje) sentence da “nepoznavaje zakona ne oslobađa od odgovornosti”.

Zakon o sportu (2016; čl. 2) definisao je da je sport delatnost od posebnog značaja za Republiku Srbiju. Pravna lica u sistemu sporta su uobličena kroz sportske organizacije koje ovaj status ostvaruju ako su osnovane radi obavljanja sportskih aktivnosti i sportskih delatnosti, u skladu sa zakonom (čl. 3). Posmatrano sa aspekta egzistencije sportske organizacije kao sistema kojim se upravlja (pravnog subjekta) i aktivnostima koje se u njoj odvijaju, a od značaja su za upravljačke strukture, Zakonom (2016) je utvrđeno (čl. 33) da se radi obavljanja sportskih aktivnosti i sportskih delatnosti sportska organizacija može osnovati kao udruženje (sportsko udruženje) ili kao privredno društvo (sportsko privredno društvo). Na pitanja koja nisu uređena ovim zakonom primenjuju se opšti propisi o udruženjima, odnosno privrednim društvima. Ono što je esencijalna odredba koja se direktno implicira i mora biti implementirana „u svest“ ljudi koji upravljaju sportskom organizacijom odnosi se na osnovne uslove koji se postavljaju u pogledu zakonitosti rada. Tako se u članu 35. Zakona eksplicitno određuje da sportska organizacija može obavljati sportske aktivnosti i sportske delatnosti ako, u skladu sa ovim zakonom i sportskim pravilima, ima: (1) učlanjene ili ugovorom angažovane sportiste; (2) angažovane sportske stručnjake u zavisnosti od vrste delatnosti; (3) obezbeđen odgovarajući prostor, odnosno sportske objekte i sportsku opremu; (4) odgovarajuću unutrašnju organizaciju i finansijska sredstva, ako učestvuje u sportskim takmičenjima; (5) osiguranu bezbednost sportista i drugih učesnika pri obavljanju sportskih aktivnosti i delatnosti.

Dakle, ovakvim zakonskim rešenjem se jasno postavljaju determinante prava i obaveza ljudskih resursa u upravljačkom delu sportske organizacije, te implicitno usmeravaju prostori pravne odgovornosti u skladu sa zakonskom regulativom okruženja u kojem se ostvaruje poslovna aktivnost, bez obzira da li se radi o sportskoj organizaciji kao udruženju (dobrovoljnoj nedobitnoj organizaciji zasnovanoj na slobodi udruživanja više fizičkih i/ili pravnih lica) ili sportskom privrednom društvu (d.o.o. ili a.d.).



ganisation based on the freedom of association of several natural persons and/or legal entities), or a sports company (LLC or JSC) is concerned.

The basis of the management responsibility in a sports organisation lies in the quintessence of sport, i.e., in the activities predominantly taking place in it. This is so-called core of the sports system – the training process. Since it takes place under permanent pressures of various kind (predominantly health risks of the basic sports substance - athletes), it is necessary to bear in mind constantly the basic postulates relating to the follows (Art. 4): everyone has the right to go in for sports; going in for sports must be human, free and voluntarily, healthy and safe, in accordance with the natural ambient and social environment, fair, tolerant, ethically acceptable, responsible, independent from any abuse and goals which are in contrast with the spirit of sport, and must be available to all citizens under equal conditions, irrespective of their age, level of physical abilities, degree of possible disability, sex, and any other personal quality.

For this reason has been defined a so-called procedural framework, to determine the basic areas covered by the legal regulations: law(s), sports rules<sup>3</sup> and conventions in the field of sport. Organisations in the field of sport accomplish their goals and carry out sporting activities in compliance with the law, sports rules, ratified conventions in the field of sport and principles set forth in the documents of international organisations, the member of which is the Republic of Serbia (Art. 6).

What is typical of the activities of a sports organisation is the specific responsibility of the people who manage the basic process – training. In this regard, it is relevant to all sports organisations to apply the basic rule of legal framework regarding the operation of sports experts. In the sporting practice (domestic and international) this refers to the fact that the applicable laws shall be applied subject to the place of performance of the work activity. In particular, the responsibilities and duties of coaches are directed towards an increased care in application of the legislation and of

<sup>3</sup> Sports rules are, in practice, considered as a kind of “sports laws“, taking into account that they are binding upon all the stakeholders in sports activities, in particular within sports competitions. The sports rules are hierarchically arranged. In this regard, the Law on Sports (2016) has recognized and explicitly defined the provisions creating a binding legal framework, stating in Art. 6 paragraph 2 and 3 that: sports rules shall directly apply to all persons falling directly or indirectly within the competence of the relevant national sport association. The relevant national sport associations bring their sports rules in line with the sports rules of the relevant international sport association, and if not brought in line, or if the relevant national sport association has failed to adopt the respective sports rules, the sports rules of the relevant international sport association shall directly apply, unless they are not in compliance with this law.

Osnova upravljačke odgovornosti u sportskoj organizaciji leži u biću sporta, odnosno aktivnostima koje se u njoj dominantno odvijaju, a to je tzv. jezgro sportskog sistema – trenažni proces. Kako se on odvija pod stalnim pritiskom različitih vrsta (prevashodno rizika po zdravlje osnovne sportske supstance – sportista) to se konstantno moraju imati u vidu osnovni postulati koji se odnose na sledeće (čl. 4): svako ima pravo da se bavi sportom; bavljenje sportom mora biti humano, slobodno i dobrovoljno, zdravo i bezbedno, u skladu sa prirodnom sredinom i društvenim okruženjem, fer, tolerantno, etički prihvatljivo, odgovorno, nezavisno od zloupotreba i ciljeva koji su suprotni sportskom duhu i dostupno svim građanima pod jednakim uslovima, bez obzira na uzrast, nivo fizičkih sposobnosti, stepen eventualne invalidnosti, pol i drugo lično svojstvo.

Zbog toga je i definisan tzv. postupajući okvir, kojim su određeni osnovni obuhvatni prostori pravne regulative: zakon(i), sportska pravila<sup>3</sup> i konvencije u oblasti sporta. Organizacije u oblasti sporta ostvaruju svoje ciljeve i obavljaju sportske aktivnosti u skladu sa zakonom, sportskim pravilima, potvrđenim konvencijama u oblasti sporta i principima utvrđenim u dokumentima međunarodnih organizacija čija je članica Republika Srbija (čl. 6).

Ono što je karakteristično za aktivnosti sportske organizacije jeste specifičnost odgovornosti ljudi koji upravljaju osnovnim procesom – treningom. U tom pogledu za sve sportske organizacije je od značaja da se u pogledu rada sportskih stručnjaka primenjuje osnovno pravilo o zakonskom okviru. U sportskoj praksi (domaćoj i međunarodnoj) to se odnosi na činjenicu da se primenjuju važeći zakoni prema mestu obavljanja radne aktivnosti. Posebno se odgovornosti i obaveze sportskih trenera usmeravaju na pojačanu pažnju u primeni zakonskih propisa, kao i sportskih pravila, koji su korespondentni sa implikacijama u sledećim aspektima rada: (a) sportski objekti, (b) sportska i trenažna oprema i rekviziti, (c) nadzor nad sportistima tokom treninga, (d) davanje

<sup>3</sup> Sportska pravila se u praksi smatraju svojevrsnim „sportskim zakonima“ obzirom da su obavezujuća za sve aktore sportskih aktivnosti, a posebno u okviru sportskih takmičenja. Sportska pravila su hijerarhijski uređena. U tom smislu je Zakon o sportu (2016) prepoznao i eksplicitno definisao odredbe kojima se stvara obavezujući zakonski okvir, gde se u čl. 6. stav 2. i 3. kaže da: sportska pravila se neposredno primenjuju na sva lica koja su, neposredno ili posredno, obuhvaćena nadležnostima nacionalnog sportskog saveza. Nadležni nacionalni sportski savezi usaglašavaju svoja sportska pravila sa sportskim pravilima nadležnog međunarodnog sportskog saveza, a u slučaju da nisu usaglašena ili da nadležni nacionalni sportski savez nije doneo odgovarajuća sportska pravila, neposredno se primenjuju sportska pravila nadležnog međunarodnog sportskog saveza, osim ako nisu u skladu sa ovim zakonom.

sports rules as well, which correspond to implications in the following aspects of work: (a) sporting facilities, (b) sporting and training equipment and requisites, (c) supervision of athletes during training, (d) provision of expert and other instructions, (e) recommending physical exercises, and (f) testing of athletes/those who work out.

The permanent duty of the management of any sport organisation is to take care of application of the current legal regulations in the operation of the sports organisation managed by it. Therefore, the attention of the top management should be in particular oriented towards a certain number of legal regulations. The laws primarily relating to the operation of sports organisations and constituting *jus commune*, and as can be said also *lex communis*, are (1) the Law on Sports, (2) the Law on the Prevention of Violence and Improper Behaviour at Sports Events, and (3) the Law on the Prevention of Doping in Sports.

However, some other laws that, directly or indirectly, can be the basis of procedures of the management in certain situations, are not less important. These include, inter alia: (a) Law on Public Peace and Order, (b) Criminal Code, (c) Labour Law, (d) Law on Personal Income Tax, (e) Accounting Law, (f) Law on Contract and Torts, (g) Law on Copyright and Related Rights, (h) Law on the Public Information and Media, (i) Law on Free Access to Information of Public Importance, (j) Law on Free Access to Information of Public Importance; etc.

In addition to the Law on Sports, it is necessary to know and apply other bylaws that encompass the most important provisions in the field of sports law. Such documents elaborate in more detail particular segments relevant not only to the management of a sports organisation as a whole, but also to the activities of organising of sports competitions (Nešić, 2020). It is necessary to be aware of, and keep a “constant touch” with them, because they directly stem from the Law on Sports and govern in more detail the method of its application in the operation of sports organisations. This specifically refers to the following<sup>4</sup>: a) Rulebook on sports branches and fields in the Republic of Serbia and sports disciplines within the sports branches and fields, b) Rulebook on detailed conditions for the performance of sports activities and sport business industry, c) Rulebook on competent national sports associations for sports branches and fields of sport in the Republic of Serbia, d) Rulebook on the national categorisation of sports, e) Rulebook on the conditions for carrying out sport business industry activities, f) Rulebook on the use of public sporting facilities and performance of sports activities at public sporting facilities, g) Rulebook on the nomenclature of sports professions and

stručnih i drugih uputstava, (e) preporučivanje vežbi i (f) testiranja sportista/vežbača.

Menadžement sportske organizacije ima stalan zadatak da vodi računa o primeni pozitivno pravne regulative u radu sportske organizacije kojom upravlja. Zbog toga se pažnja top menadžmenta treba posebno usmeriti ka jednom broju pravnih propisa. Zakoni koji se prioriteto odnose na rad sportskih organizacija i predstavljaju *jus commune*, a može se reći i *lex communis*, su: (1) Zakon o sportu, (2) Zakon o sprječavanju nasilja i nedoličnog ponašanja na sportskim priredbama, i (3) Zakon o sprečavanju dopinga u sportu.

Međutim nisu ništa manje značajni i neki drugi zakoni koji direktno ili indirektno mogu biti osnov za postupanje menadžmenta u određenim situacijama. To su, između ostalih, i: (a) Zakon o javnom redu i miru, (b) Krivični zakonik, (c) Zakon o radu, (d) Zakon o porezu na dohodak građana, (e) Zakon o računovodstvu, (f) Zakon o obligacionim odnosima, (g) Zakon o autorskim i srodnim pravima, (h) Zakon o javnom informisanju i medijima, (i) Zakon o slobodnom pristupu informacijama od javnog značaja; itd.

Pored Zakona o sportu, potrebno je poznavanje i primena ostalih podzakonskih akata kojima su obuhvaćene najznačajnije odrednice iz oblasti sportskog prava. Ovim dokumentima se detaljnije razrađuju pojedini segmenti koji su od značaja, kako za upravljanje sportskom organizacijom u celini, tako i za aktivnosti organizovanja sportskih takmičenja (Nešić, 2020). Njih je neophodno poznavati i biti „u stalnom kontaktu“ jer direktno proizilaze iz Zakona o sportu i detaljnije uređuju način njegove primene u radu sportskih organizacija. To se posebno odnosi na sledeće<sup>4</sup>: a) Pravilnik o sportskim granama i oblastima sporta u Republici Srbiji i sportskim disciplinama u okviru sportskih grana i oblasti sporta, b) Pravilnik o bližim uslovima za obavljanje sportskih aktivnosti i sportskih delatnosti, c) Pravilnik o nadležnim nacionalnim sportskim savezima za sportske grane i oblasti sporta u Republici Srbiji, d) Pravilnik o nacionalnoj kategorizaciji sportova, e) Pravilnik o uslovima obavljanja sportskih delatnosti, f) Pravilnik o korišćenju javnih sportskih objekata i obavljanju sportskih aktivnosti u javnim sportskim objektima, g) Pravilnik o nomenklaturi sportskih zanimanja i zvanja; h) Pravilnik o sadržini i načinu vođenja Jedinствene evidencije udruženja, organizacija i preduzetnika u oblasti sporta; itd.

<sup>4</sup> In the context of sports in the Republic of Serbia

<sup>4</sup> U kontekstu sporta u Republici Srbiji

titles, h) Rulebook on the contents and methods of keeping the Single Register of associations, organisations and entrepreneurs in the field of sport; etc.

## CONCLUSION

The modern sport may be considered from different angles: as a social phenomenon with multiple social benefits and influences; as a kinesiology activity, predominantly aimed to upgrade physical (motoric and functional) performances of athletes; as a bio-psychological phenomenon penetrating the sphere of human cognitive and conative functioning mechanisms; as a field of medical treatment (prevention and therapy); etc. However, in the broadest sense of understating the concept definition, and especially its activation part (sports activities), sport should be treated holistically. To this should be certainly added its institutionalised component. Therefore, it is logical that such contexts of consideration of sport and the role of sports organisations in its vitality should be considered and studied from different angles, including also with respect to legal relations prevailing in it.

The contents of all activities in sport are accompanied by appropriate rules. Some of them are universally applicable to all sports and sports disciplines, while some of them differ, subject to specific features of the specific sports branch. For this reason, the sports law, as a young area of the law science, in everyday practice increasingly gains importance. It is known that various state structures may differently determine the legal relations in sport, so that there is a risk of heterogeneous interpretation and application of the sports legislation, in particular regarding the existence of, and adherence to sports rules. Therefore, it is especially important to emphasize the existence of national and international sports bodies<sup>5</sup>, one of the tasks of which is enactment of legal documents related to the application of international sports rules. As the sports system at the global level<sup>6</sup> is hierarchically arranged, the international sports rules are applied in a subordinate manner accordingly. On the other hand, the fact is that a number of legal norms, which are applied to sport, exist concurrently in the legal documents of other traditional law branches, so that to the physiognomy of the sports law can be attributed a correlative legal character. Therefore, the sports law (Vuleta, 2015) can be generally defined and treated as a set of legal rules governing the legal relations in sport (the relations in which the sports entities enter, in connection with such rules).

As far as the management of sports organisations is concerned, viewed from the angle of obligation of adhering

<sup>5</sup> This is predominantly related to international sports federations and associations for every sports branch, including the International Olympic Committee.

<sup>6</sup> This in the first instance refers to the competition sports, i.e. high-performance sports (certainly including the professional sports).

## ZAKLJUČAK

Savremeni sport je moguće sagledavati iz različitih uglova: kao društvenu pojavu sa mnogosturkim socijalnim benefitima i uticajima; kao kineziološku aktivnost koja je dominantno usmerena ka podizanju telesnih (motoričko-funkcionalnih) performansi vežbača; kao bio-psihološku pojavu koja zadire u područja čovekovih kognitivnih i konativnih mehanizama funkcionisanja; kao oblast medicinskog tretmana (u prevenciji i lečenju); itd. Međutim sport u najširem shvatanju pojmovnog određenja, a posebno njegov aktivacioni deo (sportske aktivnosti), neophodno je tretirati holistički. Tome treba svakako dodati njegovu institucionalizovanu komponentu. Zbog toga je logično da se ovakvi konteksti razmatranja sporta i uloge sportskih organizacija u njegovoj životvornosti, treba da sagledavaju i proučavaju iz različitih uglova, pa tako i u pogledu pravnih odnosa koji u njemu vladaju.

Sadržaji svih aktivnosti u sportu prate i odgovarajuća pravila. Neka su univerzalno primenljiva na sve sportove i sportske discipline, a neka se razlikuju u odnosu na specifičnosti konkretne sportske grane. Zbog toga sve veći značaj u svakodnevnoj praksi dobija sportsko pravo kao mlado područje pravne nauke. Poznato je da različita državna uređenja mogu različito da utvrđuju pravne odnose u sportu, tako da postoji opasnost od heterogenosti tumačenja i primene sportskog zakonodavstva. Posebno u pogledu egzistencije i poštovanja sportskih pravila. Zato je od posebnog značaja naglašavanje postojanja nacionalnih i međunarodnih sportskih tela<sup>5</sup> kojima je jedan od zadataka donošenje pravnih akata koji su vezani za primenu međunarodnih sportskih pravila. Kako je sistem sporta na globalnom nivou<sup>6</sup> hijerarhijski uređen, tako se i međunarodna sportska pravila primenjuju subordinativno. Sa druge strane činjenica je da veliki broj pravnih normi koje se primenjuju u sportu egzistira u pravnim aktima drugih tradicionalnih grana prava tako da se fizionomiji sportskog prava može opredeliti korelativan pravni karakter. Stoga se sportsko pravo (Vuleta, 2015) uopšteno može definisati i tretirati kao skup pravnih pravila kojima se uređuju pravni odnosi u sportu (oni odnosi u koje sportski subjekti stupaju u vezi s tim pravilima).

Kada je reč o upravljanju sportskim organizacijama, posmatranog iz ugla obaveze poštovanja pozitivno pravne regulative, pažnja se usmerava i ka izvorima

<sup>5</sup> Dominantno se to odnosi na međunarodne sportske federacije i asocijacije za svaku sportsku granu, kao i Međunarodni olimpijski komitet.

<sup>6</sup> Ovo se u prvom redu odnosi na takmičarski sport, odnosno sport visokih performansi (gde svakako spada i profesionalni sport).

to the current legal regulations, the attention is also paid to the sources of sports law. The influence of the international law has become extremely prominent in the field of sport, and one of the basic reasons is its internationalisation. Sports organisations (sports clubs) often act in circumstances related to international sports competitions, thus coming in touch, in addition to international sports rules, also with other forms of international legal regulations. Therefore it is necessary to take care of two “existing legal planes”: (1) sources of sports law, which are in the domain of operation of international/inter-state organisations (legislative bodies of specific states) and (2) general legal documents of non-governmental sports organisations and national sports federations/associations in charge of prescribing sports rules.

Therefore, it is advisable to consider the sources of sports law, as factors of management of sports organisations, in the light of observation (Šuput, 2009: 252) that the laws governing the issue of sport in certain states are regarded as the most important source of sports law. In the first instance, due to the fact that regulations in question are enacted by the supreme state legislative authority, and also because such laws legally govern the structure of the sports system of a state (prescribe the basic rights and obligations of the factors of that system). Furthermore, the laws governing sport within national states are the central source of sports law, since their provisions establish the public interest in the field of sport (prescribe the relation between the governmental and non-governmental sectors within the sports system, determine the way in which the exercising of the public interest in the field of sport is funded; etc.).

sportskog prava. Uticaj međunarodnog prava postao je izrazito naglašen u oblasti sporta, a jedan od osnovnih razloga je njegova internacionalizacija. Sportske organizacije (sportski klubovi) se često nalaze u uslovima međunarodnih sportskih takmičenja, čime se, pored internacionalnih sportskih pravila, susreću i sa drugim oblicima međunarodne pravne regulative, tako da se mora voditi računa o dve “pozitivno pravne ravni”: (1) izvori sportskog prava koji su u domenu rada međunarodnih/međudržavnih organizacija (zakonodavnih organa konkretnih država) i (2) opšti pravni akti međunarodnih nevladinih sportskih organizacija i nacionalnih sportskih federacija/saveza u čijoj je ingerenciji propisivanje sportska pravila.

Stoga je uputno da se izvori sportskog prava, kao činioци upravljanja sportskim organizacijama, posmatraju u svetlu konstatacije (Šuput, 2009: 252) da se zakoni koji uređuju materiju sporta u pojedinim državama smatraju najvažnijim izvorom sportskog prava, prvenstveno zbog činjenice da se radi o propisima koje donosi najviši državni zakonodavni organ, ali i zbog toga što se takvim zakonima pravno uređuje struktura sportskog sistema države (propisuju osnovna prava i obaveze činilaca tog sistema). Takođe, zakoni koji uređuju sport u okvirima nacionalnih država jesu centralni izvor sportskog prava obzirom da svojim odredbama utvrđuju javni interes u oblasti sporta (propisuju odnos vladinog i nevladinog sektora u okviru sportskog sistema, određuju načine za finansiranje ostvarivanja javnog interesa u oblasti sporta; itd.).

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# THE EFFECTS OF NEUROMUSCULAR STABILIZATION ON INCREASING THE FUNCTIONALITY AND MOBILITY OF THE LOCOMOTOR SYSTEM

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**Abstract:** The general concept of dynamic neuromuscular stabilization (DNS) is, among other things, directly aimed at core stabilization as well as proper and “stable breathing”. DNS is based on the integration of the stabilization system which is mainly composed of intersegmental spinal muscles, deep neck flexor muscles, the diaphragm, abdominal muscles, and the pelvis. Although it is a relatively recent rehabilitation and training concept, a lot of researchers focus on DNS due to its positive effects. The review started with the hypothesis that the DNS concept achieves high and positive results on the locomotor system in terms of better core stabilization, increasing the functionality of the locomotor system and quickening the rehabilitation process. The method included searching Google Scholar, PubMed and Web of Science for scientific material. Out of 50 reviewed scientific papers, the sample was consisted of 12 papers that are, according to their research topic, compatible with the review in question. The results of the review indicate that the DNS concept has positive effects on the functionality of the locomotor system.

**Key words:** dynamic neuromuscular stabilization, rehabilitation, motoric control.

## INTRODUCTION

Dynamic neuromuscular stabilization (DNS) is a contemporary concept in the rehabilitation process and generally in improving the functionality of a locomotor apparatus. Any insufficiency of the bone-joint apparatus can be seen as a mismatch between the internal and external forces acting on the body and thus impairing the functionality of the locomotor apparatus (Mahdiah et al., 2020). Thus, if there is no clear synergy between the agonist and antagonist followed by an non-centered joint position, it may lead to impaired function of the entire locomotor apparatus. Dr. Pavel Kolar (according to Kobesova, 2014) points to the importance of the neurophysiological principles of DNS from the perspective of the proper functioning of the locomotor apparatus. The essence of the DNS concept is based on the application of ontogenetic developmental patterns of motion, thereby stimulating the key segments responsible for the proper functioning of the locomotor apparatus. Such patterns of motion are characteristic for the first year of the child’s developmental phase which witnesses intensive development of the motor control. In this way, a proper redistribution of internal forces occurs and thus contributes to the greater functionality of the motions. Ontogenetic patterns or homologous positions (Figure 1), proper manual centering of the joints, as well as proper activation of the diaphragm are used as key means of DNS therapy. Centering the joints and properly activating the diaphragm with pelvic floor contributes to better stability of the entire open kinetic chain.



Figure 1. Homologous positions

Also, the proper redistribution of all internal and external forces acting on each segment of the body contributes to better motor control (movement efficiency). Postural control is directly dependent on breathing function as well. Improper posture results in irregular breathing the same way the irregular breathing affects postural stability. Proper breathing and activation of the diaphragm directly affect the formation of intra-abdominal pressure, thus contributing to greater trunk stability. The postural respiratory connection is not fully under “voluntary” control and can hardly be influenced by the standard rehabilitation approach. Postural control, i.e. trunk stability, as well as underlying extremity movements are assumed to be largely controlled by the subcortex. If the CNS function is appropriate and the muscles are activated in a timely manner, this directly affects the proper centering of all the joints, which is crucial for good postural control. If the interosseous contact is greater, there will be better transfer of force from one to another part of the kinetic chain (Figure 2). Thus, the optimal joint position is not a static contraction, but a neuromuscular strategy of movement and stabilization.

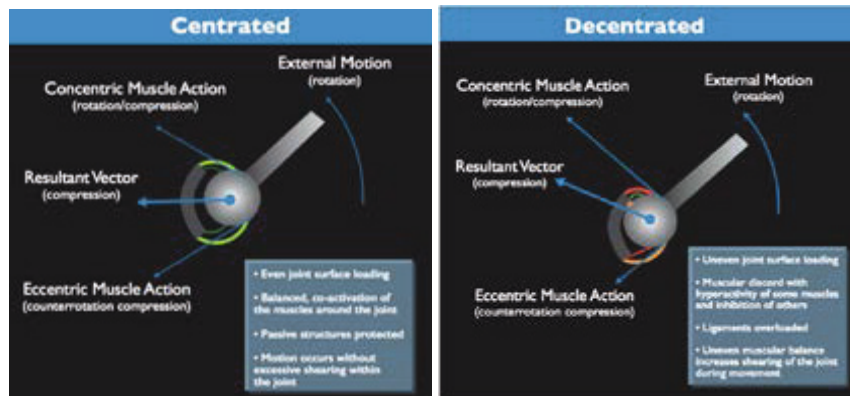


Figure 2. Transfer of force with the centered and non-centered joint

Besides the improved breathing and centering of the joints in a neutral or more optimal position, there are several other key points that actually contribute to the overall stabilization system. Therefore, the integral part of the stabilization system is also composed of deep neck muscles, abdominal wall and intersegmental spinal muscles (*multifidi*). Essentially, the DNS concept is the use of ontogenetic patterns, proper breathing functionality, intra-abdominal pressure control (IAP) and other parts of the stabilization system in order to improve the general and specific functionality of the locomotor apparatus. Accordingly, the defined goal of this document relates to determining the effects of DNS therapy on the functionality of the locomotor apparatus.

## METHOD

In order to provide more relevant overview of the previous research in the field of sports therapy and kinesi-therapy, the author has primarily opted for scientific papers exploring the various effects of dynamic neuromuscular stabilization. Available scientific literature was used through Google Scholar, PubMed, Scopus and Web of Science, while the keywords were “dynamic neuromuscular stabilization, motor stability, motor control, postural control, DNS, sports rehabilitation, physical therapy”. The search was limited to studies conducted in the last 10 years. The study started with the assumption that DNS therapy gives positive results to the locomotor apparatus in terms of better stabilization of the trunk, improvement of the functionality of the locomotor apparatus and speeding up the rehabilitation process.

## RESULTS

*Table 1. An overview of research on the effectiveness of DNS method*

A study with the original title	Objective of the study	Intervention	Conclusion
Kobesova, A., Kolar, P., Mlckova, J., Svehlik, M., Morris, C. E., Frank, C., ... & Kozak, J. (2012). Effect of functional stabilization training on balance and motor patterns in a patient with Charcot-Marie-Tooth disease. <i>Neuroendocrinol Lett</i> , 33(1), 3-10.	Enhancement of balance and movement patterns to increase the quality of life	Use of the DNS method according to Kolar	Improvement observed in modified clinical trials with sensorimotor balance interactions
O'Driscoll, J., Kerin, F., & Delahunt, E. (2011). Effect of a 6-week dynamic neuromuscular training programme on ankle joint function: a case report. <i>Sports Medicine, Arthroscopy, Rehabilitation, Therapy &amp; Technology</i> , 3(1), 13.	Effects of a 6-week DNS treatment on ankle function in athletes	Six-week DNS programme	Improvement of all sensorimotor parameters related to the ankle in athletes
Frank, C., Kobesova, A., & Kolar, P. (2013). Dynamic neuromuscular stabilization & sports rehabilitation. <i>International journal of sports physical therapy</i> , 8(1), 62.	Understanding developmental kinesiology, interconnections between joints and muscles during movement.	Examination work - no intervention	The DNS approach serves as a very important method for assessing muscle condition as well as for developing their physiological function
Lee, J., Kim, D., Shin, Y., & You, S. (2016). Differential effects of abdominal drawing-in maneuver, abdominal bracing, and dynamic neuromuscular stabilization on core stability and diaphragm-abdominal core muscle activation. <i>Journal of Orthopaedic &amp; Sports Physical</i> , 46(1).	Comparison of diaphragm movement, abdominal muscle thickness, and abdominal movement in an adult population with unstable trunk	Application of three different techniques ADIM, AB, and DNS	The results indicate that the DNS technique gives the best effects when it comes to increasing the stability of the trunk in coactivation with the diaphragm
Kobesova, A., Dzvonik, J., Kolar, P., Sardina, A., & Anđel, R. (2015). Effects of shoulder girdle dynamic stabilization exercise on hand muscle strength. <i>Isokinetics and Exercise Science</i> , 23(1), 21-32.	Determining the effect of rotator cuff stabilization on arm strength	Application of six specific DNS exercises five times a week. Exercises designed to achieve maximum shoulder stability.	Shoulder region exercises based on the DNS method can significantly and clinically increase arm strength.
Son, M. S., Jung, D. H., You, J. S. H., Yi, C. H., Jeon, H. S., & Cha, Y. J. (2017). Effects of dynamic neuromuscular stabilization on diaphragm movement, postural control, balance and gait performance in cerebral palsy. <i>NeuroRehabilitation</i> , 41(4), 739-746.	Effects of DNS technique on the functionality of movement, movement of the diaphragm and abdominal muscles in children with cerebral palsy	Application of DNS technique 30 minutes a day, three times a week for a period of 4 weeks	DNS technique is a good method for activating deep muscles of the trunk, diaphragm and abdominal muscles in a population with cerebral palsy
Kim, D. H., An, D. H., & Yoo, W. G. (2017). Effects of 4 weeks of dynamic neuromuscular stabilization training on balance and gait performance in an adolescent with spastic hemiparetic cerebral palsy. <i>Journal of physical therapy science</i> , 29(10), 1881-1882.	Effects of four-week DNS treatment on balance in children with cerebral palsy	Application of DNS technique for a period of four weeks	The results indicate that a four week DNS training provides positive results for balance in children with cerebral palsy
. Miketa, T., Ivančić, N., & Kuzmanić, B. (2017). Relationship of breathing exercises with improvement of postural stability in healthy adults. <i>Acta kinesiologica</i> , 11(2), 59-62.	Establishing whether breathing exercises three times a week for ten minutes increase intra-abdominal pressure, i.e. postural balance	Breathing exercises on a sample of 16 children divided into experimental and control groups	Breathing exercises increase postural stability over a period of 15 days



Cho, M., & Gong, W. (2017). The effects of dynamic exercise using the proprioceptive neuromuscular facilitation pattern on posture in healthy adults. <i>Journal of physical therapy science</i> , 29(6), 1070-1073.	Effects of dynamic exercise with the PNF method on posture in healthy adults	The treatment consisted of five sets of dynamic exercise with proprioception, three times a week for a period of six weeks.	The treatment influenced the posture resulting in improved trunk stabilization.
Yoon, H. S., & You, J. S. H. (2017). Reflex-mediated dynamic neuromuscular stabilization in stroke patients: EMG processing and ultrasound imaging. <i>Technology and Health Care</i> , 25(S1), 99-106.	Effects of the DNS concept on trunk stabilization, muscle activity as well as trunk muscle thickness in stroke patients	DNS concept of exercise	The results indicate that the DNS concept is much more efficient than the NDT concept in both healthy and stroke population.
Lee, N. G., You, J. S. H., Chung, H. Y., Jeon, H. S., Choi, B. S., Lee, D. R., ... & Yoon, H. S. (2018). Best Core Stabilization for Anticipatory Postural Adjustment and Falls in Hemiparetic Stroke. <i>Archives of physical medicine and rehabilitation</i> , 99(11), 2168-2174.	Comparison of the DNS Method with the conventional therapy for postural adjustment, balance, and fear of fall in stroke population	The treatment consisted of twenty sessions of conventional therapy and twenty sessions of DNS exercise for thirty minutes, five times a week, for four weeks.	The first clinical study proving the importance of trunk stabilization for balance and reducing fear of falling
Bae, W. S., Lee, K. C., & Lee, D. Y. (2019). The Effects of Dynamic Neuromuscular stabilization Exercise on Forward Head Posture and spine Posture. <i>Medico-Legal Update</i> , 19(2), 670-675.	The aim of the study is to investigate the influence of the DNS concept on the head movement in the sagittal plane.	The treatment involved applying the DNS concept to the experimental group.	The DNS concept of exercise affects the posture of the head.

## DISCUSSION

Based on the analysis of the reviewed literature, one can immediately notice an extremely wide range of effects of dynamic neuromuscular stabilization. The application of the DNS concept is also clearly defined, so few studies address the effects observed in the training process, while other effects relate to the rehabilitation process, which also indicates widespread applicability. If we look at the results of the studies reviewed, it can be immediately concluded that most of the effects of the DNS method are related to better muscle control and better balance. Methods that apply higher IAP can, of course, be linked to a better motor response, that is, greater body stability by providing better support for the spinal column (Kobesova et al., 2012). Proper activation of the diaphragm and other muscles involved in breathing contributes to a better and stronger formation of IAP, thereby increasing the stability of the spinal column and thus the whole body (Liebenson, 2007). Research (Lee et al., 2016; Son et al., 2017) points to the importance of IAP formation in coactivation with the diaphragm during postural stability. Proper activation of the diaphragm and the formation of IAP in all directions of the abdominal region, creates a positive pressure on the spinal column, as well as greater and stronger stabilization of the pelvic floor, and therefore the pelvis. Joint centering and increasing interosseous contact is one of the key elements of DNS therapy. Proper centering contributes to greater muscular functionality and a better transition of force from one to another part of the kinetic chain. If the CNS adequately processes proprioceptive information, it is clear that the centering of the joint will be adequate. On the other hand, if there is any muscular mismatch or muscular asymmetry, incorrect force transfer from the lever to the lever can occur. Research (Kobesova et al., 2015) indicates the effectiveness of DNS treatment on the rotator cuff, in order to increase joint stability, that is, to strengthen the said proprioceptive effect. A similar study (O, Driscoli et al., 2011) conducted on athletes also indicates the importance of proper centering of the joints, where an increase in the sensorimotor response was observed and thus an increase in the general function of the ankle joint. Based on the effects of DNS on sensorimotor status and body stability, it is logical to conclude that such effects will also be also reflected on the posture, that is, the better ratio between the segments of the locomotor apparatus. Increased trunk stabilization obtained through proprioceptive facilitation influences the improvement of the posture (Cho et al., 2017). This points directly to the connection between body stability and body posture, which can again be linked to DNS therapy and how it prioritizes the abdominal region or the entire trunk.

Activation of the deep muscles of the trunk also contributes to better stabilization in conditions such as cerebral palsy (Son et al., 2017). Activation of the intercostal and transversal abdominal muscles contributes to better

stabilization of the whole body. Research (Kim et al., 2017) points to the positive outcomes of DNS therapies for balance in children with developmental disabilities. The inability to isolate movement in children with cerebral palsy results in significantly worse postural control. If these muscles are specifically targeted, a better motor response in the movement itself is achieved as well as better kinesthesia, and therefore improved postural balance. As a therapeutic tool, the DNS method is also used in the stroke population. The effects are reflected through better motor control and enhanced postural balance (Yoon et al., 2017). The study (Lee et al., 2018) points to the significant contribution to reducing the fear of falling in stroke patients, which again is associated with better motor control and a greater degree of postural stabilization.

## CONCLUSION

Based on the facts presented and the literature reviewed, it can be said as a general conclusion that dynamic neuromuscular stabilization contributes to the overall improvement of the functionality of the locomotor apparatus. Whether it is the rehabilitation or training process, DNS through stabilization, joint centering, proprioception and proper trunk activation, provides all of its positive effects. Isolated muscular contractions with a properly centered joint system enable an adequate redistribution of all internal forces, thus providing greater functionality of movement. Muscle isolation and elimination of excess synergistic movements contribute to a better motor response in children with cerebral palsy as well as in stroke patients. Based on the literature reviewed and the analysis of studies in the field of DNS therapy, it can be safely concluded that such an approach, both in rehabilitation and in training, has its positive effects on different parts and systems of the locomotor apparatus viewed through general functionality.

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# EFEKTI DINAMIČKE NEUROMUSKULATORNE STABILIZACIJE NA PODIZANJE FUNKCIONALNOSTI I MOBILNOSTI LOKOMOTORNOG APARATA

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**Apstrakt:** Generalni koncept dinamičke neuromuskulatorne stabilizacije (DNS) je između ostalog direktno usmeren na stabilizaciju trupa kao i na pravilno i "stabilno disanje". DNS-a se zasniva na integraciji stabilizacionog sistema koji je u prvom redu sačinjen od intersegmentarnih kičmenih mišića, dubokih mišića fleksora vrata, dijafragme, trbušnog zida kao i karlice. Iako relativno mlad rehabilitacioni i trenažni pravac, veliki broj autora pridaje veliku pažnju DNS zbog njegovih pozitivnih efekata. U preglednu studiju se pošlo sa pretpostavkom da DNS koncept daje visoke i pozitivne rezultate na lokomotorni aparat u smislu bolje stabilizacije trupa, podizanje funkcionalnosti lokomotornog aparata, ubrzavanje rehabilitacionog procesa. Metodski postupak je podrazumevao pretraživanje naučne građe preko pretraživača Google Schoolara, PubMeda i Web of Sciense. Od 50 pregledanih naučnih radova u uzorak istraživanja je ušlo 12 radova koji po svom predmetu istraživanja odgovaraju aktuelnom preglednom radu. Rezultati preglednog istraživanja ukazuju na pozitivne efekte DNS koncepta na funkcionalnost lokomotornog aparata.

**Ključne reči:** Dinamička neuromuskulatorna stabilizacija, rehabilitacija, motorna kontrola.

## RELATIONSHIPS OF MOTOR ABILITIES AND PRECISION OF SHOOTING IN HANDBALL

## RELACIJE MOTORIČKIH SPOSOBNOSTI I PRECIZNOSTI IZVOĐENJA ŠUTA U RUKOMETU

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**Abstract:** This research aimed to determine the relationship between motor skills and the precision of shooting in handball. A battery of 21 motor tests was applied to a sample of 36 male subjects aged 20-22 years. Criteria variables were selected representing shots from the position with 7m and 9m and jump shots with 9m. The general results of the canonical analysis indicated a canonical correlation value of 0.974, with the HI value of the test square being 114.44 and a statistically significant correlation of the variables used at the  $p .042$  level. 3 canonical roots were obtained of which only the first showed statistical significance  $p .042$ . Observing the correlations of the variables used, it can be said that the motor abilities of explosive power, agility and coordination discriminated respondents results in performing situational-motor tasks. The results of the analysis of the criterion variables indicate that the largest projection on the first canonical root is shown by the variable 9mSKOK (0.739), and the variables 9mSTAV (0.484) and 7mSTAV (0.043). The obtained results confirm the positive relation of the situational motor ability of the shot precision with the level tested motor abilities, ie. a higher level of motor skills of agility and coordination, repetitive and explosive power is directly related to the success of performing a shot on goal from the positions used.

**Keywords:** handball, precision, shot, motor, students.

### INTRODUCTION

The change in the rules of handball game led to a significant development of handball as a sports game, which at the same time implies the need for better and more significant management of the processes of transformation of motor skills in the training process of handball players. The systemic management of the transformation processes of

**Apstrakt:** Cilj ovog istraživanja bio je utvrđivanje relacija motoričkih sposobnosti sa preciznošću izvođenja šuta u rukometu. Baterija od 21 motoričkog testa je primjenjena na uzorku od 36 ispitanika muškog pola starosne dobi 20-22 godine. Kriterijumske varijable bile su su šutevi iz stava sa 7m i 9m, te skok šut sa 9m. Generalni rezultati kanoničke analize ukazali su na vrijednost kanoničke korelacija 0.974, pri čemu je vrijednost HI kvadrat testa 114.44 te statistički značajnu povezanost korištenih varijabli na nivou  $p .042$ . Dobijena su 3 kanonička korijena od kojih je samo prvi pokazao statističku značajnost  $p .042$ . Posmatrajući korelacije korištenih varijabli, može se reći da su motoričke sposobnosti eksplozivne snage, agilnosti i koordinacije diskriminisale ispitanike u izvođenju situaciono-motoričkih zadataka. Rezultati analize kriterijumskih varijabli, ukazuju da najveću projekciju na prvi kanonički korijen pokazuje varijabla 9mSKOK (0.739), te varijable 9mSTAV (0.484) i 7mSTAV (0.043). Dobijeni rezultati potvrđuju pozitivnu relaciju situaciono motoričke sposobnosti preciznosti šuta sa nivoom nekih od testiranih motoričkih sposobnosti tj. viši nivo motoričkih sposobnosti agilosti i koordinacije, repetitivne i eksplozivne snage direktno je povezan sa uspješnošću izvođenja šuta na gol sa korištenih pozicija.

**Ključne reči:** rukomet, preciznost, šut, motorika, studenti.

### Uvod

Promjena pravila rukometne igre dovela je do značajnog napredovanja rukometa kao sportske igre što je istovremeno uslovalo potrebu boljeg i značajnijeg upravljanja procesima transformacije motoričkih sposobnosti u trenažnom procesu rukometaša. Sistemsko upravljanje procesima transformacije motoričkih

motor skills implies in this case the management of the development and level of motor skills and the role and importance of specific situational motor skills (Demir, 1998). The dynamics of today's handball game have been raised to a higher level, which requires a higher level of players' skills in both defensive and attacking movements. The efficient execution of simple or complex technical structures, repetitive cyclical or acyclic movements becomes an imperative that requires a high level of general motor skills and a high level of efficiency of specific motor skills. This dual role of motor skills can be read in the role of parameters that distinguish between the average and superior performance of adequate tasks and the role of the performance of specific movement structures of handball, which give it uniqueness in comparison with other sports (Schmidt & Wrisberg, 2000). The canonical relationship between general and specific motor skills is an interesting topic in handball (Alba, 1996; Avila-Moreno, 1997; Findak, 2003; Grujić, S., Perić, D.B., Ahmetović, Z., Okičić, T., & Isaković, M. 2018;) and with the results of this research, the authors wanted to contribute to the exegesis of the theoretical approach and to enable the determination of its relationship, which could have an impact on further work and training at universities and other educational institutions, including students of handball schools (Vlahović, L., Babin, B. & Babin, J. 2015; Vlahović, L., Babin, J. and Babin, B. 2016).

## METHODOLOGY

Authors of this exploratory research set the goal calculation and determination of the relations of certain motor abilities with the execution of the shot from the position with 7m 9m (7mSTAV and 9mSTAV) and the shot jump with 9m (9Mskok). The sample of respondents consisted of 36 male respondents, from the student population of the Faculty of Physical Education and Sports at the University of Banja Luka, who were aged between 20-22 years. At the end of regular classes in the subject of Handball, a test of motor skills and an assessment of the accuracy of the shot were performed by an expert commission. The predictor variables used were presented through a set of 21 motor tests, which the authors consider to cover a part of the motor space that could be positively correlated with the successful performance of shots from a distance of 7m and 9m. Tests were standardized by the author Kurelić et al. (1975) as follows: push-ups (MRESKL), agility on the floor (MAGONT), crawling under barrier and jumping over it (MBKPOP), figure eight running drill with bending under rope (MAGOSS), lateral shuffle (MAGKUS), one leg stand facing along the beam with eyes closed (MBAU1Z), leg tapping against the wall (MBFTAZ), hand tapping (MBFTAP), leg tapping (MBFTAPN), shoul-

spodobnosti podrazumijeva, u tom slučaju, upravljanje razvojem i nivoom motoričkih sposobnosti te ulogu i značaj specifičnih situaciono-motoričkih sposobnosti (Demir, 1998). Dinamika današnje rukometne igre podignuta je na viši nivo što zahtijeva i viši nivo sposobnosti igrača kako u odbrani tako i u napadu. Efikasno izvođenje jednostavnih ili složenih tehničkih struktura, pojedinačnih ili ponavljajućih cikličnih ili acikličnih pokreta postaje imperativ koji nameće visok nivo opštih motoričkih sposobnosti i visok stepen efikasnosti specifično-motoričkih sposobnosti. Ta dvostruka uloga motoričkih sposobnosti očitava se kroz ulogu parametara koji čine razliku između prosječnog i vrhunskog izvođenja adekvatnih zadataka te uloga izvođenja specifičnih rukometnih kretnih struktura koje joj daju posebnost u odnosu na druge sportove (Schmidt & Wrisbergu, 2000). Kanonički odnos opštih i specifičnih motoričkih sposobnosti interesantna je tema u rukometu (Alba, 1996; Avila-Moreno, 1997; Findak, 2003; Grujić, S., Perić, D.B., Ahmetović, Z., Okičić, T., & Isaković, M. 2018; ) te su rezultatima ovog istraživanja autori željeli doprinijeti egzegzi teorijskog pristupa i omogućiti utvrđivanje povezanosti istih, što bi moglo imati uticaj na daljnji rad i obuku kako na visokoškolskim tako i na ostalim obrazovnim institucijama uključujući i polaznike rukometnih škola (Vlahović, L., Babin, B. & Babin, J. 2015; Vlahović, L., Babin, J. i Babin, B. 2016).

## METOD

Autori su za cilj ovog eksplorativnog istraživanja postavili izračunavanje i utvrđivanje relacija određenih motoričkih sposobnosti sa izvođenjem šuta iz stava sa 7m i 9m (7mSTAV i 9mSTAV) te skok šuta sa 9m (9Mskok). Sam uzorak ispitanika činilo je 36 ispitanika muškog pola, iz populacije studenta Fakulteta fizičkog vaspitanja i sporta Univerziteta u Banjoj Luci, koji su bili starosne dobi između 20-22 godine. Po završetku redovnog pohađanja nastave iz predmeta Rukomet izvršeno je testiranje motoričkih sposobnosti i procjena preciznosti šuta od strane ekspertske komisije. Korištene prediktorske varijable predstavljene su kroz set od 21 motoričkog testa, za koje autori smatraju da pokrivaju dio motoričkog prostora koji bi mogao biti u pozitivnoj korelaciji sa uspješnim izvođenjem šuteva sa udaljenosti od 7m i 9m. Testovi su standardizovani od strane autora Kurelić i saradnici (1975): sklekovi (MRESKL), okretnost na tlu (MAGONT), provlačenje i preskakanje (MBKPOP), osmica sa saginjanjem (MAGOSS), koraci u stranu (MAGKUS), stajanje na jednoj nozi uzdužno na klupici zatvorenih očiju (MBAU1Z), taping nogama o zid (MBFTAZ), taping rukama

der and chest opener with rod (MFLISK), standing shoulder extension (MFLPRG), lateral arm raises (MFLONK), forward bend (MFPRET), leg extension lying on the back (MFLPLK), leg extension lying face down on the floor (MFZANL), leg extension lying on the side(MFODNL), standing long jump (MFESDM), standing triple jump (MFETRO), lying medicine ball throw (MFEBML), supinated pull-ups (MRAZGP), laying back extensions (MRCZTL). The sample of criterion variables consisted of shots on goal from a distance of 7m and 9m and a jump shot from a distance of 9m (7mSTAV, 9mSTAV, and 9mSKOK). The accuracy of the shots was performed through 4 shots from each distance and was evaluated by points: 2 points for the affected corners up left and top right and 1 point each for the affected corners down left and downright. Canonical correlation analysis in the STATISTICA 12 software package was used for statistical data processing.

### RESULTS AND DISCUSSION

If we analyze the canonical correlation analysis procedure used to determine the relationship between the subjects' motor skills and the accuracy of the shots, it can be seen that the general results of the canonical analysis (Table 1) indicate a canonical correlation value of 0.974, a HI quadratic test value of 114.44 and a statistically significant correlation of the variables used at the level of  $p .042$ . Looking at the preserved canonical roots, we find that, out of the three preserved canonical roots, only the first has the statistical significance of  $p .042$ .

In the continuation of the analysis, by consulting Table 2 (extract from the cross-correlation matrix), it is noticeable that the results obtained indicate a significant

(MBFTAP), taping nogama (MBFTAPN), iskret palicom (MFLISK), jarbol (MFLPRG), odručenje (MFLONK), pretklon sjedeći (MFPRET), prednoženje (MFLPLK), za-noženje (MFZANL), odnoženje (MFODNL), skok u dalj iz mjesta (MFESDM), troskok iz mjesta (MFETRO), bacanje medicinke iz ležećeg položaja (MFEBML), zgibovi pothvatom (MRAZGP), podizanje trupa ležeći na stomaku (MRCZTL). Uzorak kriterijumskih varijabli činili su udarci na gol sa udaljenosti 7m i 9m te skok šut sa udaljenosti 9m (7mSTAV, 9mSTAV te 9mSKOK). Preciznost izvođenja šuteva je izvršena kroz 4 šuta sa svake distance i ocijenjena je bodovima: 2 boda za pogođene uglove gore lijevo i gore desno te po 1 bod za pogođene uglove dole lijevo i dole desno. Za statističku obradu podataka korištena je kanonička korelaciona analiza u softverskom paketu STATISTICA 12.

### REZULTATI I DISKUSIJA

Analizirajući primjenjenu proceduru kanoničke korelacione analize, sa ciljem utvrđivanja relacija između motoričkih sposobnosti ispitanika i preciznosti izvedenih šuteva, može se konstatovati da generalni rezultati kanoničke analize (tabela 1), ukazuju na vrijednost kanoničke korelacija 0.974, vrijednošću HI kvadrat testa od 114.44 te statistički značajnu povezanost korištenih varijabli na nivou  $p .042$ . Posmatrajući dobijene kanoničke korijene vidljivo je da, od tri dobijena kanonička korijena, samo prvi pokazuje statističku značajnost  $p .042$ .

U nastavku analize, inspekcijom tabele 2 (izvod iz matrice kroskorelacije), primjetno je da postignuti rezultati ukazuju na značajnu povezanost testova koordinacije i agilnosti, repetitivne i eksplozivne snage, testova iz

**Table 1.** General results of canonical analysis / **Tabela 1.** Generalni rezultati kanoničke analize

	N	CR	CR2	HI	DF	L	P	
LS	16.98	1	0.974566	0.949780	114.4776	90	0.001730	0.042097
DS	100	2	0.928039	0.861256	60.6336	58	0.034440	0.381234
RVLS	14.70	3	0.867048	0.751772	25.0813	28	0.248228	0.623385
RVDS	87.56							
CR	.974							
HI	114.44							
DF	90							
P	.042							

**Legend:** (LS = left set variance, DS = right set variance, RVLS = left set redundant variance, RVDS = right set redundancy variance, CR = canonical correlation, N = extracted eigenvalue, CR2 = canonical correlation square, HI = hi- square test, DF = degrees of freedom, L = lambda prime, P = probability)

**Legenda:** (LS = varijansa lijevog seta, DS = varijansa desnog seta, RVLS = redundantna varijansa lijevog seta, RVDS = redundantna varijansa desnog seta, CR = kanonička korelacija, N = ekstrahirana eigen vrijednost, CR<sup>2</sup> = kvadrat kanoničke korelacije, HI = hi-kvadrat test, DF = stepeni slobode, L = lambda prime, P= probabilitet)

correlation between coordination and agility tests, repetitive and explosive strength, tests from the space of individual movement speed and flexibility of the lower limbs with criterion variables, the construction of a complex set of motor skills that influence the accuracy of shooting in handball. The variables of agility and coordination (MBKPOP, MAGOSS, MAGKUS, MAGONT, MKTOZ) are represented by the results on the time scale, whereby the lower the values on the time scale, the better the results. Hence the negative sign of the variables mentioned, which indicates a strong correlation with the criterion variables. The results of tests that represented some of the other segments of a motor ability that did not show a high degree of correlation with the criterion variables do not reduce their potential importance or correlation with the criterion variables, but indicate a certain degree of motor ability hierarchy in this sample. planned specific motor tasks (Delija & Šimenc, 1994). Looking only at the execution of a shot on goal, it can be said that, in a narrow sense, it consists in defining the direction of movement and the appropriate speed of movement that determines the ball's arrival in the goal (Zvonarek, Vuleta, & Hraski, 1997; Pori, Bon, & Sibila, 2005 ). A higher degree of positive correlation (better results are on the scale and higher results) of motor variables with specific motor variables was found in the variables of explosive power of the upper and lower extremities in relation to the indication of the speed of ball movement. Overall, it can be said that the motor skills of repetitive and explosive strength and agility and coordination, motor skills, each of which in its own way showed the highest correlation with the criterion variables, discriminated the respondents the most when performing situation motor tasks and showed a correlation with them.

prostora brzine pojedinačnog pokreta kao i fleksibilnosti donjih ekstremiteta sa kriterijumskim varijablama ukazujući na potrebu izgrađenosti složenog seta motoričkih sposobnosti koje utiču na preciznost izvođenja šuteva u rukometu. Varijable agilnosti i koordinacije (MBKPOP, MAGOSS, MAGKUS, MAGONT, MKTOZ) predstavljene su kroz rezultate vremenske skale pri čemu su rezultati bolji što su na vremenskoj skali niže vrijednosti. Otuda potiče i negativan predznak navedenih varijabli ukazujući na veliku povezanost sa kriterijumskim varijablama. Rezultati testova koji su predstavljali neke od drugih segmenata neke motoričke sposobnosti, koji nisu pokazali visok stepen korelacije sa kriterijumskim varijablama, ne umanjuju njihov potencijalni značaj ili povezanost sa kriterijumskim varijablama, već ukazuju na određeni stepen hijerarhije učešća motoričkih sposobnosti, na ovom uzorku, pri izvođenju planiranih specifičnih motoričkih zadataka (Delija & Šimenc, 1994). Posmatrajući samo izvođenje šuta na gol može se reći da se, u najužem smislu, sastoji od definisanja pravca kretanja kao i adekvatne brzine kretanja koja uslovljava dolazak lopte do gola (Zvonarek, Vuleta, & Hraski, 1997; Pori, Bon, & Sibila, 2005). Viši stepen pozitivne korelacije (bolji rezultati su na skali i viši rezultati) motoričkih varijabli sa specifično-motoričkim varijablama pokazale su varijable eksplozivne snage gornjih i donjih ekstremiteta u smislu saopštavanja brzine kretanja lopte. Ukupno posmatrajući može se reći da su motoričke sposobnosti repetitivne i eksplozivne snage te agilnosti i koordinacije, motoričke sposobnosti koje su pokazale najveću korelaciju sa kriterijumskim varijablama, svaka na svoj način, najviše diskriminisale ispitanike u izvođenju situaciono-motoričkih zadataka i ukazale na povezanost sa istim.

**Table 2.** Extract from the cross-correlation matrix / **Tabela 2.** Izvod iz matrice kroskorelacije

	<b>7m STAV</b>	<b>9m STAV</b>	<b>9m SKOK</b>
MRESKL	0.522	0.314	0.443
MFESDM	0.401	0.354	0.373
MFETRO	0.533	0.466	0.458
MBKPOP	-0.179	-0.358	-0.239
MAGOSS	-0.404	-0.383	-0.342
MAGKUS	-0.410	-0.274	-0.249
MAGONT	-0.083	-0.242	-0.354
MKTOZ	-0.436	-0.469	-0.507
MBFTAPL	0.337	0.313	0.502
MBFTAZ	0.324	0.338	0.317
MRAZGP	0.501	0.468	0.593
MFEBML	0.483	0.470	0.456
MFLISK	-0.394	-0.424	-0.386
MFLZANL	0.443	0.493	0.354

Analyzing the correlations of motor variables with the canonical root (Table 3), it can be concluded From the analysis of the correlations of the motor variables with the canonical root (Table 3) it can be concluded that the coordination variable MAGONT (-0.429) has the largest projection on the canonical root, followed by the variables MBFTAPL (0.381), MRAZGP (0.360), MKTOZ (-0.309), MFLPKL (0.305). The variables MAGONT and MKTOZ show a negative projection on the first isolated canonical factor, suggesting that agility and coordination of motor skills are highest in addition to the variables representing motor skills of repetitive force (MRAZGP), individual movement speed (MBFTAPL) and leg flexibility (MFLPLK). Respondents with poorer scores on these motor skills showed less precision in the execution of goal shots. The above-mentioned variables cover a part of the motor space studied by various authors from these areas for more efficient execution of situation motor skills (Delija & Šimenc, 1994; Mekić & Mavrić, 2005; Mavrić, 2006; Bojić & Pavlović 2015; Grujić, Perić, Ahmetović, Okičić & Isaković, 2018). Looking at the results of the analysis relating to the criterion variables, we can say that the greatest projection on the first canonical root is shown by the variable 9mSKOK (0.739) and the variables 9mSTAV (0.484) and 7mSTAV (0.043). Given the complexity of the execution of jump shots (previous research has led to five phases of running, reflection, flight, ejection and landing (Zvonarek, Vuleta & Hraski, 1997; Pori, Bon & Sibila, 2005) from a distance of 9mSKOK, the results confirm a greater dependence. The shooting with 9mSTAV is slightly easier to perform due to the previously occupied position be-

Analizirajući korelacije motoričkih varijabli sa kanoničkim korijenom (tabela 3), može se zaključiti da varijabla koordinacije MAGONT (-0.429) ima najveću projekciju na kanonički korijen dok je slijede varijable MBFTAPL (0.381), MRAZGP (0.360), MKTOZ (-0.309), MFLPLK (0.305). Varijable MAGONT i MKTOZ pokazuju negativnu projekciju na prvi izolovani kanonički faktor, ukazujući da su agilnost i koordinacija motoričke sposobnosti, pored varijabli koje predstavljaju motoričke sposobnosti repetitivne snage (MRAZGP), brzine pojedinačnog pokreta (MBFTAPL) i fleksibilnost zadnje lože buta (MFLPLK), najviše diskriminisale ispitanike. Ispitanici sa slabije postignutim rezultatima ovih motoričkih sposobnosti iskazali su manju preciznost u izvođenju šuteva na gol. Gore navedene varijable pokrivaju dio motoričkog prostora, koji su istraživali različiti autori sa ovih prostora, za efikasnije izvođenje situaciono-motoričkih sposobnosti (Delija & Šimenc, 1994; Mekić & Mavrić, 2005; Mavrić, 2006; Bojić & Pavlović 2015; Grujić, Perić, Ahmetović, Okičić & Isaković, 2018). Posmatrajući rezultate analize, koji se odnose na kriterijumske varijable, može se reći da najveću projekciju na prvi kanonički korijen pokazuje varijabla 9mSKOK (0.739), te varijable 9mSTAV (0.484) i 7mSTAV (0.043). Obzirom na složenost izvođenja skok šuta (prethodnim istraživanjima došlo se do pet faza izvođenja: zalet, odraz, let, izbačaj i doskok), (Zvonarek, Vuleta & Hraski, 1997; Pori, Bon & Sibila, 2005) sa udaljenosti od 9mSKOK, dobijeni rezultati potvrđuju veću zavisnost situaciono motoričke sposobnosti preciznosti šuta od ni-

**Table 3.** Canonical factors of predictor and criterion variables  
**Tabela 3.** Kanonički faktori prediktorskih i kriterijumskih varijabli

<b>Predictor set of variables / prediktorski set varijabli</b>	<b>1</b>	<b>1</b>	<b>Criterion set of variables / kriterijumski set varijabli</b>	<b>1</b>
MRESKL	0.114	MFEBML	7mSTAV	0.043
MFESDM	0.148	MBAU1ZD	9mSTAV	0.484
MFETRO	0.144	MBAU1ZL	9mSKOK	0.739
MBKPOP	-0.193	MFLPRGD		
MAGOSS	-0.107	MFLPRGL		
MAGKUS	0.040	MFLISK		
MAGONT	-0.429	MFLONKD		
MKTOZ	-0.309	MFLONKL		
MBFTAPD	0.220	MFLPRET		
MBFTAPL	0.381	MFLPDNZL		
MBFTAPNL	-0.218	MFLZANL		
MBFTAPND	0.015	MFLDNL		
MBFTAZ	0.148	MFLPLK		
MRAZGP	0.360	MFLZAND		
MRCZTL	0.210	MFLDND		



fore the ejection phase, while shooting with 7mSTAV (due to the reduction of the shooting distance) is the easiest to perform of the three variables used, which has been confirmed, by projecting the results on the first canonical factor.

Looking at the kinematic derivation of the shot from the posture, one can speak of the dominant role of the ball throwing phase, which starts its kinetic chain from the muscles of the rear lobe of the lower extremities via the knee, hip, shoulder and elbow joints and finally via the wrist and fingers. Ejection efficiency is determined by the level of explosive force of the shoulder girdle, trunk and legs, as well as by the mobility of the shoulder girdle and the flexibility of the lower extremities. The accuracy of the shot from the position, which is executed from a distance of 7 m and 9 m, depends largely on the phase of the ball throw and thus on the motor coordination ability. For a jump shot from a distance of 9 m from the goal line, he introduces four further phases of the shot: run-in (in this case with the ball in his hand), reflection, flight and landing. Each of these phases is characterized by the kinematics of the execution, which forms a complex kinetic sequence of the execution of a jump shot, which places the execution of this task in the category of complex situation-motor tasks (Burger, 2016). Accordingly, for better performance and thus greater precision of the shot, a high degree of more motor skills is required, which affects the same: explosive strength of the upper and lower extremities, trunk strength, agility and coordination, as well as mobility of the shoulder girdle. The results obtained follow some of the recent research on this topic in a similar sample (Burger, 2016; Vlahović, L., Babin, B. & Babin, J. 2015; Vlahović, L., Babin, J. and Babin, B. 2016).

## CONCLUSION

The general results of the canonical analysis showed a canonical correlation value of 0.974, a HI quadratic test value of 114.44 and a statistically significant correlation of the variables used at the level  $p = .042$ . Looking at the preserved canonical roots, it can be seen that, of the three preserved canonical roots, only the first has statistical significance  $p = .042$ . Overall, when looking at the correlations of the variables used, it can be said that the motor skills of explosive power and coordination, as the two motor skills that showed the highest correlation with the criterion variables, discriminated against the respondents in the execution of situation motor tasks and shooting accuracy. Results of the analysis, relating to the criterion variable 9mSKOK, demonstrates greatest projection on the first canonical root (0.739) and for the variables 9mSTAV (0.484) and 7mSTAV (0.043). Given the complexity of the execu-

voa ostalih motoričkih sposobnosti. Izvedba šutiranja sa 9mSTAV je nešto jednostavnija zbog prethodno zauzetog položaja prije same faze izbačaja dok je šut sa 7mSTAV (zbog smanjenja udaljenosti mjesta šutiranja) od tri korištene varijable, najjednostavniji za izvedbu, što je potvrđeno kroz projekciju rezultata na prvi kanonički faktor.

Posmatrajući kinematičko izvođenje šuta iz stava može se govoriti o dominantnoj ulozi faze izbačaja lopte koja započinje svoj kinetički lanac iz mišića zadnje lože donjih ekstremiteta prenoseći se kroz zglobove koljena, kuka, ramena, lakta i na kraju tog lanca kroz zglob šake i prste. Efikasnost izbačaja uslovljena je nivoom eksplozivne snage ramenog pojasa, trupa i nogu te pokretljivošću ramenog pojasa i fleksibilnošću donjih ekstremiteta. Sama preciznost šuta iz stava izvođenog sa udaljenosti od 7m i 9m u najvećoj mjeri zavisi od faze izbačaja lopte samim tim i od motoričke sposobnosti koordinacije. Izvođeci šutiranja iz skok šuta sa udaljenosti od 9m od gol linije uvodi još četiri faze šuta: zalet (u ovom slučaju sa loptom u ruci), odraz, let i doskok. Svaka od ovih faza je karakteristična po kinematici izvođenja čineći složeni kinetički slijed izvođenja skok šuta čime se samo izvođenje tog zadatka svrstava u kategoriju složenih situaciono-motoričkih zadataka (Burger, 2016). Shodno tome za bolje izvođenje, a samim time i veću preciznost šuta potreban je visok nivo više motoričkih sposobnosti koje utiču na šut: eksplozivna snaga gornjih i donjih ekstremiteta, snaga trupa, agilnost i koordinacija, te pokretljivost ramenog pojasa. Dobijeni rezultati su u skladu sa nekim od novijih istraživanja na ovu temu kod sličnog uzorka (Burger, 2016; Vlahović, L., Babin, B. & Babin, J. 2015; Vlahović, L., Babin, J. i Babin, B. 2016).

## ZAKLJUČAK

Generalni rezultati kanoničke analize ukazali su na vrijednost kanoničke korelacije 0.974, vrijednost HI kvadrat testa od 114.44, te statistički značajnu povezanost korištenih varijabli na nivou  $p = .042$ . Posmatrajući dobijene kanoničke korijene vidljivo je da, od tri dobijena kanonička korijena, samo prvi pokazuje statističku značajnost  $p = .042$ . Ukupno posmatrajući korelacije korištenih varijabli, može se reći da su motoričke sposobnosti eksplozivne snage i koordinacije, kao dvije motoričke sposobnosti koje su pokazale najveću korelaciju sa kriterijumskim varijablama, diskriminisale ispitanike u izvođenju situaciono-motoričkih zadataka i preciznosti šutiranja. Posmatrajući rezultate analize, koji se odnose na kriterijumske varijable, može se reći da najveću projekciju na prvi kanonički korijen pokazuje varijabla 9mSKOK (0.739), te varijable 9mSTAV (0.484) i 7mSTAV (0.043).

tion of the jump shot (in some previous studies there were five phases of running, reflecting, flying, throwing and landing (Zvonarek, Vuleta & Hraski, 1997; Pori, Bon & Sibila, 2005) from a distance of 9m, the results confirm the importance of the research. It demonstrates the importance of the programming process that would lead to the desired transformation of explosive strength of the upper and lower extremities, trunk strength, agility and coordination, as well as mobility of the shoulder girdle, which, as it turned out, contribute most to precise goal-shooting as one of the most important segments of handball. Creating a training process, through the time scale in working with younger categories, more attention should be devoted to the development of coordination and agility motor skills. This creates a good foundation that can upgrade the development of explosive power and shoulder girdle mobility to get better results in performing goal shots.

Obzirom na složenost izvođenja skok šuta (u nekim prethodnim istraživanjima došlo se do pet faza izvođenja: zalet, odraz, let, izbačaj i doskok), (Zvonarek, Vuleta & Hraski, 1997; Pori, Bon & Sibila, 2005) sa udaljenosti od 9m, dobijeni rezultati potvrđuju veću zavisnost situaciono motoričke sposobnosti preciznosti šuta od nivoa ostalih motoričkih sposobnosti. Značaj istraživanja je da ukazuje na važnost procesa programiranja koji bi vodio ka željenoj transformaciji motoričkih sposobnosti za koje je utvrđeno da najviše doprinose preciznom šutiranju na gol, kao jednoj od najvažijih segmenata rukometne igre. Kreirajući razvojni put kroz trenažni proces mlađih kategorija, posebnu pažnju treba usmjeriti prvenstveno na razvoj koordinacije i agilnosti. Na taj način bi se stvorila dobra baza koja se u daljnjem procesu može nadograditi razvojem eksplozivne snage i mobilnosti ramenog pojasa kako bi došlo do povećanja uspješnosti u šutiranju na gol.

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# METHODOLOGICAL BASIS OF STRENGTH DEVELOPMENT IN SPORT | METODOLOŠKE OSNOVE RAZVOJA SNAGE U SPORTU

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**Abstract:** *This work covers the methodological basis and procedures in strength development within the fitness preparation of athletes in order to achieve great results. Strength is one of the most important skills and it is the basis of improving all other motor (physical) skills. The knowledge of methods and its procedures, which provide the development of this skill, represents a significant foundation and prerequisite for its development through the process of training. Methods and methodological processes most frequently used for development of different types of strength are presented in this work.*

**Keywords:** *methods, strength, athletes.*

## INTRODUCTION

Human strength is without a doubt one of the most important, and by now probably the most studied motor skill of a human being. During the last 10 years, a great number of scientific and professional papers, books and other publications related to defining issues, diagnosing and developing strength has been released. However, there are still many questions and obscurities related both to defining and developing the dimensions of strength. The author hopes that this article will bring a better understanding of the methodological bases of certain strength dimensions.

A young 15-year-old athlete enters the so-called period of sports specialization as a talented and versatile athlete, in terms of fitness. During the next period of 4 years, he and his coach have an important homework to do in order for him to become an athlete that can equally participate in the training and competing among seniors. During this period the athletes are ready to take on harder trainings, the fitness trainings become very specific for each sports branch, and their intensity

**Apstrakt:** *Rad obuhvata prikaz metodoloških osnova i postupaka za razvoj snage u okviru kondicione pripreme sportista radi postizanja visokih sportskih rezultata. Snaga je jedna od najvažnijih sposobnosti i temelj nadogradnje svih ostalih motoričkih (fizičkih) sposobnosti. Poznavanje metoda i metodskih postupaka koji obezbjeđuju razvoj ove sposobnosti predstavlja značajnu osnovu i preduslov za njen razvoj kroz trenajni proces. U radu su detaljno prikazane metode i metodski postupci koji se najčešće koriste za razvoj različitih vidova snage.*

**Ključne reči:** *metode, snaga, sportisti.*

## UVOD

Ljudska snaga je bez sumnje jedna od najvažnijih i do sada verovatno najčešće proćavana motorička dimenzija ćovjeka. U posljednjih 10-ak godina objavljen je velik broj znanstvenih i stručnih radova, knjiga i drugih publikacija vezanih uz problematiku definisanja, dijagnostifikovanja i razvoja snage. Usprkos tome, još uvijek postoje brojne nejasnoće, kako u definisanju, tako i u razvoju dimenzija snage. Autor se nada da će ovim radom doprinjeti boljem razumijevanju metodike razvoja pojedinih dimenzija snage.

U razdoblje tzv. sportske specijalizacije mladi sportaš ulazi kao talentovani i u kondicijskom smislu svestrano oblikovan sportaš petnaestogodišnjak. Tokom naredne ćetiri godine pred njim i pred njegovim trenerom važna je zadaća – postati sportaš koji može ravnopravno sudjelovati u treningu i takmićenju u seniorskoj konkurenciji. U ovom su dobu sportaši spremni podnijeti veće zahtjeve treninga, kondicijske vježbe postaju specifićne za određenu sportsku granu, a njihov se intenzitet povećava s ciljem poboljšanja nivoa takmićarske učinkovitosti (Bompa, Pasquale i Cornacchia, 2012). Da bi bio spo-

increases with the aim of improving their competing skills (Bompa, Pasquale i Cornacchia, 2012). In order for him to be able to endure the intensity of senior trainings and competitions, but also to be able to keep improving his knowledge and skills with as few injuries as possible, the young athlete must be taught and led professionally and carefully during this period. Only the athletes who have been properly prepared and trained will be able to reach the senior level of sports. Before anything else the coach must see if the athlete is ready for such a change (precondition for sports specialisation isn't only the chronological age), and then prepare the proper trainings to ensure further development of knowledge and skills.

## METHOD

This paper was based on descriptive methods, supported by theoretical analysis and generalisation. This method implies equal treatment of empirical and theoretical researches. This paper presents the methods which are most frequently used in strength development. Web of Science and Google Scholar databases were used to research about theoretical and practical cognitions about strength development.

## METHODOLOGY OF INDIVIDUAL STRENGTH DIMENSIONS DEVELOPMENT

Methodology of strength training developed along with kinesiology and the development of modern sport. However, the peak of training methods development was achieved in the last 40 years. Weightlifting, body-building, athletics, powerlifting and gymnastics contributed the most.

Therefore, it is not surprising that most of the modern methods and means for basic and specific forms of strength originate from the previously mentioned sports disciplines.

There are several ways to group the strength development methods in sports science. Some authors (Chisfield, 2001) mention some methods based on the performance of muscles (static – isometric and dynamic – concentric and eccentric). Regarding to that, there are two types of methods for strength development, and they are:

1. Functional methods for strength development
2. Structural methods for strength development.

However, there are other types of methods for strength development which are also frequently used in the process of training, and they are:

soban pratiti intenzitet seniorskih treninga i natjecanja, ali i da bi nastavio unapređivati svoja znanja i sposobnosti uz što manju mogućnost ozljeda mladi sportaš u razdoblju specijalizacije mora biti pažljivo i stručno vođen. Jedino oni sportaši koji su prošli kvalitetnu dugoročnu pripremu moći će nesmetano ući u seniorski sport. Trener prvo mora prepoznati je li sportaš spreman za takvu promjenu (uslov za sportsku specijalizaciju nije samo hronološka dob), a nakon toga prilagođenim programom treninga osigurati nastavak razvoja sposobnosti i znanja. Naravno, veliki broj talentiranih juniora ne uspije ostvariti taj prijelaz, što dokazuje koliko je to osjetljivo doba i s koliko opreza i stručnosti trener mora pristupiti mladom sportašu.

## METOD

Za izradu rada korištena je deskriptivna metoda, potkrijepljena teorijskim analizama i uopštavanjem. Ova metoda je podrazumijeva ravnopravan tretman empirijskih i teorijskih istraživanja. Prikazane su metode koje se najviše koriste u razvoju snage. Pretraživanje teorijskih i praktičnih saznanja o korištenim metodama za razvoj snage sprovedena je korišćenjem baze pretraživača Web of Science, i Google Scholar. Pretraženi su i mnogi časopisi iz oblasti sportskih nauka, a u vezi sa sportskim treningom.

## METODIKA RAZVOJA POJEDINIH DIMENZIJA SNAGE

Metodika treninga snage razvijala se uporedo sa razvojem kineziološke i njoj srodnih nauka, te uporedo sa razvojem savremenog sporta. Ipak, najveći napredak metodika treninga snage doživjela je u posljednjih 40-ak godina. Poseban doprinos u razvoju metoda i sredstava za razvoj snage dali su sljedeći sportovi: a) dizanje tegova, b) body-building, c) atletika, d) powerlifting, e) sportska gimnastika.

Stoga ne čudi činjenica da većina savremenih metoda i sredstava za razvoj bazičnih i specifičnih oblika snage u sportu potiče upravo iz spomenutih sportskih grana.

U sportskoj nauci postoji više načina grupisanja metoda treninga snage. Neki autori (Chisfield, 2001.) navode metode na temelju vrste mišićne akcije (statičke -izometričke i dinamičke -koncentrične i eksentrične). Sa tog aspekta moguće je govoriti o dvije vrste metoda za razvoj snage i to:

1. Funkcionalne metode za razvoj snage i
2. Strukturalne metode za razvoj snage.

1. Supramaximum methods for strength development
2. Pyramidal method for strength development
3. Strength endurance method.

## FUNCTIONAL METHODS

Functional methods are directed towards strength development without a significant increase in muscle mass. The most significant changes related to developing the maximum strength using these methods happen at the neural level (improvement of intramuscular and intermuscular coordination). Within functional methods, according to Marković and Peruško (2003) the following methods are most frequently used:

- a. The Maximum Effort Method
- b. The Explosive Dynamic Stress Method
- c. The Reactive Method

### *The Maximum Effort Method*

This group of functional methods is characterised by short explosive muscle actions in overcoming the maximum (90%-100% of maximum) and supramaximum overload (150% of maximum; maximum eccentric action). Training methods that belong to this group are ideal for maximum strength development, and those with explosive actions of concentric and explosive strength. It's important to note that all the strength training methods which belong to this group are recommended only to highly trained athletes with years of experience in strength training (Schmidtbleicker 1984).

Maximum stress methods can be:

- *Maximum dynamic contractions*

Implies working with maximum and submaximum load (3RM to 1RM) that athlete can master (eccentric and concentric part of movement). It's very characteristic for powerlifters (bench press and squats) who have to lift (concentric part) and lower (eccentric part) the maximum load.

- *Maximum concentric contractions*

The fundamental feature of this method is to overcome the maximum (100%) load only in the concentric part of movement. During the trainings it is mostly done in series (5-6 series), usually repeating once, with the 3-5 pause in-between series. While overcoming the load the movement is done explosively. In example, Bulgarian weightlifters try to lift maximum load at each training session.

Međutim, potrebno je istaći i druge vrste metoda za razvoj snage koje se takođe često koriste u trenažnom procesu, a to su:

1. Supramaksimalne metode za razvoj snage,
2. Piramidalne metode za razvoj snage i
3. Metode snažne izdržljivosti.

## FUNKCIONALNE METODE

Funkcionalne metode su usmjerene na razvoj snage bez značajnijeg povećanja mišićne mase. Najznačajnije promjene vezane za razvoj maksimalne snage primjenom ovih metoda dešavaju se na neuralnom nivou (poboljšanje intramuskularne i intermuskularne koordinacije). Prema Marković i Peruško (2003) u okviru funkcionalnih metoda najčešće se koriste sljedeće metode:

- a. Metoda maksimalnih naprežanja,
- b. Metoda eksplozivnih dinamičkih naprežanja,
- c. Reaktivna metoda.

### *Metode maksimalnih naprežanja*

Ovu grupu funkcionalnih metoda karakterišu kratkotrajne eksplozivne mišićne akcije pri savladavanju maksimalnih (90%-100% od maksimalnog) i supramaksimalnih opterećenja (do 150% od maksimalnog; maksimalne ekscentrične akcije). Metode treninga koje pripadaju ovoj grupi idealne su za razvoj maksimalne snage, a one s eksplozivnim izvođenjem koncentrične faze i za eksplozivne snage. Treba naglasiti kako se sve metode treninga snage, koje spadaju u ovu grupu su preporučljive samo visoko treniranim sportistima koji imaju višegodišnje iskustvo u treningu snage (Schmidtbleicker, 1984).

Metode maksimalnih naprežanja mogu biti:

- *Maksimalne dinamičke kontrakcije*

Podrazumijeva rad sa maksimalnim i submaksimalnim opterećenjima (3RM do 1RM) koje sportista može savladati (ekscentrični i koncentrični dio pokreta). Karakteristična je npr. za "powerliftere" (benč pres i čučanj) koji moraju maksimalno opterećenje podići (koncentrični dio) i spustiti (ekscentrični dio).

- *Maksimalne koncentrične kontrakcije*

Osnovna odlika ove metode jeste da se samo u koncentričnom dijelu pokreta savladava maksimalno (100%) opterećenje. Na treningu se najčešće radi u serijama (5 – 6 serija), obično sa 1 ponavljanjem, a pauza između serija 3-5 minuta. Prilikom savladavanja opterećenja pokret se izvodi eksplozivno. Primjera radi, bugarski dizači tegova, na svakom treningu pokušavaju podići maksimalna opterećenja.

- *Maximum isometric contractions*

Maximum isometric contractions are performed contrary to stationary load. 5 series are repeated 2 times, and each contraction lasts between 3 and 6 seconds.

- *Maximum eccentric contractions*

This method is performed by controlled lowering (eccentric part of the movement) of supramaximum load (130%-150%). Eccentric part of the movement lasts 5 to 6 seconds, is repeated 4 to 5 times in 3 series. The pause in-between series lasts 3 minutes. To use this method two assistants are needed during the part of concentric movement.

- *Nearly maximum concentric contractions*

This method uses loads from 90% to 100%. The usual training includes the so-called "flat" pyramid: repeating 1 series 3 times with 90%; repeating 1 series once with 95%; repeating 1 series once with 97,5%; repeating 1 series once with 100%; an attempt to master 1 series of load 1kg heavier than 100% (an attempt to break own record).

- *Concentric-eccentric maximum contractions*

This method is known for using the advantages of concentric methods in intramuscular coordination development and using the method of quick shifting from eccentric phase to concentric phase of movement in order to reach maximum muscle stress. During the training the athlete repeats 3-5 series for 5-8 times, using the load of 70% to 90% in the way that the load in the beginning phase is being released (eccentric part) quickly, after which it slows down and then quickly transitions to the concentric part of movement and maximum acceleration of load. According to author, it is necessary to point out how this method represents a certain level of risk of movement apparatus injury, because heavy loads lowers quickly. For that reason, this exercise should be done very carefully (KnowNels, D. 1999).

The content of basic parameters of maximum stress training methods are shown in Table 1.

- *Maksimalne izometričke kontrakcije*

Maksimalne izometričke kontrakcije se izvode nasuprot nepokretnog opterećenja. U vježbi imamo po 2 ponavljanja u 5 serija, a trajanje svake kontrakcije je između 3 i 6 sekundi

- *Maksimalne ekscentrične kontrakcije*

Ovom metodom izvodi se kontrolisano popuštanje (ekscentrični dio pokreta) supramaksimalnih opterećenja (130-150%). Trajanje ekscentričnog dijela pokreta je 5 do 6 sekundi, ponavlja se 4 do 5 puta u 3 serije. Pauze između serija su 3 minute. Kod primjene ove metode u fazi izvođenja koncentričnog dijela pokreta potrebna su dva asistenta.

- *Skoro maksimalne koncentrične kontrakcije*

U ovoj metodi koriste se opterećenja koja se kreću u rasponu od 90% do 100%. Najčešće oblikovani trening predstavlja tzv. "ravnu" piramidu: 3 ponavljanja u 1 seriji na 90%; 1 ponavljanje u 1 seriji na 95%; 1 ponavljanje u 1 seriji na 97,5%; 1 ponavljanje u 1 seriji na 100%; 1 pokušaj u 1 seriji savladavanja opterećenja većeg od 100% za 1 kg (pokušati oboriti lični rekord).

- *Koncentrišno-ekscentrične maksimalne kontrakcije*

Ova metoda se odlikuje time što nastoji da s jedne strane iskoristi prednosti koncentrične metode u razvoju intramuskularne koordinacije, a druge strane brzi prelazak iz ekscentrične faze u koncentričnu fazu pokreta da bi se postigla maksimalna anapetost mišića. Za vrijeme treninga sportista izvodi 5 do 8 ponavljanja u 3 do 5 serija pri opterećenju od 70 do 90% na način da se opterećenje u početnoj fazi popušta (ekscentrični dio) brzo, nakon čega slijedi njegovo usporavanje te brzi prelaz u koncentrični dio pokreta i maksimalno ubrzanje opterećenja. Prema autorovom mišljenju, neophodno je istaknuti kako metoda koncentrišno – ekscentrične maksimalne kontrakcije, predstavlja određeni stepen opasnosti povređivanja aparata za kretanje jer dolazi do brzog snižavanja velikih opterećenja. Iz tog razloga izvođenju vježbe treba pristupiti sa posebnom pažnjom (KnowNels, D. 1999).

Sadržaj osnovnih parametara treninga metoda maksimalnih naprežanja prikazan je u tabeli 1.

**Table 1.** Parameters of maximum stress methods. (Source: Schmidtbleicker, D. (1984). *Grupsifizierung der Trainingsmethoden im Krafttraining. Lekre der Leichtathletik in Zs. Leichtathletik*)**Tabela 1.** Parametri treninga primjenom metoda maksimalnih naprezanja (Izvor: Schmidtbleicker, D. (1984). *Grupsifizierung der Trainingsmethoden im Krafttraining. Lekre der Leichtathletik in Zs. Leichtathletik*)

Maximum stress methods / Metoda maksimalnih aprezanja	Max dynamic contractions / Maks. dinamičke kontrkcije	Max concentric contractions / Maks. koncentrične kontrkcije	Max isometric contractions / Maks. izometričke kontrkcije	Max eccentric contractions / Maks. eksentričkontrakti	Nearly max contractions / Skoro maksimalne kontrkcije	Conc-ecc max contractions / Konc.-eksc. maks kontrkcije
Performance pace / Tempo izvođenja vježbe	Slow / Spor	Explosive / Eksplozivan	Explosive / Eksplozivan	Slow / Sporo	Explosive / Eksplozivan	Explosive / Eksplozivan
Intensity – external load (%) / Intenzitet – vanjsko opterećenje (%)	90/95/100/90	100%	100%	120-150%	90/95/97/100 +	70-90%
Times repeated / Broj ponavljanja	3/1/1/3	1	2	5	3 1/1/1/+1	6-8
Series per exercise / Broj serija po vježbi	4	5	5	3	5 in total / ukupno 5	3-5
Rest intervals (min) / Intervali odmora (min)	5	3-5	5	3	3-5	5
Exercises per training / Broj vježbi na treningu	2-3	3-4	3	2	3-4	3
Training sessions per week / Broj treninga tjedno	2	2	2	1	2-3	2

### **The Explosive Dynamic Stress Method**

The method of explosive dynamic stress is distinctive by its manifestation of reaching maximum force in order to make as bigger as possible acceleration of smaller and medium load. The way of such muscle stressing by using these methods is ballistic and explosive. That is why these methods are ideal for quick strength development and its components (explosive and beginning strength).

The methods of explosive dynamic stresses are:

- *The speed-strength method*

The characteristics of load in this method are relatively smaller (30% to 50%) and medium (60% to 70%) depending on the workout type, and the concentric part of movement is performed as fast as possible. The workout is done 3-10 times and repeated in 5-6 series. An important aspect in this method is time control or time checking, because that is the only way the athlete and his coach can get the information about the effects of this way of training (Tidow, 1990, Tidow and Wiemann, 1993). This means that time checking allows the athlete to concentrate on reaching maximum speed of weights each time he repeats it. In order for the speed of weights to be maximum it is necessary to keep fatigue on low

### **Metoda eksplozivnih dinamičkih naprezanja**

Metodu eksplozivno dinamičkih naprezanja odlikuje brzo ispoljavanje maksimalne sile sa ciljem što je moguće većeg ubrzanja malih i srednjih opterećenja. Karakter mišićnog naprezanja kod primjene ovih metoda je balistički i eksplozivni. Upravo zbog toga ove metode su idealne za razvoj brzinske snage i njenih komponenti (eksplozivne i startne snage).

Metode eksplozivnih dinamičkih naprezanja su:

- *Brzinsko-snažna metoda*

Karakteristike ove metode su relativno manja (30 do 50%) i srednja (60 do 70%) opterećenja (zavisno od vježbe koja se izvodi), izvodi se koncentrični dio pokreta maksimalno brzo. Vježba se izvodi sa po 3 do 10 ponavljanja i ponavlja u 5 do 6 serija. Kod primjene brzinsko – snažne metode veoma važan aspekt se odnosi na vremensku kontrolu, odnosno vremensko provjeravanje, jer samo na taj način sportista i njegov trener mogu dobiti povratnu informaciju o efektima brzinsko- snažne metode treninga (Tidow, 1990., Tidow i Wiemann, 1993). To znači da, vremensko provjeravanje omogućuje sportisti da se usredotoči na postizanje maksimalne brzine te gova u svakom ponavljanju. Da bi brzina tegova bila mak-

level. The pauses in-between the series vary depending on the number of repeating, allowing each repetition to reach maximum strength.

- *The Ballistic method*

The most distinctive feature of ballistic method of training is that the athlete aims to accelerate load (which can be weight, his own mass, weight or medicine ball) to the highest speed and project it in the concentric phase of the movement.

While training, the athlete aims to speed up the exterior resistance by explosive force and eject it as far as possible (i.e. throwing the medicine ball forward over his head) or as high as possible (i.e. jump with load from the squatting position). Key factor in using ballistic met-

simalna i faktor umora je potrebno svesti na minimum. Pauze između ponavljanja unutar serije su promjenjive u zavisnosti od broja ponavljanja, te se tako u svakom ponavljanju može ispoljiti veliku mehaničku snagu.

- *Balistička metoda*

Osnovna odlika balističke metode treninga po čemu se ona i razlikuje od brzinsko-snažne metode jeste što sportista nastoji da opterećenje koje može biti uteg, vlastita masa, kugla ili medicinka maksimalno ubrza i izbaci u koncentričnoj fazi pokreta.

Sportista pri izvođenju vježbi nastoji da eksplozivnim djelovanjem sile, ubrza spoljašnji otpor i da ga izbaci što je moguće dalje (npr. bacanje medicinke preko glave naprijed) ili što je moguće više (npr. skok iz čučnja sa op-

**Table 2.** The training parameters using explosive dynamic stress method (Source: Schmidbleicker, D. (1984). Grupsifizierung der Trainingsmethoden im Krafttraining. *Lekre der Leichtatletik in Zs. Leichtatletik*)

**Tabela 2.** Parametri treninga primjenom metoda eksplozivnih dinamičkih naprezanja (Izvor: Schmidbleicker, D. (1984). Grupsifizierung der Trainingsmethoden im Krafttraining. *Lekre der Leichtatletik in Zs. Leichtatletik*)

<b>Types of explosive dynamic stress methods / Vrste metode eksplozivnih dinamičkih naprezanja</b>	<b>Speed-strength method / Brzinsko-snažna metoda</b>	<b>Ballistic method / Balistička metoda</b>
<i>Performance pace / Tempo izvođenja vježbe</i>	<i>Explosive / Eksplozivan</i>	<i>Explosive / Eksplozivan</i>
<i>Intensity – external load (%) / Intenzitet – spoljašnje opterećenje (%)</i>	30-70%	< 30%
<i>Times repeated / Broj ponavljanja</i>	3-10	6-15
<i>Series per exercise / Broj serija po vježbi</i>	5	3-5
<i>Rest intervals (min) / Intervali odmora (min)</i>	3-5	3
<i>Exercises per training / Broj vježbi na treningu</i>	3-4	2-3
<i>Trainings per week / Broj treninga tjedno</i>	2-3	2-3

hod is the speed of workout, which is performed while the athlete maintains the speed of ejecting. Workout is repeated 6-15 times in 3-5 series, which also depends on the load size, while the intensity should be less than 30% of maximum (Bompa i Carrera, 2015).

Basic training parameters using this method are shown in Table 2.

### **The Reactive Method**

The content of the reactive method of training represents the explosive-reactive ballistic way of muscle stressing. That stressing is only present in eccentric-concentric cycle of muscle performance, where a quick phase of musculoskeletal system is preceded in the concentric part of movement. However, the eccentric-concentric cycle cannot be the only criteria for the selection of reactive method trainings, because then even slow running could be sorted into the content of reactive methods. That

terećenjem). Ključni faktor u primjeni balističke metode je brzina izvođenja vježbe, izvodi se sve dok zadržavamo brzinu izbačaja. Vježbe se izvode sa 6 do 15 ponavljanja u 3 do 5 serija, što zavisi od veličine opterećenja, a intenzitet bi trebao biti manji od 30% od max (Bompa i Carrera, 2015).

Osnovni parametri treninga primjenom metoda eksplozivnih dinamičkih naprezanja prikazan je u tabeli 2.

### **Reaktivna metoda**

Sadržaji koji spadaju u reaktivne metode treninga odlikuje eksplozivno-reaktivno balistički način naprezanja mišića. To naprezanje prisutno je samo kod ekscentrično-koncentričnog ciklusa mišićne akcije gde se u koncentričnom dijelu pokreta prethodi brza faza istezanja mišićno-tetivnog sistema. Međutim, ekscentrično – koncentrični ciklus ne može biti jedini kriterijum za selekciju reaktivnih metoda treninga jer bi po tom krite-



is why the force gradient (explosiveness), which characterises reactive methods, is in the transition from eccentric to concentric part of muscle performance. In order to reach the necessary force gradient (explosiveness) the time of transition from eccentric to concentric phase of movement (i.e. duration of contact with pad while jumping) needs to be as short as possible <250ms (Bükrle, 1987). The time of transition is longer in the EKC activities, which is why the contribution of musculoskeletal system characteristics is considerably smaller, along with reflex mechanism and external muscle force. Intensity of load is determined on the basis of requirements of neuromuscular system. This method primarily aims to develop explosive and elastic strength.

- *Plyometric*

The basics of plyometric training have been first founded by Soviet sports scientists that worked with Verkhoshansky. The main goal of this training method is increasing the explosive strength and reactive ability of musculoskeletal system, so-called elastic strength (Verkhoshansky, 1979). This method covers different types of horizontal and vertical jumps and hopscotch in place, from the place and while moving.

- *The Contrast Method*

This method was founded by Russian and Bulgarian coaches, and in its original form it is based on the combined use of heavier and lighter loads under one training session, starting with the heavier load and then using lighter load. It can be considered a reactive method only if the plyometric content is used in its complex workout. There are two basic ways of using the contrast method:

- a. Combining the lifting of lighter and heavier loads in-between the series,
- b. Combining the lifting of lighter and heavier load in the series (superseries).

Other way of using implies lifting heavier loads during one exercise (over 90%) through a couple of series, after which it's necessary to perform structurally and biomechanically similar exercises with lighter load but maximum speed.

Primary way of using the contrast method is grouping two exercises (or more) and performing them under one big series (superseries), in order to constantly alternate working with heavier load and lighter load, while using the maximum speed of performance. An example of such way of using the contrast method is the so-called "Russian Complex" (Knowles, 1999).

rijumu i lagano trčanje mogli svrstati u sadržaje iz grupe reaktivnih metoda. Zato se gradijent sile (eksplozivnost) koji karakteriše reaktivne metode nalazi na prelazu iz eksentričnog u koncentrični dio mišićne akcije. Da bi se postigao potreban gradijent sile (eksplozivnost) potrebno je da vrijeme prelaska iz eksentrične u koncentričnu fazu pokreta (npr. trajanje kontakta s podlogom u skoku) bude što kraće <250ms (Bükrle, 1987). Kod aktivnosti EKC u kojima je to vrijeme prelaska duže, značajno se smanjuje doprinos elastičnih karakteristika mišićno – tetivnog sistema te refleksnih mehanizama i spoljašnjoj mišićnoj sili. Intenzitet opterećenja se određuje na osnovu zahtjeva što ga na neuromišićni sistem postavljaju pojedini sadržaji. Ova metoda služi prvenstveno za razvoj eksplozivne i elastične snage.

- *Pliometrija*

Osnove pliometrijskog treninga među prvima su utemeljili sovjetski sportski naučnici okupljeni oko Verkoškanskog. Glavni cilj ovakve metode treninga je povećanje eksplozivne snage i reaktivne sposobnosti mišićno - tetivnog sistema, tj. elastične snage (Verkoškanski, 1979). Metoda obuhvata različite varijante horizontalnih i vertikalnih skokova i poskoka u mjestu, iz mjesta i u kretanju.

- *Kontrastna metoda*

Metoda treninga je utemeljena od strane ruskih i bugarskih trenera, u izvornom se obliku bazira na kombinovanoj primjeni velikih i malih opterećenja unutar jednog treninga, pri čemu se prvo radi sa velikim opterećenja, kasnije sa malim. U reaktivne metode se može ubrajati samo onda ako se u kompleksu vježbi primjenjuju pliometrijski sadržaji. Dva su osnovna načina primjene kontrastne metode:

- a. kombinovanje podizanja malih i velikih opterećenja između serija,
- b. kombinovanje podizanja malih i velikih opterećenja unutar serija (superserije).

Drugi način podrazumijeva podizanje velikih opterećenja u jednoj vježbi (preko 90%) kroz nekoliko serija, nakon čega je potrebno izvoditi strukturalno i biomehanički slične vježbe sa manjim opterećenjem ali maksimalnom brzinom.

Prvi način primjene kontrastne metode je grupisati dvije vježbe (ili više njih) te ih izvoditi unutar jedne velike serije (super serije) tako da se neprestano izmjenjuje rad sa velikim opterećenjima i rad sa malim opterećenjem ali maksimalnom brzinom izvođenja. Primjer ovog načina primjene kontrastne metode je tzv. "ruski kompleks" (Knowles, 1999):

**Table 3.** The content of basic parameters of reactive method trainings.

**Tabela 3.** Sadržaj osnovnih parametara treninga reaktivnih metoda (Izvor: Schmidtbleicker, D. (1984). Grupsifizierung der Trainingsmethoden im Krafttraining. *Lekre der Leichtatletik in Zs. Leichtatletik*)

<b>The Reactive Method / Reaktivna metoda</b>	<b>Plyometric / Pliometrija</b>	<b>Contrast reactive method / Kontrastna reaktivna metoda</b>
<i>Performance pace / Tempo izvođenja vježbi</i>	<i>Explosive / Eksplozivan</i>	<i>Explosive / Eksplozivan</i>
<i>Intensity of load (%) force (external resistance) / Intenzitet opterećenja (%) sila (vanjski otpor)</i>	<i>No load / bez opterećenja</i>	0 do 90-100%
<i>speed of performing / brzina izvođenja</i>	<i>Maximum intensity / maksimalan intenzitet</i>	<i>Maximum intensity / maksimalan intenzitet</i>
<i>Times repeated / Broj ponavljanja</i>	3-10	2-3/6-10
<i>Series per exercise / Broj serija po vježbi</i>	2-5	3-5
<i>Rest intervals (min) / Intervali odmora (min)</i>	3-10	5-8
<i>Exercises per trainings / Broj vježbi na treningu</i>	2-8	2-3
<i>Trainings per week / Broj treninga tjedno</i>	1-3	2-3

Last squat: 2-3 times of repetition in 2 series with 90% of 1RM. Pause between the two series is 3-4 minutes, and after a long series it's 4-6 minutes.

Deep squat jumps: repeated 10 times in 2 series (the height of jump is altered according to the individual skills of a person). Pause between the series lasts 3-4 minutes. The whole workout (squats plus deep squat jumps) is repeated 2-3 times during the training, with pauses between them lasting 8-10 minutes.

Contrast method is based on the phenomenon called post-tetanic facilitation (PTF). PTF implies the short ability of neural system to react with bigger excitatory post-synaptic potential to the pre-synaptic stimulus after tetanisation (Güllick and Sckmidtbleicker, 1996). The content of basic parameters of reactive methods is presented in Table 3.

### STRUCTURAL METHODS

Structural methods in the process of training are used in order to increase maximum strength, primarily through structural changes of muscle – muscle hypertrophy. The main group of methods which lead to strength increase through muscle hypertrophy is considered a method of repetition.

#### *Repetition methods*

This group of methods is characterised by overcoming medium load (50 to 80% of 1RM) with larger number of repetitions (6 to 12). It's possible to perform repetitions until muscle fatigue occurrence (submaximum effort) or “failure” (maximum effort). Both ways can cause muscle hypertrophy, but maximum effort gives better results. Having in mind that hypertrophy can only

Zadnji čučanj: 2 do 3 ponavljanja u 2 serije sa 90% od 1RM. Između dvije serije vježbi pauza je 3 do 4 minute, a nakon druge serije 4 do 6 minuta.

Duboki skokovi: 10 ponavljanja u 2 serije (visina sa skoka se podešava prema individualnim sposobnostima pojedinca). Pauza između serija je 3 do 4 minute. Cijeli kompleks (čučanj plus duboki skokovi) se ponavlja 2 do 3 puta u treningu sa pauzama između kompleksa od 8 do 10 minuta.

Kontrastna metoda temelji se na fenomenu zvanom post – tetanička facilitacija (PTF). Pod post-tetaničkom facilitacijom podrazumijeva se kratkotrajnu sposobnost živčanog sistema da nakon tetanizacije, na isti pre – sinaptički podražaj reaguje većim ekscitatornim post – sinaptičkim potencijalom (Güllick i Sckmidtbleicker, 1996). Sadržaj osnovnih parametara reaktivnih metoda dat je u Tabeli 3.

### STRUKTURALNE METODE

Strukturalne metode u trenažnom procesu se primjenjuju sa ciljem povećanja maksimalne snage prvenstveno kroz strukturalne promjene u mišićima – hipertrofije mišića. Osnovna grupa metoda koje dovode do povećanja snage putem hipertrofije mišića smatra se metoda ponavljanja.

#### *Metode ponavljanja*

Ovu grupu metoda karakteriše savladavanje srednjih opterećenja (50 do 80% od 1 RM) sa većim brojem ponavljanja (6 do 12). Ponavljanja je moguće izvoditi do pojave mišićnog zamora (submaksimalni uloženi napor) ili do “otkaza” (maksimalni uloženi napor). Sa oba načina je moguće izazvati hipertrofiju mišića, ali veće efekte izaziva maksimalni uloženi napor. Imajući u vidu da se

be caused in the activated muscle tissue, the method of repetition with maximum effort results with activation of larger numbers of muscle fibres, and for that reason it will cause a bigger muscle hypertrophy.

According to Sckmidtbleicker (1984) the methods of repetition can be:

- *Standard method*

This method is characterised by overcoming the constant load stress from 80%, repeated 7 to 10 times, in 3 to 5 series. Pauses between the series are 3 to 4 minutes long.

- *Extensive bodybuilding method*

Group bodybuilding training often uses this method to extensively discharge the muscular energy stores. It's performed in 3 to 5 series and repeating 12 do 20 times, with the load being between 60% and 70%. The pauses between the series are relatively short (1 to 2 minutes). This is the reason why this method is good for development of repetitive strength, as well.

- *Intensive bodybuilding method*

This method is used to intensively discharge muscular energy stores. The load is between 85% and 95%, done in 3 to 5 series, and it's repeated 5 to 8 times. Pauses in-between series are 3 minutes long.

There are many varieties of trainings within these two methods, which bodybuilders use in their training, all for the cause of evocating as big as possible changes in the muscles.

- *Isokinetic method*

Isokinetic method is based on the measurement of muscle force in terms of concentric and eccentric contraction of muscles, usually using the special isokinetic devices (KIN-COM, CYBEX, BIODEX) for the cause of using the so-called diagnostic method, training methods or rehabilitation method. It uses isokinetic dynamometers that measure everything: force that generates muscles, muscle torque and angles of movements in the joint.

Such devices are usually made to enable performing isolated exercises, which is why the speed of extremities' movement is adjustable and constant. In other words, no matter how big the ejected force is while overcoming the loads, the movement speed is constant. The training speed can be regulated and usually varies between 36 and 300  $\text{s/s}$  (angular velocity). It's possible to perform eccentric and concentric muscle movement. In order to develop the strength through muscle hypertrophy it's re-

hipertrofija odvija samo u aktiviranim mišićnim vlaknima, metoda ponavljanja sa maksimalnim uložnim naporom se rezultira aktivacijom većeg broja mišićnih vlakana te shodno tome će izazvati i veću hipertrofiju mišića. Na taj način kod maksimalnih napora će biti veći i prirast snage.

Prema Sckmidtbleickeru (1984.) u metode ponavljanja spadaju:

- *Standardna metoda*

Ovu metodu karakteriše savladavanje konstantnog opterećenja od 80% sa po 7 do 10 ponavljanja, u 3 do 5 serija. Između serija pauze su 3 do 4 minute.

- *Ekstenzivna bodybuilding metoda*

U grupnom se bodybuilding treningu ova metoda često koristi u svrhu ekstenzivnog pražnjenja energetskih zaliha muskulature. Izvodi se 3 do 5 serija sa po 12 do 20 ponavljanja, pri čemu je opterećenje između 60 i 70%. Pauze između serija su relativno kratke (do 1 do 2 minute). Samim tim ova metoda je pogodna i za razvoj repetitivne snage.

- *Intenzivna bodybuilding metoda*

Ova metoda služi za intenzivno pražnjenje energetskih zaliha muskulature. Sa opterećenjem između 85 i 95%, izvodi se 3 do 5 serija, dok broj ponavljanja varira od 5 do 8. Između serija pauze su 3 minute.

Unutar ove dvije metode postoje brojne varijante treninga koje bodibilderi primjenjuju u svom treningu, a sve u cilju izazivanja što većih adaptivnih promjena na mišićima.

- *Izokinetička metoda*

Izokinetička metoda se zasniva na mjerenju mišićne sile u uslovima koncentrične i ekscentrične kontrakcije mišića, najčešće korišćenjem specijalni izokinetičkih uređaja (KIN-COM, CYBEX, BIODEX), a u svrhu primjene tzv. dijagnostičke metode, metode treninga ili metode rehabilitacije. Služi se izokinetičkim dinamometrima koji mjere više parametara: od sile koju generira mišić, preko obrtnog momenta mišića pa sve do uglova pokreta u zglobovima.

Takvi uređaji su najčešće oblikovani tako da omogućuje izvođenje izolujućih vježbi, pri čemu je brzina pokretanja ekstremiteta podesiva i konstantna. Drugim riječima, bez obzira koliko veliku silu ispoljili pri savladavanju opterećenja, brzina pokreta je konstantna. Brzina kojom se trenira može se regulisati te najčešće varira između 36 i 300  $\text{s/s}$  (ugaona brzina). Moguće je izvoditi ekscentrične i koncen-

**Table 4.** Basic parameters of repetition method (Source: Schmidtbleicker, D. (1984). Grupsifizierung der Trainingsmethoden im Krafttraining. *Lekre der Leichtathletik in Zs. Leichtathletik*)

**Tabela 4.** Osnovni parametri treninga metodom ponavljanja (Izvor: Schmidtbleicker, D. (1984). Grupsifizierung der Trainingsmethoden im Krafttraining. *Lekre der Leichtathletik in Zs. Leichtathletik*)

<b>Repetition method / Metoda ponavljanja</b>	<b>Standard method / Standardna metoda</b>	<b>Extensive bodybuilding method / Ekstenzivna bodybuilding metoda</b>	<b>Intensive bodybuilding method / Intenzivna bodybuilding metoda</b>	<b>Isokinetic method / Izokinetička metoda</b>	<b>Isometric Method / Izometrička metoda</b>
<i>Performance pace / Tempo izvođenja vježbe</i>	<i>Moderate / Umjeren</i>	<i>Moderate / Umjeren</i>	<i>Moderate / Umjeren</i>	<i>Fast / Brz</i>	<i>Moderate / Umjeren</i>
<i>Load intensity (%) / Intenzitet opterećenja (%)</i>	80%	60-70%	85-95%	70%	70-100%
<i>Times repeated / Broj ponavljanja</i>	7-10	12-20	8-5	12-15	4-6
<i>Series per exercise / Broj serija po vježbi</i>	3-5	3-5	3-5	3	3-5
<i>Rest intervals (min) / Intervali odmora (min)</i>	3-5	1-2	3	3	3
<i>Contraction length (3) / Trajanje kontrakcije (3)</i>					5-6
<i>Exercises per training / Broj vježbi na treningu</i>	5-8	5-8	5-8	2-3	3-4
<i>Trainings per week / Broj treninga tjedno</i>	2-4	2-4	2-3	3-5	2-4

commended to do 3 to 4 series, repeating 12 to 15 times, with pauses being 3 minutes long approximately. Intensity of the load is 70% of the maximum.

• *Isometric method*

Maximum isometric stress represents one of the variants of isometric method previously mentioned. It's based on repeating a bigger number of isometric stresses, from load retention to manifesting the force towards an immobile object. In order to use the isometric method as a way of developing strength structurally (muscle hypertrophy) it's recommended to use the load from 70% to 100% of maximum load. Following that, we perform 3 to 5 series with 4 to 6 isometric contractions, which last between 5 and 6 seconds.

The content of basic parameters of repetition method trainings is presented in Table 4.

**OTHER STRENGTH TRAINING METHODS**

This group includes all the methods that couldn't be classified based on the chosen criteria (adaptive characteristic and way of producing maximum muscle stress). These are the non-classified methods (Zaciorski i Kramer, 2009):

- Supramaximum methods,
- Pyramidal methods,

trične mišićne akcije. U cilju razvoja snage putem hipertrofije mišića preporučuju se izvođenje 3 do 4 serije sa po 12 do 15 ponavljanja, pri čemu su pauze između serija 3 minute. Intenzitet opterećenja je 70% od maksimalnog.

• *Izometrička metoda*

Maksimalna izometrička naprezanja predstavlja jednu od varijanti izometričke metode koju smo već spomenuli u prethodnom tekstu. Temelji se na ponavljanju većeg broja izometričkih naprezanja bilo zadržavajući opterećenje, bilo ispoljavajući silu nasuprot ne pokretnog objekta. Za primjenu izometričke metode kao načina strukturalnog povećanja snage (hipertrofija mišića) preporučuje se korištenje opterećenja od 70 do 100% od maksimalnog opterećenja. Tako se može izvoditi 3 do 5 serija. sa po 4 do 6 izometričkih kontrakcija, koje traju između 5 i 6 sekundi.

Sadržaj osnovnih parametara treninga metode ponavljanja dat je u tabeli 4.

**OSTALE METODE TRENINGA SNAGE**

U ostale metode treninga snage spadaju metode koje se nisu mogle klasifikovati na osnovu izabranih kriterija (adaptacijske karakteristike te način ispoljavanje maksimalne mišićne napetosti). U ostale metode mogu se ubrojati sljedeće metode (Zaciorski i Kramer, 2009):

- Supramaksimalne metode,

- Strength endurance methods

### ***Supramaximum methods***

The characteristic of supramaximum methods is that by using these methods it is possible to produce stress in the muscle which surpasses its maximum stress, which the muscle can produce in the regime of isometric and concentric performance (Baker, 2003).

- *Electrostimulation (EMS)*

Electrostimulation as a method has been used for more than 200 years, mostly in medical and physical therapy. During the process of training former USSR started using this method by the end of the 1960s in 20<sup>th</sup> century. The main purpose of electrostimulation in the training process for strength development was based on the fact that using this method it's possible to activate each muscle, while a person is not able to willingly activate all muscles using maximum contraction. That's why this method also belongs to supramaximum methods of training.

- *Partial repetitions*

In this method - athlete chooses the load bigger than maximum, which he can successfully lift and do a couple of concentric or combined (concentric-eccentric) repetitions, whose amplitude is limited in the area where the strength curve is the biggest (i.e. deadlift).

Methods of maximum eccentric contraction also belong to this group, which we have previously mentioned.

### ***Pyramidal methods***

The main reason this pyramidal method was presented as a special method is because using this method it's possible to develop the maximum strength and also using the structural and functional adaptive changes. In addition, pyramidal method can be used to develop other strength manifestation, such as repetitive strength, endurance strength etc.

The main feature of pyramidal method comes from its name, which is progressive increase (or regressive decrease) of load in the shape of pyramid (Sale, 2002).

Considering the development of certain strength manifestation, there are three types of pyramids (modified according to Milanović, 1997): maximum, intensive and extensive pyramid.

- Piramidalne metode,
- Metode snažne izdržljivosti

### ***Supramaksimalne metode***

Karakteristika supramaksimalnih metoda je ta što je njihovom primjenom moguće proizvesti ovu napetost u mišiću koja prevazilazi njihovu maksimalnu napetost koju mišić može proizvesti u režimu izometričkog ili koncentričnog rada, zbog toga se i primjenjuje za razvoj maksimalne snage (Baker, 2003).

- *Elektrostimulacija (EMS)*

Elektrosimulacija kao metoda primjenjuje se više od 200 godina koja se najviše koristila u medicini i fizikalnoj terapiji. Utrenažnom procesu elektrosimulacija se počela primjenjivati krajem 60-tih godina XX vijeka u bivšem SSSR-u. Osnovna svrha primjene elektrosimulacije u trenažnom procesu za razvoj snage bazirana je na činjenici da je njenom primjenom moguće aktivirati sve mišiće, dok čovjek nije u stanju aktivirati sve mišiće maksimalnom voljnom kontrakcijom. Zbog toga i spada u supramaksimalne metode treninga.

- *Parcijalna ponavljanja*

Kod metode parcijalnih ponavljanja sportista bira opterećenje koje je veće od maksimuma, a koje on može podići kroz cijeli opseg pokreta u vježbi i sa njime izvodi nekoliko koncentričnih ili kombinovanih (koncentrično – eksentričnih) ponavljanja čija je amplituda ograničena u području gdje je krivulja snage najveća (npr. mrtvo vučenje od natkoljenica).

U ovu grupu metoda treninga spadaju i metode maksimalne eksentrične kontrakcije, o kojima je već bilo govora u prethodnom poglavlju.

### ***Piramidalne metode***

Osnovni razlog zbog kojeg je piramidalna metoda prikazana kao posebna metoda jeste što je njenom primjenom moguće razvijati maksimalnu snagu i primjenom strukturalnih i funkcionalnih adaptacijskih promjena. Pored toga, piramidalna metoda se može primjenjivati i za razvoj drugih manifestacija snage, kao što su repetitivna snaga, snažna izdržljivost itd).

Osnovna karakteristika piramidalne metode se nazire iz samog njenog naziva, a to je progresivno povećanje (ili regresivno smanjenje) opterećenja u obliku piramide (Sale, 2002).

S obzirom na razvoj pojedinih manifestacija snage, razlikuju se tri vrste piramida (modifikovano prema Milanoviću, 1997): maksimalna, intenzivna i ekstenzivna piramida.

- *Maximum pyramid*

Maximum pyramid is used to develop maximum strength, primarily improving intramuscular coordination (neural adaptation), which is why it's closer to the functional methods. However, the method of maximum pyramid can cause structural changes, as well, such as muscle hypertrophy. Load intensity in this method is between 85% and 100%. Pauses for recovery in-between the series lasts 3-5 minutes.

Maximum pyramid method is usually done in 4 series as follows:

- First series 85% repeating 6 times,
- Second series 90% 4 times,
- Third series 95% 2-3 times,
- Fourth series 100% once.

- *Intensive method*

In this method we can differentiate between two types of pyramids:

*Intensive pyramid type I:*

Intensive pyramid type I is used in order to increase maximum strength, but primarily through structural changes, that is - increasing the cross section of muscle. Most of the external load is 65% to 85% of maximum. Exercises are done in series, usually in 4 series, and loads are distributed as follows:

- First series 70% repeated 12 times,
- Second series 75% 10 times,
- Third series 80% 7-8 times,
- Fourth series 85% 6 times.

Optimal resting time in-between the series is 4 minutes.

*Intensive pyramid type II:*

Intensive pyramid type II is used to develop the explosive strength. Using this type of pyramid means explosive performance of concentric phase of movement. The number of repeating in the series is smaller, depending on the load, usually 3 to 6. Number of series is 4 to 5. Resting time in-between the series is around 5 minutes. Although the size of load is between 65% and 85%, the speed of performance is maximum which is why the total intensity of load is maximum.

Example of workout using intensive pyramid type II:

- First series 70% repeated 5 times,
- Second series 75% 4 times,
- Third series 2 x 80% 3 times.

- *Maksimalna piramida*

Maksimalna piramida se primjenjuje za razvoj maksimalne snage prvenstveno poboljšanjem intramuskularne koordinacije (neuralna adaptacija) zbog čega je bliža funkcionalnim metodama. Međutim, metoda maksimalne piramide može izazvati i strukturalne promjene, tj. hipertrofiju mišića. Intenzitet opterećenja kod ove metode kreće se između 85 i 100%. Vrijeme oporavka između serija je 3-5 minuta.

Metoda maksimalne piramide se najčešće izvodi u 4 serije na slijedeći način:

- Prva serija 85% x 6 ponavljanja,
- Druga serija 90% x 4 ponavljanja,
- Treća serija 95 % x 2-3 ponavljanja,
- Četvrta serija 100% x 1 ponavljanje.

- *Intenzivna metoda*

Kod intenzivne metode mogu se razlikovati dvije vrste piramida:

*Intenzivna piramida tipa I:*

Intenzivna piramida tipa I primjenjuje se s ciljem povećanja maksimalne snage, ali prvenstveno putem strukturalnih promjena, odnosno povećanja poprečnog presjeka mišića. Veličina spoljašnjeg opterećenja iznosi 65 do 85% od maksimalnog. Vježbe se izvode u serijama, najčešće u 4 serije, a opterećenja su rapoređena na sljedeći način:

- Prva serija 70% x 12 ponavljanja,
- Druga serija 75% x 10 ponavljanja,
- Treća srija 80% x 7-8 ponavljanja,
- Četvrta serija 85% x 6 ponavljanja.

Optimalno vrijeme oporavka između serija iznosi do 4 minute.

*Intenzivna piramida tipa II:*

Intenzivna piramida tipa II primjenjuje se za razvoj eksplozivne snage. Izraziti zahtjev kod primjene ove vrste piramide jeste eksplozivno izvođenje koncentrične faze pokreta. Broj ponavljanja u seriji je manji, u zavisnosti od opterećenja, obično 3 do 6. Broj serija iznosi 4 do 5. Vrijeme oporavka između serija je oko 5 minuta. Iako je veličina opterećenja između 65 i 85%, brzina izvođenja zadatka je maksimalna pa je zato i ukupni intenzitet opterećenja maksimalan.

Primjer rada u intenzivnoj piramidi tipa II:

- Prva serija 70% x 5 ponavljanja,
- Druga serija 75% x 4 ponavljanja,
- Treća serija 2 x 80% x 3 ponavljanja.

**Table 5.** The basic parameters of pyramidal method of strength training (Source: Schmidtbleicker, D. (1984). *Grupsifizierung der Trainingsmethoden im Krafttraining. Lekre der Leichtatletik in Zs. Leichtatletik*)

**Tabela 5.** Osnovni parametri piramidalne metode treninga snage (Izvor: Schmidtbleicker, D. (1984). *Grupsifizierung der Trainingsmethoden im Krafttraining. Lekre der Leichtatletik in Zs. Leichtatletik*)

<b>Pyramidal method / Piramidalna metoda</b>	<b>Maximum pyramid / Maksimalna piramida</b>	<b>Intensive pyramid I / Intenzivna piramida I</b>	<b>Intensive pyramid II / Intenzivna piramida II</b>	<b>Extensive pyramid / Ekstenzivna piramida</b>	<b>Group pyramid / Grupična piramida</b>
<i>Performance pace / Tempo izvođenja vježbe</i>	<i>Explosive / Eksplozivan</i>	<i>Moderate / Umjeren</i>	<i>Explosive / Eksplozivan</i>	<i>Moderate to fast / Umjeren do brz</i>	<i>Moderate / Umjeren</i>
<i>Load intensity (%) / Intenzitet opterećenja (%)</i>	85/90/95/100%	70/75/80/85%	65-85%	40-65	70/80/90/100%
<i>Times repeated / Broj ponavljanja</i>	6/4/2-3/1	12/10/7/5	3-6	15-35	12/7-8/3-4/1
<i>Series per exercise / Broj serija po vježbi</i>	4	4-5	4-5	3-4	4
<i>Rest intervals (min) / Intervali odmora (min)</i>	3-5	5	3	1-2	3-4
<i>Exercises per training / Broj vježbi na treningu</i>	3-6	4-6	3-5	6-12	3-6
<i>Trainings per week / Broj treninga tjedno</i>	2-4	2-4	2-4	2-3	3-4

• *Extensive pyramid*

Extensive pyramid is primarily used for the development of strong (muscle) endurance and repetitive strength. Most of the external load is between 40% to 65%. It is done in 3 to 4 series, while the distribution of load are possible as follows:

- 40% x 35-40 repetitions / 45% times x 30 repetitions / 50% x 25 repetitions or 50% x 25-30 repetitions / 55% x 20-25 repetitions / 60% x 18-20 repetitions. Pauses in-between series are 1-2 minutes long.

Alongside of previously mentioned methods there is also a so-called group pyramid (Neineck, 2000):

- 70% x 10-12 repetitions / 80% x 7-8 repetitions / 90% x 3-4 repetitions / 100% x once.

The content of basic parameters of pyramidal method is shown in Table 5.

**Strength endurance methods**

As the title states, these methods are used to develop strength (muscular) endurance. The purpose of using this method, which is also its main characteristic, is overcoming loads in the zone of intensity between 30% and 60% with moderate tempo. Choosing the intensity of load (30% to 60%) primarily depends on whether the strength endurance has medium or long tempo.

• *Ekstenzivna piramida*

*Ekstenzivna piramida se primarno koristi za razvoj snažne (mišićne) izdržljivosti i repetitivne snage. Veličina spoljašnjeg opterećenja iznosi između 40 do 65%. Izvodi se 3 do 4 serije a distribucije opterećenja moguće su na sljedeći način:*

- 40% x 35-40 ponavljanja / 45% x 30 ponavljanja / 50% x 25 ponavljanja ili 50% x 25-30 ponavljanja / 55% x 20-25 ponavljanja / 60% x 18-20 ponavljanja. Pauze između serija su 1 do 2 minute.

Pored spomenutih vrsta piramide postoji i tzv. grupna piramida (Neineck, 2000):

- 70% x 10-12pon / 80% x 7-8ponavljanja / 90% x 3-4ponavljanja / 100% x 1ponavljanje.

Sadržaj osnovnih parametara piramidalne metode prikazan je u Tabeli 5.

**Metode snažne izdržljivosti**

Kako naslov i kaže, ove metode koriste se za razvoj snažne (mišićne) izdržljivosti. Svrha primjene ove metode, a što je i njena osnovna karakteristika jeste savladavanje opterećenja u zoni intenziteta između 30% i 60% umjerenim tempom. Izbor intenziteta opterećenja (30 do 60%) primarno zavisi od toga da li se radi o snažnoj izdržljivosti srednjeg ili snažnoj izdržljivosti dugog trajanja.

**Table 6.** Basic parameters of strength endurance method (Source: Schmidtbleicker, D. (1984). Grupsifizierung der Trainingsmethoden im Krafttraining. *Lekre der Leichtathletik in Zs. Leichtathletik*)**Tabela 6.** Osnovni parametri metoda snažne izdržljivosti (Izvor: Schmidtbleicker, D. (1984). Grupsifizierung der Trainingsmethoden im Krafttraining. *Lekre der Leichtathletik in Zs. Leichtathletik*)

<b>Strength endurance method / Metoda snažne izdržljivosti</b>	<b>Strength endurance method I / Metoda snažne izdržljivosti I</b>	<b>Strength endurance method II / Metoda snažne izdržljivosti II</b>
<i>Performance pace / Tempo izvođenja vježbe</i>	<i>Moderate to fast / Umjeren do brz</i>	<i>Moderate to fast / Umjeren do brz</i>
<i>Load intensity (%) / Intenzitet opterećenja (%)</i>	40-60%	30-40%
<i>Times repeated / Broj ponavljanja</i>	15-30	30-50
<i>Series per exercise / Broj serija po vježbi</i>	2-4	3-5
<i>Rest intervals (sec) / Intervali odmora (sec)</i>	60-90	30-60
<i>Exercises per training / Broj vježbi na treningu</i>	4-8	4-6
<i>Trainings per week / Broj treninga tjedno</i>	2-3	2-3

The basic principle of strength endurance development is based on the increase of number of repeating with a given load to the defined level. After that, the load size is increased (intensity). Circular organised form of work during training is the most used for strength endurance development. Considering the objective differences in load sizes between medium endurance level and long endurance level, there are two basic strength endurance training methods (modified according to Letzelter, 1978, Schmidt Bleicker, 1985):

#### *Strength endurance method I*

A method which implies repetitive overcoming of loads between 40% to 60%, with 2 to 4 series, whose number of repeats varies from 15 to 35 times. Pauses are very short, 30 to 60 seconds.

#### *Strength endurance method II*

This method I based on repetitive performance with load from 30% to 40%. Number of repeating in a series is in between 30 to 50 with 3 to 5 series. The pauses are very short, 30 to 60 seconds.

Basic parameters of strength endurance methods are shown in the table 6.

### CONCLUSION

After presenting all types of strength and basic methods of their development, it should be pointed out that all the mentioned parameters of some strength development methods do not represent the final models of training, but guidelines that should be used in the precise forming of training operators. The most important criteria for deciding the size of load and number of repeating

Osnovni princip razvoja snažne izdržljivosti se bazira na povećanju broja ponavljanja sa zadanim opterećenjem sve do definisanog nivoa. Nakon toga se povećava veličina opterećenja (intenziteta). Za razvoj snažne izdržljivosti najčešće se koristi kružni organizacijski oblik rada na treningu. S obzirom na objektivne razlike u veličini opterećenja između sportova izdržljivosti srednjeg i sportova izdržljivosti dugog trajanja, razlikuju se dvije osnovne metode treninga snažne izdržljivosti (modifikovano prema Letzelter, 1978., Schmidt Bleicker, 1985):

#### *Metoda snažne izdržljivosti I*

Metoda koja podrazumijeva repetitivno savladavanje opterećenja između 40 do 60%, pri čemu broj serija kreće između 2 i 4, a broj ponavljanja varira između 15 do 35. Između serija pauze su kratke, 60 do 90 sekundi.

#### *Metoda snažne izdržljivosti II*

Temelji se na repetitivnom izvođenju sa opterećenjem od 30 do 40%. Broj ponavljanja u seriji je između 30 do 50 ponavljanja, sa 3 do 5 serija, a pauze između serija su vrlo kratke 30 do 60 sekundi.

U tabeli 6 prikazani su osnovni parametri metoda snažne izdržljivosti.

### ZAKLJUČAK

Na kraju prikaza o tipovima snage te osnovnim metodama njihovog razvoja, valja istaknuti, da svi navedeni parametri pojedinih metoda treninga snage ne predstavljaju gotove modele treninga, već smjernice koje trebaju poslužiti u egzaktnom oblikovanju trenažnih operatora. Najvažniji kriterijum za određivanje veličine opterećenja i broja ponavljanja tokom treninga je tehnički isprav-



during training is technically correct way of performing an exercise, successful use of certain strength training methods that depend on explicitly defined goals of trainings, period and phase of training, and also age and level of acquired knowledge and trainings of athletes.

na izvedba vježbe, uspješna primjena pojedinih metoda treninga snage zavisi od eksplicitno definisanim ciljevima treninga, perioda i faze treninga te uzrastu i stepenu usvojenog znanja i treniranosti sportista.

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**Apstrakt:** Svaki rad mora sadržati apstrakt. Apstrakt treba da sadrži osnovnu ideju sa konačnim rezultatima istraživanja. Rad treba pisati u skladu sa uputstvom u nastavku. Apstrakt može sadržati do 250 reči.

**Ključne reči:** Najviše pet ključnih reči ili fraza odvojenih zarezom.

Rad mora sadržati jasan uvod, naveden problem, način rešavanja problema, rezultate, zaključak i reference. Rad ne treba da sadrži više od 8 stranica formata B5 (16,8 x 24,0 cm), uključujući slike, tabele i reference. Margine moraju biti: gornja i donja 2,5 cm, unutrašnja 2,5 cm i spoljašnja 2 cm. Stranice ne treba da budu numerisane.

Naslov rada (koristite font Times New Roman 12; naslov mora biti označen opcijom Bold) treba da bude postavljen na sredini prve stranice, pomeren za dva razmaka, veličina fonta 10 pt, ispod gornje margine. Nakon naslova treba ostaviti jedan razmak, veličina fonta 10 pt. Rad mora biti poslat Programskom odboru Kongresa u elektronskom obliku (PDF ili DOC) putem *obrasca za podnošenje radova*, ili kao prilog e-mail-u na *siz@apeiron-edu.eu*.

Trebalo bi da postoji natpis iznad tabele, koji navodi, na primer, „Tabela 1. Interkorelaciona matrica“. Ispod slike treba da bude broj i legenda, na primer “Slika 3: Rad sa predškolskim decom”.

Uredništvo prihvata rukopise napisane na engleskom (američki ili britanski engleski) i opciono na nekom od slovenskih jezika.

Rukopisi mogu biti odbijeni ako su napisani na lošem engleskom ili slovenskom jeziku. Autor je u potpunosti odgovoran za stil (formalan, nepristrasan u bilo kom smislu), jezik i sadržaj rada. Ipak, Urednički odbor ima pravo da komentariše formu i jezik rada pre nego što bude prihvaćen za objavljivanje. Očekuje se dobra, standardna upotreba gramatike u pisanom engleskom jeziku. Izbegavajte nestandardne skraćenice.

## REFERENCE

Potrebno je navesti sve izvore koji se koriste za vaš rad. Preporučuje se **APA** stil citiranja. Autori moraju da navedu kontakt podatke autora sa njegovim/njenim punim imenom, akademskim nazivom, institucijom, adresom, e-mail adresom i brojem telefona (opciono).

## PROCEDURA RECENZIJE

Radovi poslani časopisu će najpre biti ocenjeni od strane Uredništva imajući u vidu nekoliko kriterijuma: prikladnost teme i sadržaja časopisa; uređivanje (priprema rukopisa) i format; i “opšta” valjanost. Ako su ovi kriteriji ispunjeni, rad će biti poslat na dvostruku anonimnu recenziju od strane najmanje dva priznata i nezavisna recenzenta, a proces recenzije može trajati do 8 sedmica.

Samo radovi koji dobiju pozitivne recenzije će biti prihvaćeni. Jedan od presudnih razloga recenzije je navođenje citata i referenci relevantne literature. Urednički odbor ima pravo da komentariše formu rada pre nego što on bude prihvaćen za objavljivanje. Redakcija nije obavezna da objavljuje radove po hronološkom redosledu njihovog prijema ili po redosledu po kom su prihvaćeni za objavljivanje. Nijedan značajan deo rada ne treba da bude objavljen negde drugde. Prikazivanje rezultata u izvodima, sažecima, apstraktima, disertacijama i magistarskim tezama, recenzijama i radovima sa konferencija (do tri stranice, koje sadrže sažetke, grafičke prezentacije i reference) ne smatra se objavljivanjem. Ako rukopis sadrži rezultate koji su već objavljeni, autor(i) moraju dobiti pristanak prvog izdavača i jasno citirati izvor.

# ETHICS

## Publication ethics, disclosure policy and malpractice statement

### Publication and authorship

- All submitted articles are subject to strict peer-review process by at least two reviewers that are experts in the area of the particular paper.
- The factors that are taken into account in review are relevance, soundness, significance, originality, readability and language.
- The paper acceptance is constrained by such legal requirements as shall then be in force regarding libel, copyright infringement and plagiarism.
- For published articles, information on relevant potential conflicts of interest will be made available to the public.

### Authors' responsibilities

- Authors must certify that their manuscripts are their original work.
- Authors must certify that the manuscript has not previously been published elsewhere.
- In case a submitted manuscript is a result of a research project, or its previous version has been presented at a conference in the form of an oral presentation (under the same or similar title), detailed information about the project, the conference, etc. shall be provided navesti gde se navode. A paper that has already been published in another journal cannot be reprinted in this journal.
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- Editors should preserve the anonymity of reviewers.
- Editors should act if they suspect misconduct, whether a paper is published or unpublished, and make all attempts to persist in obtaining a resolution to the problem.
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# ETIKA

## Etika objavljivanja, pravila objavljivanja i zloupotreba podataka

### Objavljivanje i autorska prava

- Svi pristigli članci podliježu strogoj recenziji od strane barem dva recenzenta koji su stručnjaci iz oblasti naučnog rada.
- Faktori koji se uzimaju u obzir prilikom recenzije su relevantnost, ispravnost, značaj, originalnost, čitljivost i jezik.
- Prihvatanje rukopisa je ograničeno takvim zakonskim uslovima koje će se primijeniti u slučaju klevete, zloupotrebe autorskih prava i plagijata.
- Kod objavljenih članka, informacije o relevantnim potencijalnim sukobima interesa biće dostupne javnosti.

### Odgovornosti autora

- Autori moraju da potvrde da je njihov rukopis njihovo autorsko djelo.
- Autori moraju da potvrde da njihov rukopis nije prethodno objavljen na nekom drugom mjestu.
- U slučaju da je poslati rukopis rezultat naučnoistraživačkog projekta ili da je, u prethodnoj verziji, bio izložen na skupu u vidu usmenog saopštenja (pod istim ili sličnim naslovom), detaljniji podaci o projektu, konferenciji i slično, navode se u navesti gdje se navode. Rad koji je već objavljen u nekom časopisu ne može biti preštampan u ovom časopisu.
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- Autori su dužni da navedu sve izvore koje su koristili u pisanju njihovog rukopisa.
- Autori su dužni da se pridržavaju etičkih standarda koji se odnose na naučnoistraživački rad.

### Obaveze recenzenta

- Recenzija mora biti objektivna. Komentari koji se tiču ličnosti autora smatraju se neprimjerenim. Sud recenzenta mora biti jasan i potkrepljen argumentima.
- Recenzenti bi trebalo svoje stavove da iskažu jasno, sa pratećim argumentima.
- Recenzenti bi trebalo da čuvaju u povjerenju sve informacije u vezi članka i smatraju ih privilegovanim informacijama.
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- Urednici imaju punu odgovornost i ovlaštenje da odbiju/prihvate članak.
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- Urednici bi uvijek trebalo da razmotre potrebe autora i čitaoca pri pokušaju da se poboljša publikacija.
- Urednici bi trebalo da sačuvaju anonimnost pregledanog članka.
- Urednici bi trebali da osiguraju da je sav materijal koji objavljuju u skladu sa međunarodno prihvatljivim etičkim smjernicama.
- Urednici bi trebalo da djeluju ukoliko posumnjaju na zloupotrebu, bez obzira da li je rad objavljen ili ne, i preduzmu mjere kako bi uspjeli da riješe problem.
- Urednici ne bi trebalo da odbace članak na osnovu sumnje.





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