



# SPORTSKE NAUKE I ZDRAVLJE

## SPORTS SCIENCE AND HEALTH

Volume 9

Issue 1

1

Naučno-stručni časopis iz oblasti sportskih i medicinsko-rehabilitacionih nauka  
Scientific Journal in Sports and Medical-Rehabilitation Science

Godina 9 • Broj 1  
Decembar 2019.  
Republika Srpska  
Bosna i Hercegovina

Volume 9 • Issue 1  
December 2019  
The Republic of Srpska  
Bosnia and Herzegovina

ISSN 2232-8211 (Print)  
ISSN 2232-822X (Online)



UDC: 612  
UDC: 613  
UDC: 796



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# SPORTSKE NAUKE I ZDRAVLJE

SPORTS SCIENCE AND HEALTH

Naučno-stručni časopis iz oblasti sportskih i medicinsko-rehabilitacionih nauka

Scientific Journal in Sports and Medical-Rehabilitation Science

Izdavač/Published by Pan-european university "Apeiron" Banja Luka/ Pan-European University "Apeiron" Banja Luka, Bosnia and Herzegovina

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### Dizajn/Design

### Web dizajn/Web Design

### Štampa/Printed by

Oliver Krička, Bosnia and Herzegovina

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Sretko Bojić

Miloš Pašić

Art print, Banja Luka

Tiraž: 300 kom. /Printed in 300 copies/

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UDC 796

SPORTS SCIENCE AND HEALTH is registered with the Ministry of Science and Technology of the Republic of Srpska by serial registration code 07.030-053-85-2/11, date 08.02.2011., number 612.

SPORTS SCIENCE AND HEALTH (ISSN 2232-8211) is an international journal published two time a year.

# SPORTSKE NAUKE I ZDRAVLJE

SPORTS SCIENCE AND HEALTH

Vol. 9(2019) No. 1 (1-80)

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## Poštovani čitaoci,

Časopis "Sportske nauke i zdravlje" u kontinuitetu, već devetu godinu, objavljuje radove iz oblasti sportskih i rehabilitacionih nauka te pokušava da različite teme iz ove oblasti, približi široj naučnoj i stručnoj javnosti.

U ovom broju radove su nam poslali autori iz nekoliko država: Islanda, Srbije, Sjeverne Makedonije i Bosne i Hercegovine. Radovi koje smo uvrstili u ovaj broj Časopisa, odnose se na razlike u ventilacijskim sposobnostima dječaka i djevojčica, morfološke karakteristike kao prediktor rezultatske uspješnosti u testovima agilnosti u fudbalu, izokinetičku dijagnostiku, psihološke karakteristike kao faktor uspjeha u karateu, efekte treninga sa opterećenjem u nestabilnim uslovima, nivo stresa kod studenata u odnosu na pokazatelje životnog stila, opterećenje zglobova donjih ekstremiteta i razloge zbog kojih mladi izbjegavaju da se bave sportom i sportskim aktivnostima.

Veoma smo ponosni na sve vas, koji zajedno sa nama učestvujete u kreiranju naših izdanja. Ohrabrujemo sve autore da i dalje šalju radove putem naše web stranice, koji već uveliko pristižu za sljedeći broj Časopisa.

*"Najveća radost čovjeku koji razmišlja jest istraživanje i tiko poštovanje prema neistraženome."*

*Johann Wolfgang Goethe*

UREDNIŠTVO ČASOPISA

## DEAR READERS,

For the ninth year, the journal "Sports Science and Health" publishes articles in the field of sports and rehabilitation sciences, trying to bring various topics in this field closer to the broad scientific and professional public.

In this issue, articles have been sent to us by authors from several countries: Iceland, Serbia, North Macedonia and Bosnia and Herzegovina. The papers that we have included in this issue refer to differences in the ventilation capabilities of boys and girls, morphological characteristics as predictors of results in agility tests in football, isokinetic diagnostics, psychological characteristics as a success factor in karate, effects of training with stress in unstable conditions, stress level among students in relation to lifestyle indicators, lower extremity joints and the reasons why young people avoid sports and sports activities.

We are very proud of all of you, who, along with us, participate in creating our issues. We encourage all authors to continue sending their articles through our website, which are already arriving for the next issue of the Journal.

*"The greatest joy to the man who is thinking is research and quiet respect for the unexplored."*

*Johann Wolfgang Goethe*

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# YOUNG ATHLETES UPPER KNEE MUSCULAR STRENGTH ISOKINETIC TESTING

BRANKO ĐUKIĆ, MANE MIRKOVIĆ, SNEŽANA VUJANOVİĆ,  
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**Abstract:** This research main goal is to determine differences in maximum upper knee musculature torque moment of judo, football and handball players. For the needs of the research, 30 respondents were tested, of which 10 were football, 10 handball players and 10 judo athletes. Testing was conducted in Isokinetic Diagnostic Cabinet of the Provincial Institute for Sports and Sports Medicine in Novi Sad on the isokinetic dynamometer "Easytech prima DOC". Significant differences were noted in the maximum torque moment of both legs extensors force (PTQR, PTQL) between judo athletes and football players, in favor of judo. Obtained results between observed groups can be attributed to the various sports branches training processes specificities, i.e. performing certain techniques in the sport itself.

**Keywords:** isokinetic diagnostics, football players, judo athletes, handball players.

## INTRODUCTION

Modern training process today is unimaginable without quality athletes' training diagnostics. In this way, a sports expert meets their athlete, i.e. their good and bad sides, and in that way they are ready to enter the training process with them.

Muscles and joints function assessment is of utmost importance in sports and recreation (exercise), not only for performance purpose, but also for the assessment and injuries rehabilitation (Batzopoulos and Brodie, 1989). Isokinetic devices can serve as diagnostic devices for estimating different elements of strength, force, speed, average power, fatigue, acceleration and deceleration of segmental training and velocity (Baščevan, Baščevan, Janković, 2008).

Isokinetic testing is an examination of the functional muscles and joints parameters in active movement

# IZOKINETIČKO TESTIRANJE SNAGE NATKOLENE MUSKULATURE MLADIH SPORTISTA

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**Apstrakt:** Osnovni cilj ovog istraživanja je da se utvrdi razlike maksimalnog obrtnog momenta sile natkolene muskulature džudista, fudbalera i rukometara. Za potrebe istraživanja testirano je 30 ispitanika od kojih je 10 fudbalera, 10 rukometara i 10 džudista. Testiranje je sprovedeno u kabinetu za izokinetičku dijagnostiku Pokrajinskog zavoda za sport i medicinu sporta u Novom Sadu na izokinetičkom dinamometru „Easytech prima DOC“. Signifikantne razlike su uočene u maksimalnom obrtnom momentu sile ekstenzora obe noge (PTQR, PTQL) između džudista i fudbalera, u korist džudista. Dobijeni rezultati između posmatranih grupa se mogu pripisati specifičnostima trenažnog procesa različitih sportskih grana, tj. izvođenja određenih tehniku u samom sportu.

**Ključne riječi:** izokinetička dijagnostika, fudbaleri, džudisti, rukometari.

## UVOD

Savremeni trenažni proces danas je nezamisliv bez kvalitetne dijagnostike treniranosti sportista. Na taj način sportski stručnjak upoznaje svog sportistu, tj. njegove dobre i loše strane, i na taj način spremjan ulazi u trenažni proces sa njim.

Procena funkcije mišića i zglobova su od izuzetnog značaja u sportu i rekreaciji (vežbanju), ne samo u cilju performansi, već i za procenu i rehabilitaciju od povreda (Batzopoulos i Brodie, 1989). Izokinetički uređaji mogu poslužiti kao dijagnostički uređaji za procenu različitih elemenata snage, sile, brzine, prosečne snage, zamora, ubrzanja i usporedba segmentarnog rada i brzine (Baščevan, Baščevan, Janković, 2008).

Izokinetičko testiranje predstavlja ispitivanje funkcionalnih parametara mišića i zglobova u aktivnom po-

and in real time in relation to age, gender, body weight, daily sports activity and individual needs. Isokinetics is applied for the purpose of measurement-diagnostics, exercise-training and rehabilitation. What is relevant to the isokinetic movement is that the subject is never opposed to a resistance that cannot be overcome, because the resistance is even equal to the applied force. This means that isokinetic training is safe (*Mikić, Bajrić, Selimović, Hrnjić, Ivanek, 2018*). Isokinetics is a method of measuring muscle force in conditions of concentric and eccentric muscular contractions on a special isokinetic dynamometer. This method allows the definition of maximum force depending on the angle between the segments (knee), the force between agonists and antagonists ratio (lower extremities: m. Quadriceps - m. Biceps femoris).

Isokinetic diagnostics represents the best way to determine maximum muscle strength, muscular endurance, which are strong, and which weak athlete points. Taking into account specifics of football, judo and handball specifics, upper knee muscular power control is of great importance both in prevention of injuries and in creation of training process. In the study of upper knee muscular power of footballers, athletes, judoists and wrestlers, *Vujkov, Golik-Perić, Drid, Vujkov, Drapšin (2008)*, proved statistically significant differences in variables which show maximum knee torque of extensors of both legs and the maximum knee torque of flexors of both legs in favor of the judoists and wrestlers.

By measuring the strength of individual muscle groups that trigger certain extremities, we get parameters that define this movement. One of the basic parameters is, of course, knee moment of force (torque), that is, the value of the force that the tested muscle develops around the axis of rotation during the measured motion (moment of rotation), (*Iossifidou, 2000*).

During the motion, a constant force moment is not developed, so that the mean force mean value (Nm) - (mean torque) represents the mean value of the rotational force generated during the measured motion for a given angular velocity. Maximum torque moment (Nm) (peak torque) represents the maximum value of the rotational force generated during the measured motion at a certain angular velocity (*Jarić 2002; Lindsdrom 2006; Sykaras 2003; Veloso 2002*).

Modern football game and the increasing demands for achieving top results imply the need for a better scientific and professional quality approach, both in terms of the selection of future footballers and training technology application in the work with younger age categories. Modern training technology in the work with younger selections of footballers implies the develop-

kretu i realnom vremenu u odnosu na uzrast, pol, telesnu težinu, svakodnevnu sportsku aktivnost i individualne potrebe. Izokinetika se primenjuje u svrhu merenja-dijagnostike, vežbanja-treninga i rehabilitacije. Ono što je bitno za izokinetički pokret jeste da subjekt nikad nije suprostavljen otporu koji ne može savladati, jer je otpor celo vreme jednak primenjenoj sili. To znači da je izokinetički trening siguran (*Mikić, Bajrić, Selimović, Hrnjić, Ivanek, 2018*). Izokinetika je metoda merenja mišićne sile u uslovima koncentričnih i ekscentričnih mišićnih kontrakecija na specijalnom izokinetičkom dinamometru. Ova metoda omogućuje definisanje maksimalne sile u zavisnosti od ugla između segmenata (koleno), odnos sile između agonista i antagonistika (donji ekstremiteti: *m. quadriceps - m. biceps femoris*).

Izokinetička dijagnostika predstavlja najbolji način da se odredi kakva je maksimalna snaga mišića, mišićna izdržljivost, koje su jake, a koje slabe tačke sportiste. Uzimajući u obzir specifičnosti fudbala, džudoa i rukometa, kontrola snage natkolene muskulature od velikog je značaja, kako u prevenciji povreda, tako i u samom kreiranju trenažnog procesa. U istraživanju natkolene muskulature fudbalera, atletičara, džudista i rvača *Vujkov, Golik-Perić, Drid, Vujkov, Drapšin (2008)* su dokazali statistički značajne razlike u varijablama maksimalni obrtni moment ekstenzora kolena obe noge i maksimalni obrtni moment fleksora obe noge u korist džudista i rvača.

Merenjem snage pojedinih mišićnih grupa koji pokreću odredene delove ekstremiteta, dobijaju se parametri koji definišu taj pokret. Jedan od osnovnih parametara je, svakako, moment sile (torque), odnosno vrednost sile koju testirani mišić razvija oko ose rotacije tokom merenjeg pokreta (moment rotacije), (*Iossifidou, 2000*).

U toku izvođenja pokreta ne razvija se konstantan moment sile, tako da parametar srednja vrednost momenta sile (Nm) - (mean torque) predstavlja prosečnu vrednost rotacione sile ostvarene u toku merenog pokreta za određenu vrednost ugaone brzine. Maksimalni moment sile (Nm) (peak torque) predstavlja maksimalnu vrednost rotacione sile ostvarene u toku merenog pokreta pri određenoj ugaonoj brzini (*Jarić 2002; Lindsdrom 2006; Sykaras 2003; Veloso 2002*).

Savremena fudbalska igra i sve veći zahtevi za postizanjem vrhunskih rezultata nameću potrebu za što kvalitetnijim naučnim i stručnim pristupom, kako po pitanju same selekcije budućih fudbalera tako i po pitanju primene trenažne tehnologije u radu sa mlađim uzrasnim kategorijama. Savremena trenažna tehnologija u radu sa mlađim selekcijama fudbalera podrazumeva izradu takvih programa trenažnog rada koji će u potpunosti biti

ment of such training programs that will be completely subordinate to the characteristics and individual abilities of each individual, thereby contributing to the optimal development of all the qualities and abilities that define the anthropological status of the individual at all stages of its development (*Lolić, Bajrić, Lolić, 2011*). Analyzing component structure, considerably greater opportunities for managing and guiding football training techniques as well as the selection of future young generations are opened, and with the help of such analysis it is possible to provide monitoring and directing of connections functions between each subsystem within the football game (*Radosav, Molnar, Smajić, 2003; Bajrić, 2008*).

From the structural judo analysis itself, it follows that various manifestations of power, and then coordination are most important capabilities that determine success in judo fighting. From various types of strengths, it is considered that the ability to maximize energy mobilization in a unit of time is of utmost importance, ability to perform the maximum number of contractions with certain resistance, and the ability to develop maximum muscular strength. Modern superb judo fighter is characterized by the pronounced body muscularity and as far as motor skills are concerned, exceptional absolute, repetitive and explosive strength, perfect coordination, enviable speed, excellent balance and superb flexibility. The main goal of each judo athlete is to gain good competitive advantages in relation to its sport opponents (*Lolić, Nurkić, 2011*).

Handball game structure, match duration, technical-tactical activities during the match and training, requires that the team has handball players with highly developed physical characteristics. In relation to the position in the team, motor-functional abilities of individuals are also different. The power of the upper knee muscular is of great importance to the players in all positions. All of this suggests that isokinetic diagnostics is necessary in order to determine the current strength in order to program the training process and to prevent injury.

The aim of this paper is to determine upper knee muscular strength of football and handball players, judo athletes, and the existence of similarities or differences in the maximum torque of upper knee muscular between athletes' groups.

## WORK METHOD

The research involved 30 respondents aged 14-18, divided into three groups: 10 football players, 10 judoists and 10 handball players. Testing was done at the premises of the Provincial Institute for Sport and Sports Medicine in Novi Sad. For the needs of the test, the isokinetic dynamometer "Easytech Prima DOC" was used, at a torque of 60 step° / sec.

podređeni uzrasnim karakteristikama i individualnim sposobnostima svakog pojedinca i time doprineti optimalnom razvoju svih osobina i sposobnosti koji definišu antropološki status individue u svim fazama njenog razvoja (*Lolić, Bajrić, Lolić, 2011*). Analizom komponentne strukture otvaraju se znatno veće mogućnosti za upravljanje i usmeravanje trenažne tehnologije u fudbalu kao i samoj selekciji budućih mladih naraštaja, a ujedno uz pomoć takve analize moguće je obezbediti praćenje i usmeravanje funkcija veza između svakog subsistema unutar fudbalske igre (*Radosav, Molnar, Smajić, 2003; Bajrić, 2008*).

Iz same strukturalne analize džudoa proizlazi da su različite manifestacije snage, a zatim i koordinacije najvažnije sposobnosti koje determinišu uspeh u džudo borbi. Od različitih vidova snage smatra se da su za borbu od najvećeg značaja sposobnost maksimalne mobilizacije energije u jedinici vremena, sposobnost izvođenja maksimalnog broja kontrakcija uz određeni otpor, te sposobnost razvijanja maksimalne mišićne sile. Modernog vrhunskog džudo borca krasи naglašena muskuloznost građe tela, a što se tiče motoričkih sposobnosti izuzetna apsolutna, repetitivna i eksplozivna snaga, perfektna koordinacija, zavidna brzina, odlična ravnoteža i nadprosečna fleksibilnost. Glavni cilj svakog džudiste je da stekne dobre takmičarske prednosti u odnosu na svoje sportske protivnike (*Lolić, Nurkić, 2011*).

Struktura rukometne igre, trajanje utakmice, tehničko-taktičke aktivnosti u toku treninga i meča zahteva da ekipa u svom sastavu ima rukometare sa visoko razvijenim fizičkim karakteristikama. U odnosu na poziciju u ekipi, razlikuju se i motoričko-funkcionalne sposobnosti pojedinaca. Snaga natkolene muskulature je od izuzetnog značaja za igrače na svim pozicijama. Sve ovo nas upućuje da je izokinetička dijagnostika neophodna radi utvrđivanja trenutne snage u cilju programiranja trenažnog procesa i prevencije povreda.

Cilj rada je utvrđivanje snage natkolene muskulature fudbalera, džudista i rukometara i postojanja sličnosti ili razlika maksimalnog obrtnog momenta natkolene muskulature između grupa sportista.

## METOD RADA

U istraživanju je učestvovalo 30 ispitanika, uzrasta 14-18 godina, podeljenih u tri grupe: 10 fudbalera, 10 džudista i 10 rukometara. Testiranje je izvršeno u prostorijama Pokrajinskog zavoda za sport i medicinu sporta u Novom Sadu. Za potrebe testiranja korišćen je izokinetički dinamometar "Easytech Prima DOC", pri obrtnom momentu sile 60 step/sec.

**Testing Protocol:** On test day, athletes didn't have training, and only testing was done according to standard protocol in identical manner for everyone. Each athlete was introduced to the protocol individually before the test, then heated up adequately and prepared for testing. Dynamometer was calibrated before each test. For each respondent the dynamometer seat was specially adjusted. They were immobilized by seatbelts in order to maximally isolate tested musculature. Testing started with heating, then 2min break, and then starts the test itself. During the test, 4 maximum contractions were carried out, first with the front upper knee muscles, and then with rear, rotating. The same procedure was performed with one leg, and the other leg later. Body mass was measured before isokinetic testings on In Body 270 (bioelectric impedance) where athletes were in shorts and barefoot.



*Photo 1. Testing on Isokinetic dynamometer "Easytech Prima DOC"*

In this study, 8 tests were applied. Tests for assessment of upper knee muscular strength:

- Maximum torque of right knee extension - PTQR
- Maximum torque of left knee extension - PTQL
- Maximum torque of right knee flexion - PTHR
- Maximum torque of left knee flexion – PTHL
- Relative maximum torque of right knee extension - PTQR / W
- Relative maximum torque of left knee extension - PTQL / W
- Relative maximum torque of right knee flexion - PTHL / W
- Relative maximum torque of left knee flexion - PTHL / W
- Body mass -BM

Software package SPSS 20.0 was used for data processing. Data analysis was carried out using descriptive statistics for calculating basic descriptive parameters of the observed variables. To determine statistically significant differences in muscular strength between subjects, a univariate variance analysis (ANOVA) was used, a level of statistical significance ( $p < 0.05$ ).

**Protokol testiranja:** Na dan testiranja sportisti nisu trenirali, a samo testiranje izvedeno po standardnom protokolu na identičan način za svakog. Svaki sportista pojedinačno pre testa upoznat sa protokolom, zatim se adekvatno zagrejao i pripremio za testiranje. Dinamometar je pre svakog testiranja kalibriran. Za svakog ispitanika posebno se podešavalo sedište dinamometra. Ispitanici su bili imobilizirani trakama za sedište kako bi se maksimalno izolovala testirana muskulatura. Testiranje je počinjalo zagrevanjem, zatim 2 minuta pauze, a nakon toga se prešlo na sam test. Tokom testa izvodile su se 4 maksimalne kontrakcije, prvo prednjom, a zatim zadnjom nogom, neizmenično. Identičan postupak je izvođen prvo jednom, pa drugom nogom.

*Slika 1. Testiranje na izokinetičkom dinamometru "Easytech Prima DOC"*

U ovom istraživanju primenjeno je 8 testova. Uzorak varijabli za procenu snage natkolene muskulature:

- Maksimalni obrtni moment ekstenzije desnog kolena – PTQR
- Maksimalni obrtni moment ekstenzije levog kolena – PTQL
- Maksimalni obrtni moment fleksije desnog kolena – PTHR
- Maksimalni obrtni moment fleksije levog kolena – PTHL
- Relativni maksimalni obrtni moment ekstenzije desnog kolena – PTQR/W
- Relativni maksimalni obrtni moment ekstenzije levog kolena – PTQL/W
- Relativni maksimalni obrtni moment fleksije desnog kolena – PTHL/W
- Relativni maksimalni obrtni moment fleksije levog kolena – PTHL/W

Za obradu podataka korišćen je programski paket SPSS 20.0. Analiza podataka se sprovodila pomoću deskriptivne statistike za izračunavanje osnovnih deskriptivnih statistika posmatranih varijabli. Radi utvrđivanja statistički značajnih razlika snage natkolene muskulature

## RESULTS AND DISCUSSION

Correct development of upper knee muscles, unilateral relationship (relationship within a single muscular composition) and bilateral relationship (relationship between left and right side of the body that can be in the torso and extremities) are of utmost importance for sports structure such as football, judo, handball, both in terms of performance and in terms of injury prevention. Right time diagnosis and taking certain actions can help us with proper physical development of the athlete, and therefore in injuries prevention.

Descriptive statistics analysis (Table 1) of the observed variables based on the significance of Leven homogeneity variance test ( $p < 0.05$ ) indicates the homogeneity of all tested variables results in all three groups of athletes. The values of the asymmetry coefficient (Sk-Skewness) and the coefficient of curvature (Kurt-Kurtosis) indicate that the distributions of the analyzed variables do not deviate significantly from normal distribution. Average body weight of athletes involved in this study is  $53-120\text{kg} \pm 14.66\text{SD}$ . Mean values of measured variables that reflect upper knee musculature strength of the entire sample are shown in Table 1.

**Table 1.** Basic descriptive statistics for maximum knee torque and athletes body mass (whole sample)

Varijable / Variables	N	MIN	MAX	AS	SD	Sk	Kurt	Levenov test F p
uzrast / age	30	14.00	18.00	15.80	1.03	0.63	-0.49	0.04 0.96
TM	30	53.00	120.00	74.47	14.66	0.89	1.73	2.26 0.12
PTQR	30	123.00	335.00	233.27	54.95	-0.41	-0.71	0.95 0.40
PTQL	30	80.00	337.00	230.50	67.55	-0.58	-0.38	0.42 0.66
PTHR	30	52.00	192.00	112.60	36.87	0.43	-0.58	0.04 0.97
PTHL	30	32.00	182.00	107.40	36.38	0.12	-0.73	0.32 0.73
PTQR/W	30	2.08	4.10	3.10	0.48	-0.26	0.38	0.63 0.54
PTQL/W	30	0.98	4.25	2.84	0.90	-0.71	-0.34	1.81 0.18
PTHR/W	30	0.77	4.16	1.77	0.74	1.47	2.54	1.87 0.17
PTHL/W	30	0.60	3.18	1.49	0.52	1.13	2.44	1.23 0.31

**Legend:** N-number of research entities, TM- body mass, Min-minimum values, Max-peak values, AS-arithmetic mean, S-standard deviation, Sk-asymmetry factor, Kurt- curvature coefficient, maximum torque of right knee extension – PTQR, maximum torque of left knee extension – PTQL, maximum torque of right knee flexion – PTHR, maximum torque of left knee flexion – PTHL, relative maximum torque of right knee extension - PTQR / W, relative maximum torque of left knee extension - PTQL / W, relative maximum torque of right knee flexion - PTHL / W, relative maximum torque of left knee flexion - PTHL / W

između ispitanika korišćena je univariatna analiza varianse (ANOVA), nivo statističke značajnosti ( $p < 0.05$ ).

## REZULTATI I DISKUSIJA

Pravilna razvijenost natkolene muskulature, unilateralni odnos (odnos unutar jednog mišićnog sastava) i bilateralni odnos (odnos između leve i desne strane tela koji može biti u trupu i ekstremitetima) od izuzetnog su značaja za samu strukturu sportova kao što su fudbal, džudo, rukomet, kako u pogledu uspešnosti, tako i u pogledu prevencije povreda. Pravovremena dijagnostika i preduzimanje određenih radnji može nam pomoći pri pravilnom fizičkom razvoju sportiste, a samim tim i u prevenciji povreda.

Analiza deskriptivnih statistika (Tabela 1) posmatranih varijabli na osnovu vrednosti statističke značajnosti Levenovog testa homogenosti varijansi ( $p < 0.05$ ), ukazuje na homogenost rezultata svih testiranih varijabli kod sve tri grupe sportista. Vrednosti koeficijenta asimetričnosti (Sk-skjunis) i koeficijenta zakrivljenosti (Kurt-kurtosis) ukazuju da distribucije analiziranih varijabli ne odstupaju značajno od normalne distribucije. Prosečna telesna masa sportista obuhvaćena ovim istraživanjem iznosi  $53,00-120,00\text{kg} \pm 14,66\text{SD}$ . Srednje vrednosti izmerenih varijabli koje oslikavaju snagu natkolene muskulature čitavog uzorka su prikazane u tabeli 1.

**Tabela 1.** Osnovni deskriptivni statistici za maksimalni obrtni moment zglobo kolena (ceo uzorak)

**Legenda:** N-broj entiteta u istraživanju, TM- telesna masa, Min-minimalne vrednosti, Max-maksimalne vrednosti, AS-aritmetička sredina, S-standardna devijacija, Sk-koeficijent asimetričnosti, Kurt-koeficijent zakrivljenosti, PTQR- max obrtni moment ekstenzije desnog kolena, PTQL- max obrtni moment ekstenzije levog kolena, PTHR- max obrtni moment fleksije desnog kolena, PTHL- max obrtni moment fleksije levog kolena, PTQR/W- relativni max obrtni moment ekstenzije desnog kolena, PTQL/W- relativni max obrtni moment ekstenzije levog kolena, PTHR/W- relativni max obrtni moment fleksije desnog kolena, PTHL/W- relativni max obrtni moment fleksije levog kolena

Analysis of the basic descriptive parameters for the maximum torque of knee joint extension and flexion of football players, judo and handball players is shown in Table 2. Of all tested athletes, highest average body weight is found in judoists ( $AS = 83.30\text{kg}$ ), then handball players ( $AS = 74.90\text{kg}$ ), and the lowest footballers ( $AS = 65.20\text{kg}$ ). From the table, we can notice that there are differences in the variables that describe the force of upper knee musculature in absolute and relative values.

**Table 2.** Basic descriptive statistics for the maximum knee torque and body mass of football players, judo and handball players

Varijabla / Variable	sport	N	AS	SD	Min	Max	Varijabla / Variable	sport	AS	SD	Min	Max
TM	1	10	65.20	6.41	53.00	75.00	TM	1	65.20	6.41	53.00	75.00
	2	10	83.30	16.92	56.00	120.00		2	83.30	16.92	56.00	120.00
	3	10	74.90	13.37	53.00	92.00		2	74.90	13.37	53.00	92.00
PTQR	1	10	198.00	35.98	157.00	271.00	PTQR/W	1	2.95	0.52	2.09	3.99
	2	10	262.00	52.25	152.00	335.00		2	3.19	0.57	2.08	4.10
	3	10	239.80	57.94	123.00	308.00		3	3.17	0.35	2.32	3.54
PTQL	1	10	190.70	62.11	83.00	293.00	PTQL/W	1	2.58	1.15	1.06	4.25
	2	10	267.00	51.98	157.00	337.00		2	3.02	0.60	1.91	3.77
	3	10	233.80	69.96	80.00	308.00		3	2.91	0.89	0.98	3.70
PTHR	1	10	97.20	38.80	67.00	192.00	PTHR/W	1	1.85	0.82	1.10	3.03
	2	10	132.40	32.67	92.00	182.00		2	1.87	0.92	0.77	4.16
	3	10	108.20	32.98	52.00	148.00		3	1.58	0.45	0.88	2.58
PTHL	1	10	89.20	34.78	63.00	156.00	PTHL/W	1	1.36	0.48	0.92	2.26
	2	10	125.10	26.16	84.00	154.00		2	1.55	0.36	0.79	1.95
	3	10	107.90	40.67	32.00	182.00		3	1.55	0.71	0.60	3.18

**Legend:** 1 - football, 2 – judo, 3 – handball

Using single-factor analysis of variance (ANOVA) of different groups, the results were compared between groups in the indicators of upper knee muscular strength of athlete, where we determined on the basis of F and the level of statistical significance ( $p < 0.05$ ) that there are statistically significant differences between athletes in body mass ( $F = 4.29$ ,  $p = 0.02$ ), maximum torque extension of the right knee ( $F = 429$ ,  $p = 0.02$ ), maximum torque extension of the left knee ( $F=3,83$ ,  $p= 0.03$ ). In other variables that describe the force of tested musculature, statistically significant differences were not observed (Table 3).

In order to determine among which athletes there are statistically significant differences at level ( $p < 0.05$ ), LSD Post Hoc Tests was used (Table 3). Using the Tukey HSD test, it was found that in the variable Body Mass, where the

Analiza osnovnih deskriptivnih parametara za maksimalni obrtni moment ekstenzije i fleksije zglobo kolena fudbalera, džudista i rukometnika je prikazana u tabeli 2. Od testiranih sportista, najveću prosečnu telesnu masu imaju džudisti ( $AS=83,30\text{kg}$ ), zatim rukometari ( $AS=74,90\text{kg}$ ), a najmanju fudbaleri ( $AS=65,20\text{kg}$ ). Iz tabele možemo uočiti da postoje razlike i u varijablama koje opisuju silu natkolene muskulature u apsolutnim i relativnim vrednostima.

**Tabela 2.** Osnovni deskriptivni statistici za maksimalni obrtni moment zglobo kolena fudbalera, džudista i rukometnika

**Legenda:** 1-fudbaleri, 2-džudisti, 3-rukometari

Primenom jednofaktorske analize varianse (ANOVA) različitih grupa, poređeni su rezultati između grupa u pokazateljima snage natkolene muskulature sportista, gde smo utvrdili na osnovu vrednosti F, te nivoa statističke značajnosti ( $p<0.05$ ), da postoje statistički značajne razlike između grupa sportista u telesnoj masi ( $F=4,86$ ,  $p=0,02$ ), maksimalnom obrtnom momentu ekstenzije desnog kolena ( $F=4,29$ ,  $p=0,02$ ), maksimalnom obrtnom momentu ekstenzije levog kolena ( $F=3,83$ ,  $p=0,03$ ). U ostalim varijablama koje opisuju silu natkolene muskulature statistički značajne razlike nisu uočene (tabela 3).

Da bi se utvrdilo između kojih grupa sportista postoje statistički značajne razlike na nivou ( $p<0.05$ ), pribeglo se korišćenju LSD Post Hoc Testa (Tabela 3). Primenom Tukeyevog HSD testa ustavljeno je da se

mean value of the football players body mass ( $AS = 65.20$ ,  $SD = 6.41$ ) is statistically significantly lower ( $p = 0.01$ ) than the mean value of judo athletes body mass ( $AS = 83.30$ ,  $SD = 16.92$ ), the observed difference in the AS weight of these athletes' groups is 18.10kg in favor of the judoists. Additional comparisons with the HSD test indicate that the mean value of the maximum torque of the right knee extensions of footballers is statistically significantly lower ( $p = 0.02$ ) in relation to the judo athletes. Similar situation is with variables of maximum torque of the left knee extension ( $p = 0.03$ ), where for 76.30 AS judo athletes higher than the footballers in the observed variable. Using statistical procedures, differences were found in other variables that describe the extension and flexion in the knee joint, but differences are not significant. However, the results tell us that in all variables the best results were achieved by the judo, and that handball players are better than the footballers.

**Table 3.** Results single-factor ANOVA analysis and Post Hoc Test TukeyHSD

Dependent Variable	ANOVA		(I) sport	(J) sport	Mean Difference (I-J)	p
	F	p				
telesna masa / Body mass (TM)	4.86	.02	fudbaleri / footballers	džudisti / judoists	-18.10*	.01
			džudisti / judoists	rukometari / handballers	-9.70	.24
			rukometari / handballers	fudbaleri / footballers	18.10*	.01
			rukometari / handballers	rukometari / handballers	8.40	.34
			fudbaleri / footballers	fudbaleri / footballers	9.70	.24
			džudisti / judoists	džudisti / judoists	-8.40	.34
max obrtni moment ekstenzije desnog kolena (PTQR)	4.29	.02	fudbaleri / footballers	džudisti / judoists	-64.00*	.02
			džudisti / judoists	rukometari / handballers	-41.80	.16
			džudisti / judoists	fudbaleri / footballers	64.00*	.02
			rukometari / handballers	rukometari / handballers	22.20	.58
			rukometari / handballers	fudbaleri / footballers	41.80	.16
			džudisti / judoists	džudisti / judoists	-22.20	.58
max obrtni moment ekstenzije levog kolena (PTQL)	3.83	.03	fudbaleri / footballers	džudisti / judoists	-76.30*	.03
			džudisti / judoists	rukometari / handballers	-43.10	.28
			džudisti / judoists	fudbaleri / footballers	76.30*	.03
			rukometari / handballers	rukometari / handballers	33.20	.46
			rukometari / handballers	fudbaleri / footballers	43.10	.28
			džudisti / judoists	džudisti / judoists	-33.20	.46

**Legend:** BM-body mass, PTQR- maximum torque of right knee extension , PTQL- maximum torque of left knee extension, p-level of statistical significance of ANOVA

From the above data we can conclude that the differences between the examined sub-surveys of our research made by footballers (10), judoists (10) and handball players (10) aged 14-18 from the area of AP Vojvodina were established. Significant differences were observed in the maximum torque of both legs (PTQR, PTQL) force between the judo and football players in favor of judo. A statistically si-

u varijabli Telesna masa, gde je srednja vrednost TM fudbalera ( $AS=65,20$ ,  $SD=6,41$ ) statistički značajno manja ( $p=0,01$ ) od srednje vrednosti TM džudista ( $AS= 83,30$ ,  $SD=16,92$ ), uočena razlika AS telesne mase ovih grupa sportista iznosi 18,10kg u korist džudista.Naknadna poređenja pomoću HSD testa kazuju da je srednja vrednost maksimalnog obrtnog momenta ekstenzije desnog kolena fudbalera statistički značajno manja ( $p=0,02$ ) u odnosu na džudiste. Slična situacija je i sa varijablom maksimalni obrtni moment ekstenzije levog kolena ( $p=0,03$ ), gde je za 76,30 AS džudista veća od fudbalera u posmatranoj varijabli. Primenom statističkih procedura ustanovljene su razlike u ostalim varijablama koje opisuju ekstenziju i fleksiju u zglobu kolena, te razlike nisu značajne. Međutim, rezultati nam govore da su u svim varijablama najbolje rezultate postigli džudisti, i da su rukometari bolji od fudbalera.

**Tabela 3.** Rezultati jednofaktorske Anova analize i Post Hoc testa TukeyHSD

**Legenda:** PTQR- max obrtni moment ekstenzije desnog kolena, PTQL- max obrtni moment ekstenzije levog kolena p-nivo statističke značajnosti jednofaktorske Anova analize

Iz gore navedenih podataka možemo konstatovati da su ustanovljene razlike između ispitivanih subuzoraka našeg istraživanja koji su činili fudbaleri (10), džudisti (10) i rukometari (10) uzrasta od 14-18 godina starosti sa područja AP Vojvodine. Signifikantne razlike su uočene u maksimalnom obrtnom momentu sile ekstenzora obe noge (PTQR, PTQL) između džudista i fudbalera, u ko-

gnificant difference in maximum flexing torque moment of both knees was not established among athletes. Statistically significant differences in the rotational muscular force of the musculature in relation to the body weight of athletes were not observed. Differences in relative values were not seen in the tested variables of the judo and football players, as the TM judiciary was statistically significantly higher than the TM player, and in the calculation of the relative values influenced the obtained result.

## CONCLUSION

For the purpose of determining the differences in upper knee musculature, 30 athletes aged 14-18 participated, divided into three groups: 10 football players, 10 judoists and 10 handball players who play in the clubs from the area of AP Vojvodina. Testing was done at the premises of the Provincial Institute for Sport and Sports Medicine in Novi Sad. For the needs of the test, the isokinetic dynamometer "Easytech Prima DOC" was used, at a torque of 60 step° / sec.

The results of this study confirm results of *Vujkov and Associates Research (2008)* who found on the sample of 50 respondents (10 judoists, 10 footballers, 10 wrestlers, 10 athletes and 10 non-sporters) that the wrestlers and judoists achieved the best results of the maximum torque of the knee extension, and judoists as far as knee flexors were concerned. Isokinetic diagnostics was subject of research for *Trivić, Vujkov and Drid (2008)*, where they studies muscle disbalance of upper knee musculature among different group of athletes and non-athletes.

Obtained results by isokinetic diagnosis can be used to compare the effects of therapeutic procedures in sports injuries, but also to analyze the effects of different training protocols. The main advantages of this method in relation to others in evaluating the function of the locomotor system are efficiency, reliability, objectivity and non-invasiveness (*Golik-Perić, 2016*). The training process itself can be enriched by certain motor skills from other sports that will not violate the techniques adopted so far, and will affect the "awakening" and the development of targeted muscles and muscle groups that dominantly participate in the structure of movements and movements of a particular sports branch.

rist džudista. Statistički značajna razlika u maksimalnom obrtnom momentu fleksije oba kolena nije ustanovljena među sportistima. Statistički značajne razlike u obrtnom mometu sile natkolene mukulature u odnosu na telesnu masu sportista nisu uočene. Razlike u relativnim vrednostima nisu uočene kod testiranih varijabli džudista i fudbalera, jer je TM džudista statistički značajno veća od TM fudbalera, te je u proračunu relativnih vrednosti uticala na dobijeni rezultat.

## ZAKLJUČAK

U cilju utvrđivanja razlika natkolene mukulature stortista učestvovalo je 30 ispitanika, uzrasta 14-18 godina, podeljenih u tri grupe: 10 fudbalera, 10 džudista i 10 rukometara koji nastupaju u klubovima sa područja AP Vojvodine. Testiranje je izvršeno u prostorijama Pokrajinskog zavoda za sport i medicinu sporta u Novom Sadu. Za potrebe testiranja korišćen je izokinetički dinamometar "Easytech Prima DOC", pri obrtnom momentu sile 60 step/sec.

Rezultati ovog istraživanja potvrđuju rezultate istraživanja Vujkov i saradnika (2008) koji su na uzorku od 50 ispitanika (10 džudista, 10 fudbalera, 10 rvača, 10 atletičara i 10 nesportista) ustanovili da su rvači i džudisti postigli najbolje rezultate maksimalnih obrtnih momenata ekstenzora kolena, a džudisti kada su fleksori kolena u pitanju. Dobijena razlika u rezultatima između posmatranih grupa se mogu pripisati specifičnostima trenažnog procesa različitih sportskih grana, tj. izvođenja određenih tehniku u samom sportu. Sama struktura treninga u borilačkim sportovima je podređena usvajanju i usavršavanju pojedinih tehniku koje od sportista zahtevaju veliko angažovanje natkolene mukulature.

Rezultati dobijeni izokinetičkom dijagnostikom mogu se koristiti za poređenje efekata terapijskih procedura kod sportskih povreda, ali i za analizu efekata različitih trenažnih protokola. Glavne prednosti ove metode u odnosu na druge u evaluaciji funkcije lokomotornog sistema su efikasnost, pouzdanost, objektivnost i neinvazivnost (*Golik-Perić, 2016*). Sam trenažni proces može se obogatiti i određenim motoričkim znanjima iz drugih sportova koji neće narušiti do tada usvojene tehnike, a uticaće na "buđenje" i razvoj ciljanih mišića i mišićnih grupa koji dominantno učestvuju u strukturi kretanja i pokreta odredene sportske grane.

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Primljen: 16. mart 2019. / Received: March 16, 2019  
Prihvaćen: 13. april 2019. / Accepted: April 13, 2019

# DIFFERENCES IN VENTILATION ABILITIES IN BOYS AND GIRLS AGED 10 - 15

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**Abstract:** The aim of the study was to determine the differences in ventilation parameters between boys and girls in the 10-15 year age group (aged 10-15). The study was conducted on a sample of  $N = 1857$  subjects divided into 2 subunits taken from the boys ( $n = 968$ ) and girls ( $n = 889$ ) from the area of the City of Mostar. The sample variables consisted of 3 variables for the assessment of anthropometric measures, 24 variables were used for the evaluation of the ventilation parameters using Spirovit SP1 of the company Schiller AG. Results processing was performed in SPSS 21.0. To determine quantitative differences between groups, a canonical discriminatory analysis was applied. A discriminatory analysis found that there are statistically significant quantitative differences between groups of boys and girls on a global level. One function is isolated which explains 100% of the total variance and has a statistically significant high value (Can.Corr.=.948). The value of Wilk's lambda is low (.101) indicating high discrimination between groups. In quantitative terms, at the multivariate level, the greatest discrimination between groups in an isolated function is the variables of the Tiffen index ( $FEV1/FVC_{PRED}$ ),  $FEF50_{PRED}$   $FEF75_{PRED}$  and the percentage of the Tiffene index for respondents ( $FEV1/FVC\%$ ). This is also supported by the value of the centroid position in an isolated discriminatory function, where we can see the great distance between the centroid that is represented by groups of boys and girls in the space.

**Keywords:** ventilation, spirometry, children, discriminatory analysis capacity (FVK).

## INTRODUCTION

Ventilation is exchange of gases between external environment (atmosphere) and alveolar space in lungs and vice versa. It is examined with spirometry method

# RAZLIKE U VENTILACIJSKIM SPOSOBNOSTIMA DJEČAKA I DJEVOJČICA U UZRASNOM PERIODU OD 10 - 15 GODINE

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**Apstrakt:** Cilj istraživanja bio je utvrđivanje razlike u ventilacijskim parametrima između dječaka i djevojčica u uzrasnom periodu od 10-15 godine. Ispitanje je provedeno na uzorku od  $N=1857$  ispitanika koji je podijeljen na 2 subuzorka uzeta iz populacije dječaka ( $n=968$ ) i djevojčica ( $n=889$ ) sa područja grada Mostara. Uzorak varijabli činile su 3 varijable za procjenu antropometrijskih mjeru, za procjenu ventilacijskih parametara korištene su 24 varijable uzete pomoću spirometra marke Spirovit SP1 firme Schiller AG. Obrada rezultata izvršena je u programskom paketu SPSS 21.0. Za utvrđivanje kvantitativnih razlika između grupa, primjenjena je kanonička diskriminativna analiza. Diskriminativnom analizom utvrđeno je da postoje statistički značajne kvantitativne razlike između grupe dječaka i djevojčica na globalnom nivou. Izolovana je jedna funkcija koja objašnjava 100% ukupne varijance i ima statistički značajno visoku vrijednost (Can. Corr. = .948). Vrijednost Wilk'sove lambde je niska (.101) što ukazuje na visoku diskriminativnost između grupa. U kvantitativnom smislu na multivarijantnom nivou najveću diskriminaciju između grupa u izolovanoj funkciji čine varijable Tiffeneovog indeksa ( $FEV1/FVC_{PRED}$ ),  $FEF50_{PRED}$   $FEF75_{PRED}$  i varijabla procenta Tiffeneovog indeksa za ispitanike ( $FEV1/FVC\%$ ). Ovome u prilog ide i vrijednost položaja centroida na izolovanoj diskriminativnoj funkciji, gdje vidimo veliku udaljenost između centroida koji predstavljaju grupe dječaka i djevojčica u prostoru.

**Ključne riječi:** ventilacija, spirometrija, djeca, diskriminativna analiza.

## UVOD

Ventilacija je razmjena plinova između vanjske sredine (atmosfere) i alveolarnih prostora u plućima i obratno. Ispituje se metodom spirometrije i tjelesne ple-

and physical plethysmography. We use them to measure lungs volume (volume and capacity) and the airflow size (or resistance to the air flow) in respiratory tract. The obtained results are compared to reference values (normal, theoretical), according to sex (gender), age, height and weight of the body. By analysing the speed of air flow different states (conditions) of lungs can be determined like asthma, cystic fibrosis and KOPB - COLD (chronical obstructive lung disease). Many authors have stated the importance of development of functional abilities in children due to primary health reasons as a kind of prevention from a sedentary lifestyle and all the more common occurrences of obesity and diabetes. Children at the age of 10-15 are characterized by the fact that their lungs are rapidly developing the frequency of breathing decreases and the breathing becomes deeper. Frequentionaly the ability of respiratory tract is approaching the abilities of adults. Vital lung capacity increases and at the end of this age it reaches approximately  $2800 \text{ cm}^3$  in girls and  $3500 \text{ cm}^3$  in males (men). The value of maximum pulmonary (lungs) ventilation increases faster at girls, so at the age of 12-13 it is about 80 lit/min, and in boys it is about 75 lit/min. The maximum oxygen consumption in boys and in girls is a bit less than 2.5 lit/min. If we observe the parametres of absolute values of ventilation and their period of growth from 8 to 18 years (Mišigoj-Duraković, 2008; Stanojevic i sar., 2008) at youth in Zagreb, we can notice (see) the continuous increase in value. Forced vital, forced expiration volume in the first second (FEV1) in girls has the highest growth between the ages of 11 and 12, but in boys the trend is continuous until the age of 18 and has three times higher values compared to the age of 8. Tiffeneau's index is slightly reduced in girls until they are 10 years old, but later has constant values. In boys this index constantly declines from the ages of 8 to 10. The forced flow in the middle of the exhalation, between 25 % and 75 % of forced vital capacity, as well as forced flow between 200 ml and 1200 ml, has gradually been increasing for years, which is in accordance with their sensitivity to changes in large respiratory tracts and dependence on effort included in expiration. Spirometry is just one of diagnostic methods for measuring pulmonary function and it measures static and dynamic pulmonary volumes, capacities and flow. Due to high standardization of equipment, the way of measuring and wide availability, it represents the most important method for diagnosis and detection of respiratory obstruction. Spirometric measurement has a well-established protocol for quality control and detrmined appropriate standards the last of which was published is the current standard for performing spirometric measurements. Spiro-

tizmografije. Njima se mjere plućni obujmi (volumeni i kapaciteti) i veličina protoka zraka (ili otpor strujanju zraka) u respiratornim putevima. Dobijeni rezultati se uspoređuju s referentnim (normalnim, teorijskim) vrijednostima, prema spolu, životnoj dobi, visini i težini tijela. Analizom brzina protoka zraka mogu se utvrditi razna stanja pluća poput astme, cistične fibroze i KOPB (hronično opstruktivna bolest pluća). Mnogi autori navode izuzetnu važnost razvoja funkcionalnih sposobnosti kod djece iz primarno zdravstvenih razloga kao svojevrsnu prevenciju od sedentarnog načina života te sve češćih pojava gojaznosti i šećerne bolesti. Uzrast djece od 10-15 godine karakteriše to da se pluća se ubrzano razvijaju, frekvencija disanja opada i ono postaje sve dublje. Frekvencionalna sposobnost disajnog aparata približava se sposobnosti odraslih. Vitalni kapacitet pluća se povećava i krajem ovog uzrasta dostiže vrijednost oko  $2800 \text{ cm}^3$  kod djevojčica, a  $3500 \text{ cm}^3$  kod muškaraca. Vrijednost maksimalne plućne ventilacije se brže povećavaju kod djevojčica tako da u 12-13 godini iznosi oko 80 lit/min, a kod dječaka oko 75 lit/min. Maksimalna potrošnja kiseonika i kod dječaka i kod djevojčica iznosi nešto manje od 2,5 lit/min. Ako posmatramo apsolutne vrijednosti ventilacijskih parametara i njihov trend rasta od 8-18 godine (Mišigoj-Duraković, 2008; Stanojevic i sar., 2008)) kod zagrebačke omladine, vidimo kontinuiran porast vrijednosti. Forsirani vitalni kapacitet (FVK) i forsirani ekspiracijski volumen u prvoj sekundi (FEV1) kod djevojčica najviši prirast ima između jedaneste i dvaneste godine, dok kod dječaka trend povećanja je kontinuiran do osamneste godine i ima tri puta veće vrijednosti u odnosu na osmu godinu. Tiffeneauov indeks se kod djevojčica lagano smanjuje do desete godine, da bi kasnije imao konstantene vrijednosti. Kod dječaka ovaj indeks ima konstantan pad od osme do osamnaeste godine. Forsirani protok u sredini ekspiracije, između 25% i 75% forsiranog vitalnog kapaciteta, kao i forsirani protok između 200 ml i 1200 ml, postepeno se godinama povećavaju, što je u skladu s njihovom osjetljivošću na promjene u velikim respiratornim putevima i ovisnošću o naporu uloženom u ekspiriju. Spirometrija je samo jedna od dijagnostičkih metoda za mjerjenje plućne funkcije a mjeri statičke i dinamičke plućne volumene i kapacitete te protok. S obzirom na visok nivo standardizacije opreme, način mjerjenja i široku dostupnost, predstavlja najvažniju metodu u dijagnostici i otkrivanju opstrukcije respiratornog sistema. Spirometrijsko mjerjenje ima dobro utemeljeni protokol za kontrolu kvalitete te propisane odgovarajuće standarde od kojih je posljednji objavljeni i aktualni standard za izvođenje spirometrijskog mjerjenja. Spiro-

metric measurements should always be conducted in/under the same conditions using the same spirometer if it is possible. Everyday calibration of spirometres is needed which is based on external factors (temperature of room, air pressure , relative humidity) in order to do the correction of the measured volume to standardized conditions (terms) (BTPS standard – body temperature  $37^{\circ}\text{C}$  or  $310\text{ K}$  and air pressure  $47\text{ mmHg}$  or  $6.2\text{ kPa}$ ). Before testing, some information should be collected from the examinees (sex, age, body height and weight) which are needed so we could compare their measurements with an individual standard (expected values for sex, age, body height and weight). Nowadays that standard is built – in spirometre and it is not necessary to calculate the same, because it is automatically calculated by spirometre. Nowadays the most used standard is the one from the European Community for coal and steel. (CECA II).

## METHODS

The aim of research is to test some specific ventilation indicators for boys and girls at the age of 10-15. Morphological measures are taken according to IBP with Martin's anthropometer and electronic scales. Spirometric indicators were taken with a spirometre which is Shiller SP1 firm Schiller AG Switzerland brand.

### *The sample of examinee*

The study was conducted on the sample of  $N = 1857$  examinees divided on two subsamples taken from the boys ( $n = 968$ ) and girls ( $n = 889$ ) from the area of the City of Mostar aged 10 – 15.

### *The sample of variables*

For the evaluation of the ventilation parameters, 24 variables were used as well as 3 variables for evaluation of standard anthropometric measures ATM body weight (kg); ATV – body height (cm) and BMI –body mass index. Ventilation variables are; FCV – forced vital capacity; FVC<sub>PRED</sub> - predicted forced vital capacity; FVC% - percentage of forced vital capacity according to predicted ; FEV1 – volume of air expired in the first second ; FVC<sub>PRED</sub> - predicted volume of air expired in the first second ; FEV1% - percentage of volume of the air expired in the first second according to predicted; FEV1/FVC – Tiffen index; FEV1/ FVC<sub>PRED</sub> predicted Tiffen index; FEV1/FVC% - percentage of predicted Tiffen index; FEF – forced expiration flow; FEF<sub>25-75</sub> – forced expiration flow from 25 to 75%FVC; FEF<sub>75-85</sub> forced expiration flow from 75 – 85 % FVC; PEF – maximum expiration flow; PEF<sub>PRED</sub> - predicted maximum expiration flow; PEF%

metrijska mjerena treba uvijek provoditi u istim uvjetima, koristeći po mogućnosti isti spirometar. Potrebna je svakodnevna kalibracija spirometra temeljem vanjskih faktora (temperatura u prostoriji, pritisak zraka, relativna vлага) kako bi se izvršila korekcija izmjerene volumena na standardne uvjete (BTPS standard – tjelesna temperatura  $37^{\circ}\text{C}$  ili  $310\text{ K}$  i pritisak vazduha  $47\text{ mmHg}$  ili  $6.2\text{ kPa}$ ). Prije testiranja od ispitanika treba prikupiti odgovarajuće podatke (spol, dob, tjelesna visina i masa) koji su potrebni kako bi se njegovo mjerjenje usporedilo s individualnim standardom (očekivanim vrijednostima za spol, dob, tjelesnu visinu i tjelesnu masu ispitanika). Taj je standard danas u pravilu ugrađen u spirometar i nije potrebno izračunavanje istog, jer ga automatski obavlja aparat. Danas je najčešće korišteni standard onaj Evropske zajednice za ugljen i čelik (CECA II).

## METOD

Cilj istraživanja je da se testiraju određeni ventilacijski pokazatelji kod dječaka i djevojčica u uzrastu od 10-15 godine. Morfološke mjere uzete su prema IBP-u uz pomoć Martinovog antropometra i elektronske vase. Spirometrijski pokazatelji uzeti su pomoću spirometra marke Shiller SP1 firme Schiller AG Switzerland ([www.schiller.ch](http://www.schiller.ch)).

### *Uzorak ispitanika*

Ispitivanje je provedeno na uzorku od  $N=1857$  ispitanika koji su podjeljeni na 2 subuzorka uzeta iz populacije dječaka ( $n=968$ ) i djevojčica ( $n=889$ ) sa područja grada Mostara uzrasta 10-15 godina.

### *Uzorak varijabli*

Za procjenu ventilacijskih parametara korištene su 24 varijable i 3 varijable za procjenu standardnih antropometrijskih mjera ATM tjelesna masa (kg); ATV-tjelesna visina (cm) i BMI-indeks tjelesne mase. Ventilacijske varijable su: FVC-forsirani vitalni kapacitet; FVC<sub>PRED</sub>-predviđeni forsirani vitalni kapacitet; FVC%-procenat forsiranog vitalnog kapaciteta od predviđenog; FEV1-volumen zraka izdahnut u prvoj sekundi; FEV1<sub>PRED</sub>-predviđeni volumen zraka izdahnut u prvoj sekundi; FEV1%-procent volumena zraka izdahnut u prvoj sekundi od predviđenog; FEV1/FVC-Tiffeneauov index; FEV1/FVC<sub>PRED</sub>-predviđeni Tiffeneauov index; FEV1/ FVC%-procenat od predviđenog Tiffeneauovog indexa; FEF-forsirani ekspiracijski protok; FEF<sub>25-75</sub> - forsirani ekspiracijski protok od 25-75% FVC; FEF<sub>75-85</sub>-forsirani ekspiracijski protok od 75-85% FVC; PEF-maksimalni ekspiracijski protok; PEF<sub>PRED</sub>-predviđeni maksimalni ekspiracijski protok;

- percentage of maximum expiration flow according to predicted;  $FEF_{25}$  - maximum speed of expiration at 75% FVC;  $FEF_{25PRED}$  - predicted maximum speed of expiration at 75 % FVC;  $FEF_{50}$  - percentage from predicted maximum speed of expiration at 75%  $FEF_{50}$ ; - maximum speed of expiration at 50% FVC;  $FEF_{50PRED}$  - predicted maximum speed at of expiration at 50% FVC;  $FEF_{75}$  -maximum speed of expiration at 25% FVC;  $FEF_{75PRED}$  -predicted maximum speed of expiration at 25% FVC;  $FEF_{75\%}$  - percentage of predicted maximum speed of expiration at 25% FVC.

### ***Method of data processing***

The results were processed in the SPSS 21.0. program package. To determine the quantitative differences between groups, canonical discriminative analysis was applied in which orthogonal factors in the space of the applied variables were isolated in order to show in which correlation a set of data was, based on which a discriminatory analysis and results were made in discriminatory functions. These factors are set to divide groups of examinees in the space of variables in their best way (Rađo and Wolf, 2002).

### **THE RESULTS WITH DISCUSSION**

Table 1 shows central and dispersion parametres of tested variables in a group of boys and girls aged 10 to 15. Variables from the space of anthropometric characteristics (height, weight and BMI) are taken in order to establish normality of growth and development, as well as to provide predicted values for each examinee based on height, age and sex. By comparing the valunes of arithmetic mean of these three variables with valunes of the previous research (Čolakhodžić, Rađo and Alić, 2009; Čolakhodžić, Skender and Pistotnik, 2011; Habul, 2012) we can see that they have similar values of arithmetic mean. If we compare the values of the basic ventilation variables FVC, FVC1, Tiffen index and  $FEF_{25-75}$  with the children's results from Zagreb (Mišigoj – Duraković, 2008) and with Habul's reasearches (2012) we can see that our examinees have similar results with slightly higher or lower values at a determined age. We can conclude that the basic anthropometric variables and ventilation abilities of boys who took part in this research are at a level which corresponds to their chronological age. Comparing values of ventilation parametres with the results of the youth from Zagreb which Mišigoj – Duraković (2008) obtained, we can notice a bit higher values of ventilation capability in examinees from the area of Mostar.

ekspiracijski protok;  $PEF\%$ -procenat maksimalnog ekspiracijskog protoka od predviđenog;  $FEF_{25}$ -maksimalna brzina izdaha pri 75% FVC;  $FEF_{25PRED}$ -predviđena maksimalna brzina izdaha pri 75% FVC;  $FEF_{25\%}$ -procenat od predviđene maksimalne brzine izdaha pri 75% FVC;  $FEF_{50}$ -maksimalna brzina izdaha pri 50% FVC;  $FEF_{50PRED}$ -predviđena maksimalna brzina izdaha pri 50% FVC;  $FEF_{75}$ -maksimalna brzina izdaha pri 25% FVC;  $FEF_{75PRED}$ -predviđena maksimalna brzina izdaha pri 25% FVC;  $FEF_{75\%}$ -procenat od predviđene maksimalne brzine izdaha pri 25% FVC-a.

### ***Metod obrade podataka***

Obrada rezultata izvršena je u programskom paketu SPSS 21.0. Za utvrđivanje kvantitativnih razlika između grupa, primjenjena je kanonička diskriminativna analiza u kojoj se izoluju ortogonalni faktori u prostoru primjenjenih varijabli sa zadatkom da pokažu u kojoj su korelaciji skup podataka na osnovu kojih je vršena diskriminativna analiza i rezultati u diskriminativnim funkcijama, a koji su postavljeni tako da najbolje razdvajaju grupe ispitanika u prostoru varijabli (Rađo i Wolf, 2002).

### **REZULTATI SA DISKUSIJOM**

U tabeli 1 prikazani su centralni i disperzionalni parametri testiranih varijabli kod grupe dječaka i djevojčica uzrasta 10 – 15 godina. Varijable iz prostora antropometrijskih karakteristika (visina, masa i BMI) uzete se da bi se utvrdila normalnosti rasta i razvoja kao i da bi se unijele predviđene vrijednosti za svakog ispitanika na osnovu visine, starosti i spola. Komparacijom vrijednosti aritmetičkih sredina ove tri varijable sa vrijednostima dosadašnjih istraživanja (Čolakhodžić, Skender i Pistotnik, 2011; Habul, 2012) vidimo da imaju slične vrijednosti aritmetičkih sredina. Ako uporedimo vrijednosti osnovnih ventilacijskih varijabli FVC, FVC1, Tiffeneov indeks i  $FEF_{25-75}$  sa rezultatima zagrebačke djece (Mišigoj – Duraković, 2008) i sa rezultatima istraživanja Habual (2012), vidimo da naši ispitanici imaju slične rezultate sa nešto većim ili manjim vrijednostima kod određenog uzrasta. Možemo zaključiti da su osnovne antropometrijske varijable i ventilacijske sposobnosti dječaka koji su učestvovali u ovome istraživanju na nivou koji odgovara njihovom hronološkom uzrastu. Poredeći vrijednosti ventilacijskih parametara sa rezultatima zagrebačke omladine koje su dobili Mišigoj – Duraković (2008) primjećujemo nešto veće vrijednosti ventilacijskih sposobnosti kod ispitanica sa područja grada Mostara.

**Table 1.** Group of the basic statistic variables / **Tabela 1.** Grupna osnovna statistika varijabli

Varijabla / Variables	Dječaci / Boys		Djevojčice / Girls	
	Mean	Std. Dev.	Mean	Std. Dev.
AVIS	158.93	10.47	158.29	8.03
AMAS	49.77	12.59	49.60	10.33
BMI	19.47	3.42	19.67	3.25
FVC	3.60	1.29	3.25	1.02
FVC <sub>PRED</sub>	3.44	.68	3.26	.47
FVC%	104.26	28.90	99.77	27.89
FEV1	3.36	1.22	3.03	.99
FEV1 <sub>PRED</sub>	3.07	.60	2.99	.42
FEV1%	108.87	30.17	101.11	29.55
FEV1FVC	93.20	8.69	92.84	9.60
FEV1FVC <sub>PRED</sub>	88.99	1.23	92.25	.42
FEV1FVC%	104.79	9.96	100.58	10.26
FEF	5.32	2.00	4.76	1.73
FEF2575	4.31	1.67	4.10	1.49
FEF7585	2.56	1.11	2.55	1.03
PEF	5.98	2.24	5.34	1.93
PEF <sub>PRED</sub>	7.01	1.12	6.78	.93
PEF%	85.05	27.57	78.39	27.18
FEF25	5.74	2.19	5.19	1.93
FEF25 <sub>PRED</sub>	5.75	.80	5.90	.63
FEF25%	99.07	33.12	88.09	31.57
FEF50	4.59	1.80	4.36	1.57
FEF50 <sub>PRED</sub>	4.85	.75	4.17	.44
FEF50%	94.35	31.74	104.51	36.29
FEF75	2.96	1.24	2.93	1.13
FEF75 <sub>PRED</sub>	1.95	.32	2.12	.25
FEF75%	150.00	52.78	137.76	50.36

**Table 2.** Box's test of matrix equivalence of covariances of treated variables / **Tabela 2.** Boxov test jednakosti matrica kovarijansi tretitanih varijabli

Box's M		10142,183
	Approx.	26.432
F	df1	378
	df2	10279210.852
	Sig.	.000

Discriminatory analysis in the manifest space gives us information that one discriminative function isolated which is statistically significant at level of (Sig. .000) (TTable 3). As we can see from the TTable 3, isolated discriminative function explains 100% of total variance and has statistically significant high value (Can. Corr.= .948), which indicates in which correlation a set of data is on the basis of which we have conducted a discriminatory analysis as well as the results in discriminatory function. The value of Wilk's lambda is low (.101) which indicates/points to high discrimination between groups. Looking at the matrix structure (Table 4) and the associated (belonging) centroide groups (Table 5), we can see which variables have contributed the most to these quantitative differences between treated groups on a multivariate level. Centroides show the differences between groups (how far they are from each other) at/on discriminatory function. By analysing the matrix of structure of

Diskriminativna analiza u manifestnom prostoru nam daje informaciju da se izolovala jedna diskriminativna funkcija koja je statistički značajna na nivou od (sig..000) (tabela 3). Kao što vidimo iz tabele 3, izolovana diskriminativna funkcija objašnjava 100% ukupne varijance i ima statistički značajno visoku vrijednost (Can. Corr.= .948), a koja ukazuje u kojoj korelaciji je skup podataka na osnovu kojih smo vršili diskriminativnu analizu i rezultati u diskriminativnoj funkciji. Vrijednost Wilk'sove lambde je niska (.101) što ukazuje na visoku diskriminativnost između grupa. Posmatrajući matricu strukture (tabela 4) i pripadajuće centroide grupe (tabela 5), vidimo i koje su to varijable najviše doprinijele kvantitativnim razlikama između tretiranih grupa na multivariatnom nivou. Centroidi pokazuju koliko se grupe međusobno razlikuju (koliko su udaljene) na diskriminativnoj funkciji. Analizirajući matricu strukture diskrimi-

discriminatory function (Table 4), we notice projections of the variables which discriminate the groups. In a quantitative sense on a multivariate level, the highest discrimination between groups in an isolated function make variables of Tiffen index ( $FEV1/FVC_{PRED}$ ),  $FEF50_{PRED}$ ,  $FEf75_{PRED}$  and variable of the percentage of Tiffen index of predicted values for examinees ( $FEV1/FVC\%$ ).

**Table 3.** Discriminative analysis of treated variables /

Func.	Eigenvalue	% of Var.	Cum. %	Can. Corr.	Wilks' Lambda	Chisquare	df	Sig.
1	8,917(a)	100,0	100,0	,948	,101	4224,853	27	,000

a First 1 canonical discriminant functions were used in the analysis.

**Table 4.** The structure of discriminative function / **Tabela 4.** Struktura diskriminativne funkcije

Varijabla / Variables	Function 1
$FEV1FVC_{PRED}$	,582
$FEF50P_{RED}$	-,182
$FEF75_{PRED}$	,091
$FEV1FVC\%$	-,070
$FEF25\%$	-,057
$FVC_{PRED}$	-,051
PEF	-,050
FVC	-,050
$FEF50\%$	,050
FEF	-,050
FEV1	-,048
FEF25	-,044
FEV1%	-,043
PEF%	-,041
FEF75%	-,040
PEF <sub>PRED</sub>	-,037
$FEF25_{PRED}$	,035
FVC%	-,026
$FEV1_{PRED}$	-,026
$FEF50$	-,024
$FEF2575$	-,023
AVIS	-,011
BMI	,010
$FEV1FVC$	-,006
FEF75	-,004
AMAS	-,003
$FEF7585$	-,002

**Table 5.** The function of group centeroids / **Tabela 5.** Funkcija grupnih centroida

GRUPA / GROUP	Function 1
DJEČACI / BOYS	-2,860
DJEVOJČICE / GIRLS	3,114

## CONCLUSION

Discriminatory analysis has established that there are statistically significant quantitative differences between groups of boys and girls on a global level ( scale). Isolated discriminatory function explains 100% of the total variance and has statistically significant high value (Can. Corr.= .948), which shows us in which corelation the set of

nativne funkcije (tabela 4), uočavamo projekcije varijabli koje najviše diskriminiraju grupe. U kvantitativnom smislu na multivariantnom nivou najveću diskriminaciju između grupa u izolovanoj funkciji čine varijable Tiffeneovog indeksa ( $FEV1/FVC_{PRED}$ ),  $FEF50_{PRED}$ ,  $FEf75_{PRED}$  i varijabla procenta Tiffeneovog indeksa od predviđene vrijednosti za ispitanike ( $FEV1/FVC\%$ ).

**Tabela 3.** Diskriminativna analiza tretiranih varijabli

## ZAKLJUČAK

Diskriminativnom analizom utvrđeno je da postoje statistički značajne kvantitativne razlike između grupa dječaka i djevojčica na globalnom nivou. Izolovana diskriminativna funkcija objašnjava 100% ukupne varijance i ima statistički značajno visoku vrijednost (Can. Corr.= .948), a koja nam ukazuje u kojoj korelaciji je skup po-

data is on which we conducted discriminatory analysis as well as the results in discriminatory function. The value of Wilk's lambda is very low (.101) which shows (indicates) high discrimination between groups. The highest discrimination between groups in the isolated discriminative function is made by variables predicted Tiffen index ( $FEV_1/FVC_{PRED}$ ); predicted maximum speed of expiration at 50% FVC ( $FEF50_{PRED}$ ) and predicted maximum speed of expiration at 25% FVC ( $FEF75_{PRED}$ ). Generally, on the basis of discriminatory analysis in the space of ventilation abilities, we can conclude that there are global statistically significant differences between girls and boys aged 10 – 15. In a quantitative sense, on a multivariate level, the highest discrimination between groups in the isolated function is made by variables of Tiffen index ( $FEV_1/FVC_{PRED}$ ),  $FEF50_{PRED}$ ,  $FEF75_{PRED}$  and the percentage variable of Tiffeneau's index of the predicted value for examinee ( $FEV_1/FVC\%$ ). The examined sample is from the most turbulent period of growth and development, puberty, when particularly morphological growth takes place, but also the development of organic systems is unstable and different from individual to individual. The value of position of centroide on isolated discriminatory function contributes to this, where we can see a big distance between centeroids which represent the groups of boys and girls in the space.

dataku na osnovu kojih smo vršili diskriminativnu analizu i rezultati u diskriminativnoj funkciji. Vrijednost Wilk'sove lambde je niska (.101) što ukazuje na visoku diskriminativnost između grupa. Najveću diskriminaciju između grupa u izolovanoj diskriminativnoj funkciji čine varijable predviđenog Tiffeneveovog indeksa ( $FEV_1/FVC_{PRED}$ ); predviđena maksimalna brzina izdaha pri 50% FVC ( $FEF50_{PRED}$ ) i predviđena maksimalna brzina izdaha pri 25% FVC ( $FEF75_{PRED}$ ). Generalno možemo zaključiti na osnovu rezultata diskriminativne analize u prostoru ventilacijskih sposobnosti da postoje globalne statistički značajne razlike između dječaka i djevojčica u uzrastu od 10-15. godine. U kvantitativnom smislu na multivarijantnom nivou najveću diskriminaciju između grupa u izolovanoj funkciji čine varijable Tiffeneovog indeksa ( $FEV_1/FVC_{PRED}$ ),  $FEF50_{PRED}$ ,  $FEF75_{PRED}$  i varijabla procenata Tiffeneovog indeksa od predviđene vrijednosti za ispitanike ( $FEV_1/FVC\%$ ). Ispitivani uzorak se nalazi u najbrnjem periodu rasta i razvoja, pubertetu, kada je posebno morfološki rast, ali i razvoj organskih sistema nestabilan i različit od jedinke do jedinke. Ovome u prilog ide i vrijednost položaja centroida na izolovanoj diskriminativnoj funkciji, gdje vidimo veliku udaljenost između centroida koji predstavljaju grupe dječaka i djevojčica u prostoru.

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Primljen: 20. februar 2019. / Received: February 20, 2019

Prihvaćen: 05. mart 2019. / Accepted: March 05, 2019

# OVERVIEW OF TRAINING RESEARCH WITH LOADING IN UNSTABLE CONDITIONS

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**Abstract:** The main goal of this research was to review the works that dealt with the effects of strength training in unstable conditions. A transparent survey covered 24 papers that were not older than 10 years. The sample of respondents are young and middle age groups due to similar abilities. Out of 24 papers: 16 papers were with one group in the experiment, 6 papers were with two groups in the experiment and 2 with three groups in the experiment. After the involvement of the musculature: 9 papers treated pectoral musculature, in 10 papers the involvement of the muscles of the lower limbs was processed, 6 papers dealt with the aspect of engaging the back musculature and the same abdomen, 8 papers treated chest musculature and two papers included shoulder musculature in their research. There was no difference in the degrees of promotion on the basis of gender in the articles. The statistical effect of exercise on unstable substrates was expressed in 13 studies, there were no statistically significant effects in 7 studies, while the same effect of the effects achieved by strength exercises on unstable and stable surfaces was found in 4 papers. The work done primarily suggests a positive effect of exercise on unstable substrates in untrained individuals.

**Keywords:** Strength, Force, Swiss ball, Training, Stable and Unstable Substrate.

## INTRODUCTION

Keeping the body position is a continuous process of minimal adjustment above the existing base or support. The lower the support, the adjustments must be more precise to maintain the balance. Postural adjustment of the hull or leg, in certain situations, can be initiated before the onset of voluntary hull or upper limb movements (Gantchev & Dimitrova, 1996). Such postural adjustments are considered to be aimed at minimizing

# PREGLED ISTRAŽIVANJA TRENINGA SA OPTEREĆENJEM PRI NESTABILNIM USLOVIMA

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**Apstrakt:** Pregledno istraživanje je obuhvatilo finalno obrađenih 24 radova ne starijih od 10 godina. Uzorak ispitanika su mlada i srednja starosna grupa zbog sličnih sposobnosti. Od 24 radova: 16 radova je sa jednom grupom u eksperimentu, 6 radova je sa dve grupe u eksperimentu i 2 rada sa tri grupe u eksperimentu. Po angažovanosti muskulature: u 9 radova je obrađena grudna muskulatura, u 10 radova je obrađivano angažovanje muskulature donjih ekstremiteta, 6 radova je u svom aspektu imalo angažovanje leđne muskulature i isto toliko abdomena, 8 radova je obrađivalo grudnu muskulaturu i dva rada su obuhvatila u svom istraživanju ramenu muskulaturu. U radovima nije pronađena razlika u stepenima napredovanja na osnovu pola. Statistički efekat vežbanja na nestabilnim podlogama je bio izražen u 13 studija, nije bilo statistički značajnih efekata u 7 studija, dok jednak učinak efekata postignutim vežbama snage na nestabilnim i stabilnim površinama nalazimo u 4 rada. Obrađeni radovi prvenstveno navode pozitivan efekat vežbanja na nestabilnim podlogama kod neuteriranih osoba.

**Ključne reči:** snaga, sila, švajcarksa lopta, trening, stabilna i nestabilna podloga.

## UVOD

Održavanje položaja tela je kontinuirani proces minimalnih prilagođavanja iznad postojeće baze ili oslonca. Što je oslonac manji, prilagođavanja moraju biti preciznija da bi se održavala ravnoteža. Posturalno prilagođavanje trupa ili nogu, u pojedinim situacijama, može biti inicirano pre početka voljnih pokreta trupa ili gornjih udova (Gantchev & Dimitrova, 1996). Smatra se da ovakva posturalna prilagođavanja imaju za cilj mini-

movement disturbance disorders. When the substrate is unstable, the change in muscle potentials precedes the moment of application of force, which is designated as "muscular anticipation" (Kornecki, & Siemieński, 2001). This can be explained by the fact that the support structures must first stabilize before the motor movement is efficiently initiated. Additionally, measurements of postural adjustment at different body positions have shown that stabilizing muscles are activated for about 30 ms before muscle activation of the movement (Nouillot & Bouisset, 1992). When a person moves, he or she is usually unaware of the complex neuromuscular processes that control the position of the body. Under stable conditions, the demands of stabilizing the position under the influence of transient, for the movement of related disorders, have been reduced. On the other hand, in a very unstable situation, anticipatory postural adjustments, by themselves, can be considered as sources of disorder, when the center of gravity moves beyond the desired support surface. This anticipatory increase in synergistic muscular activity is documented using a reversed pendulum that induces arm instability (Stokes & Gardner-Morse, 2000).

Using external forces in an effort to maintain a dynamic balance is a key factor of success in most sports and necessity in everyday activities (for example, carrying bags during shopping, wearing a baby, etc.). This stabilization process consists of establishing active muscular controls in minimizing the degree of freedom in one or a series of joints, which results in the stabilization of excessive movement of external objects. Motor skills training, including balance training, increases the sensitivity of the feedback mechanisms and shortens the time to activate the selected muscles by improving the sensitivity of the feeling of position and agonistic and antagonistic muscles (Kollmitzer & Ebenbichler, 2000). Muscles, as the final parts of the mechanism of the sensorimotor system, especially contribute to maintaining the balance of the body. The use of various exercises under unstable conditions in order to improve balance and coordination has attracted attention in the past few years. However, their impact on power improvement is largely unproven, partly because of the problematic reliability of current methods for assessing muscle strength in this kind of movement, which limits their practical application. Recently, exercises performed under unstable conditions have become part of the training and rehabilitation programs. Accordingly, their influence on physical abilities and health has attracted the attention of trainers and researchers. Absence of stability can be induced by the substrate or platform on which the exercise is performed

miziranje poremećaja ravnoteže izazvanih pokretima. Kada je podloga nestabilna, promena mišićnih potencijala prethodi momentu apliciranja sile, što se označava kao „mišićna anticipacija“ (Kornecki, & Siemieński, 2001). Navedeno se može objasniti činjenicom da se potporne strukture moraju prvo stabilizovati pre nego što se motorni pokret efikasno pobudi. Uz to, merenja posturalnih prilagođavanja pri različitim položajima tela pokazala su da se stabilizirajući mišići aktiviraju oko 30 ms pre mišićne aktivacije pokreta (Nouillot & Bouisset, 1992).

Kada se čovek kreće, najčešće nije svestan složenih neuromišićnih procesa koji kontrolisu položaj tela. Pri stabilnim uslovima, zahtevi stabilizovanja položaja pod dejstvom prolaznih, za pokret vezanih poremećaja, su smanjeni. S druge strane, u vrlo nestabilnoj situaciji, anticipa-torna posturalna prilagođavanja, sama po sebi, mogu se posmatrati kao izvori poremećaja, kada se centar gravitacije (težište) pomeri van željene potporne površine. Ovaj anticipatorički porast sinergističke mišićne aktivnosti je dokumentovan pomoću obrnutog klatna koje indukuje nestabilnost ruke (Stokes & Gardner-Morse, 2000).

Upotreba spoljašnjih sila u pokušaju da se održi dinamička ravnoteža ključan je faktor uspešnosti u većini sportova i nužnost u svakodnevnim aktivnostima (npr. u nošenju torbi tokom kupovine, nošenju bebe itd). Ovaj stabilizacioni proces sastoji se iz uspostavljanja aktivnih mišićnih kontrola u minimiziranju stepena slobode u jednom ili nizu zglobova, što rezultuje stabilizovanjem prev-eklikog kretanja spoljašnjih objekata. Trening motornih veština, uključujući trening ravnoteže, povećava senzitivnost mehanizama povratne sprege i skraćuje vreme do aktivacije odabranih mišića poboljšavajući senzitivnost osećaja položaja i agonističkih i antagonističkih mišića (Kollmitzer & Ebenbichler, 2000). Mišići, kao završni delovi mehanizma senzomotornog sistema, posebno doprinose održanju ravnoteže tela. Upotreba različitih vežbi pri nestabilnim uslovima u cilju poboljšanja ravnoteže i koordinacije privlači pažnju poslednjih nekoliko godina. Međutim, njihov uticaj na poboljšanje snage je u velikoj meri neproučen, delimično zbog problematične pouzdanosti aktuelnih metoda za procenu mišićne snage pri ovakvoj vrsti pokreta, što ograničava njihovu praktičnu primenu. Nedavno su vežbe sa opterećenjem koje se izvode pri nestabilnim uslovima postale deo treninga i programa rehabilitacije. Shodno tome, njihov uticaj na fizičke sposobnosti i zdravlje privukao je pažnju i trenera i istraživača. Odsustvo stabilnosti može poticati od podloge ili platforme na kojoj se vežba izvodi (npr. lopta ili njihajuća ploča) ili iz položaja u kojima se segmenti tela postavljaju van potporne baze tela (npr. jednoručni teg-

(e.g. ball or bumper plate) or from positions in which body segments are placed outside the supporting body (e.g., single-handed weights). However, it must be borne in mind that when a person attempts to apply force in conditions of instability, the maximum forces achieved in stable conditions are not possible due to the significant functions of muscular stabilization. This requires that the number of maximum repetitions be adjusted to compensate for unstable conditions. Studies carried out showed significantly higher electromyographic activity of muscular torso stabilizer during exercise with stress at unstable but stable conditions (Anderson & Behm, 2004; Behm et al., 2005). These findings suggest that unstable conditions in training with a load can facilitate neurological adaptations of muscles of the torso stabilizer, which leads to an improvement in body stability.

Performing movements under unstable conditions results in a decrease in maximum muscle strength due to a decrease in total muscle force, an increase in co-contraction, and a change in muscular coordination (Anderson & Behm, 2005). Although the manifestation of the highest muscular strength is reduced in conditions of instability, the change in the balance of training on an unstable surface can activate the muscles of the extremities and hulls, thereby ensuring greater joint stability. Using unstable platform in strength training should enable the development of higher levels of muscle activation, through increased reliance on their stabilizing functions. As this higher level of muscle activation is achieved with less resistance, this kind of training can have positive effects in rehabilitation of muscles and joints after injury, as well as training specific to certain sports. Since most sports involve a combination of stabilization and force production functions, strength training under unstable conditions provides similar stimuli to the nervous and muscular system, leading to adequate repetitions to physiological adaptations. Power training under unstable conditions can reduce the likelihood of injury to the lower extremities due to increased sensitivity of muscle spindles and better postural control. The first targeted studies have shown that the Swiss ball provides a wide range of movements under unstable conditions, with an optimal starting position of several degrees of active hull extension (Siff, 1991). The Swiss ball (also known as the fitness ball, exercise ball, pilates ball, therapeutic ball, yoga ball, etc.) is an elastic inflatable ball made of soft polyvinyl chloride (PVC). The blowing of air is carried out by a specially designed air pump through an opening that is then closed with a safety plug. The importance of the Swiss ball in rehabilitation is documented in the reeducation of postural muscles as well as in fac-

vi). Ipak, mora se imati u vidu da kada osoba pokuša da aplikuje silu u uslovima nestabilnosti, maksimalne sile koje se postižu u stabilnim uslovima nisu moguće zbog značajnijih funkcija mišićne stabilizacije. To zahteva da se broj maksimalnih ponavljanja prilagodi, kako bi se kompenzovali nestabilni uslovi. Studije koje su sprovedene pokazale su znatno veću elektromiografsku aktivnost mišića stabilizatora trupa tokom vežbi sa opterećenjem pri nestabilnim, nego pri stabilnim uslovima (Anderson & Behm, 2004; Behm et al. 2005).. Ovi nalazi sugerisu da nestabilni uslovi pri treningu sa opterećenjem mogu da olakšaju neurološke adaptacije mišića stabilizatora trupa, što dovodi do poboljšanja stabilnosti tela.

Izvođenje pokreta pri nestabilnim uslovima rezultuje smanjenjem maksimalne mišićne snage zbog smanjenja ukupne sile mišića, povećanja ko-kontrakcija i izmene mišićne koordinacije (Anderson & Behm, 2005). Iako je ispoljavanje najveće mišićne snage smanjeno u uslovima nestabilnosti, promena ravnoteže pri treningu na nestabilnoj podlozi može da aktivira mišiće ekstremiteta i trupa i time obezbedi veću stabilnost zglobova. Korišćenje nestabilnih platformi u treningu snage treba da omogući razvoj viših nivoa aktivacije mišića, preko povećanog oslanjanja na njihove stabilizirajuće funkcije. Kako se ovaj viši nivo aktivacije mišića postiže sa manjim otporom, ovakva vrsta treninga može imati pozitivne učinke u rehabilitaciji mišića i zglobova nakon povreda, kao i u treningu specifičnom za određene sportove. Pošto većina sportova podrazumeva kombinaciju funkcija stabilizacije i proizvodnje sile, trening snage pri nestabilnim uslovima obezbeđuje slične nadražaje za nervni i mišićni sistem, dovodeći adekvatnim ponavljanjima do fizioloških adaptacija. Trening snage pri nestabilnim uslovima može smanjiti verovatnoću povreda donjih ekstremiteta zbog povećanja osetljivosti mišićnih vretena i bolje posturalne kontrole. Još su prva ciljana istraživanja pokazala da švajcarska lopta obezbeđuje široki spektar pokreta pri nestabilnim uslovima, sa optimalnom početnom pozicijom od nekoliko stepeni aktivne ekstenzije trupa (Siff, 1991). Švajcarska lopta (poznata i pod nazivima: fitnes lopta, lopta za vežbanje, pilates lopta, terapijska lopta, lopta za jogu itd.) je elastična lopta na naduvavanje napravljena od mekog polivinil-hlorida (PVC). Uduvavanje vazduha se vrši posebno oblikovnom vazdušnom pumpom kroz otvor koji se zatim zatvara sigurnosnim čepom. Važnost švajcarske lopte u rehabilitaciji dokumentovana je u reedukaciji posturalnih mišića, kao i u olakšavanju pokreta i posturalnih reakcija kod bolesnika sa neurološkim oštećenjima (Stanforth et al. 1998). Najčešće vežbe sa švajcarskom loptom se

litating movement and postural reactions in patients with neurological impairment (Stanforth et al., 1998). The most common exercises with the Swiss ball are characterized by isometric muscular activity, low loads and long periods of muscle contraction, leading to the development of central endurance (Cosio-Lima et al., 2003; Carter et al., 1998). Research with subjects who performed various typical hardening exercises in stable and unstable conditions (the Swiss ball) showed that activation of the lumbosacral and upper lumbar spine lifters, as well as deep abdominal stabilizers, was significantly higher in unstable conditions (Behm et al. 2005). Significantly higher instability of the substrate or platform relative to the usual stable conditions causes the initiation of other mechanisms of neurological and neuromuscular adaptation, which as a result has an increase in muscular strength (Radovanović & Ignjatović). The aim of the research was to review the current research on the effects of stress training in unstable conditions.

## METHOD

A descriptive method, supported by theoretical analysis and generalization, was used to produce the work. This method involves the equal treatment of empirical and theoretical research. The results of the research of foreign scientists were combined. Search research was conducted using the Web of Science, Kobson, Pubmed, and Google Scholar search engine database. The magazines in the field of sports medicine for sports medicine and sports training were searched. Search is limited to studies that have been conducted in the last 10 years. Key words were power, force, swiss ball, training, stable and unstable background.

## RESULTS

**Tabela 1.** Pregled istraživanja u kojima je bio izražen statistički efekat vežbanja na nestabilnim površinama

Studija	Grupe	Karakteristike (N)	Sportski staž	Eksperimentalni program	Oprema	Rezultat
Campbell et al., 2014 [1]	1 grupa Benč pres stabilna površina i švajcarska lopta	10 muškaraca, uzrasta $23.9 \pm 2.6$ ; težine: $82.8 \pm 10.2$ kg)	Sa iskustvom 1 godina	Potisak sa grudi 50 % RM i 25 % 1RM	EMG	trupna muskulatura da bi omogućila stabilnost pokazuje povećanu aktivnost prilikom vežbe razdvojenih opterećenja po rukama
Cug et al., 2012 [4]	1 grupa Pregibi trupa, pregibi zadnje lože, čučnjevi	60 studenata Eksperimentalna grupa 43 dečaka i 16 devojaka) Kontrolna grupa 17 studenata (9 dečaka i 8 devojaka) (uzrasta 21.67-23.44; Visina dečaka 174 cm, Visina devojaka 164 cm; težina dečaka: 71-77kg, devojaka 57kg)	Bez iskustva	10 nedelja, 3 x nedeljno progresivno podižući opterećenja	Izokinetički dinamometar	Trenirana grupa je povećala težinski vrh ekstenzije trupa za 20,1%, dok je kod kontrolne grupe opalo za 6,8%. Trenirana grupa povećala težinski vrh fleksije trupa trupa za 18,1%, dok je kod kontrolne grupe opalo za 0,4%. Propriorekcija u zglobu kolena se povećala za 44,7%.

karakterišu izometrijskom mišićnom aktivnošću, malim opterećenjima i dugim periodima kontrakcije mišića, što vodi razvoju centralne izdržljivosti (Cosio-Lima et al. 2003; Carter et al. 1998). Istraživanje sa subjektima koji su izvodili različite tipične vežbe za jačanje trupa u stabilnim i nestabilnim uslovima (švajcarska lopta) pokazalo je da je aktivacija lumbosakralnog i gornjeg lumbalnog podizača kičme, kao i dubokih abdominalnih stabilizatora, bila znatno veća u nestabilnim uslovima (Behm et al. 2005). Značajno veća nestabilnost podloge ili platforme u odnosu na uobičajene stabilne uslove uzrokuje pokretanje i ostalih mehanizama neurološke i neuromišićne adaptacije, što kao rezultat ima povećanje mišićne snage (Radovanović & Ignjatović). Istraživanje je imalo za cilj da izvrši pregled dosadašnjih istraživanja vezanih za efekte treninga sa opterećenjem pri nestabilnim uslovima.

## METOD

Za izradu rada upotrebljena je deskriptivna metoda, potrepljena teorijskim analizama i uopštavanjem. Ova metoda je podrazumeva ravnopravan tretman empirijskih i teorijskih istraživanja. Objedinili su se rezultati istraživanja stranih naučnika. Pretraga istraživanja sprovedena je korišćenjem baze pretraživača Web of Science, Kobson, Pubmed i Google Scholar. Bili su pretraženi časopisi iz oblasti sportske nauke za sportsku medicinu i sportskog treninga. Pretraga je ograničena na studije koje su sprovedene u poslednjih 10 godina. Ključne reči su bile snaga, sila, švajcarksa lopta, trening, stabilna i nestabilna podloga.

## REZULTATI

Granacher et al., 2014 [6]	1 grupa Prednji, bočni i donji deo trupa	27 ispitanika 13 dečaka uzrasta 13.7; visine 168.6; težine: 53.1kg 14 devojčica uzrasta 13.8; visine 169.6; težine 51.4kg	Sa iskustvom	6 nedelja, 3-4 treninga nedeljno, izometrija 3x40-45 s, 3x20-23 ponavlja	-	Značajan trenažni efekat je postignut u vremenu izvođenja vežbi u razlici pre i posle tretmana, balansu i skokovima. Istraživanje nije dalo rezultata kod statičkih vežbi
Escamilla et al., 2010 [7]	1 grupa Pike skeleksi, pregibi trupa, roll out (abdomen)	18 ispitanika 9 momaka uzrasta $29.9 \pm 6$ ; visine: $178.1 \pm 4.3$ cm; težine: $73.3 \pm 7.2$ kg 9 devojaka uzrasta $27.7 \pm 7.7$ ; visine: $165.0 \pm 7.0$ cm; težine: $61.1 \pm 7.8$ kg)	Bez iskustva	5x8 na nestabilnoj podlozi i 2 na stabilnoj podlozi	EMG	Prva tri mesta u angažovanju muskulature čine vežbe pike, crunch i roll out. Na poslednjem mestu postignutog efekta je sed na švajcarskoj lopti.
Sekendiz et al., 2010 [21]	1 grupa švajcarska lopta snaga trupa, donji deo leda i donji eksfremiteti.	21 ispitanica (uzrasta $34 \pm 8.09$ ; visine: $163 \pm 6.91$ cm; težine: $64 \pm 8.69$ kg)	bez iskustva	5 nedelja, 3x15 - 4x25 ponavlja	-	petonedeljni trenažni program sa švajcarskom loptom uzrokuje značajno povećanje izdržljivosti u snazi ekstenzora trupa nego na podu.
Kohler et al., 2010 [10]	1 grupa potisak sa ramena (ramena i abdomen)	30 ispitanika 24 muškaraca i 6 žena uzrasta $30 \pm 8$ , težine: $75 \pm 14$	1 godina iskustva	3x3 i 2x10 (benč pres/švajcarska lopta)	EMG	kada se povećava intenzitet nestabilnosti, smanjuje se intenzitet opterećenja..
Lawrence & Carlson, 2015 [12]	1 grupa Zadnji čučanj	15 utreniranih muškaraca (uzrasta $24.2 \pm 3.4$ ; visine: $170 \pm 10$ cm; težine: $83.4 \pm 18.7$ kg)	Sa iskustvom	10 X60 %1RM	-	vežbanje na nestabilnoj podlozi uzrokuje veću mišićnu aktivaciju mišića rectus abdominis, external oblique, i soleus
Marin & Hazell, 2014 [13]	1 grupa 4. vrsta podloga (stabilna, nestabilna, nestabilna sa vibracijama 30Hz i 50Hz	28 studenata (uzrasta $21.7 \pm 1.3$ ; visine: $176.7 \pm 0.3$ cm; težine: $74 \pm 6.4$ kg	bez iskustva	5 min zagrevanje, 10x zgibovi, butt kicks, skok kolena-grudi, čučnjevi i lateralni iskoraci	EMG	korišćenje vibracija pri 30Hz je povećalo EMG mišića od 20 do 40% od ostalih vrsta testiranja
Marshall & Desai, 2010 [14]	1 grupa Izdržaji i pregibi trupa, čučnjevi	14ispitanika 7 momaka i 7 devojaka uzrasta $24.1 \pm 1.7$ ; visine: $174 \pm 8$ cm; težine: $72.9 \pm 13.17$ kg	bez iskustva	1 sesija upoznavanje sa vežbama 2 sesija 3 testiranja	EMG	povećanje aktivnosti mišića triceps bachii za 32,4%, vastus lateralis za 44,2% i rectus abdominis za 28,5% na vežbi most koristeći švajcarsku loptu
Saeterbakken & Fimland, 2013 [18]	1 group Benč pres švajcarska lopta	16 utreniranih muškaraca (uzrasta $22.5 \pm 2$ ; visine: $182 \pm 6$ cm; težine: $82 \pm 7.8$ kg)	Sa iskustvom	6RM opterećenje $85 \pm 15.6$ kg 72 časa pauza između testova	EMG	najveće vrednosti potiska sa grudi su na stabilnoj površini (podu), a najmanje na švajcarskoj lopti
Nagla, E. (2011) [16]	1 grupa Karate snaga stomaka, leda i nogu, fleksibilnost u kićmi i statičko dinamičkom balansu.	12 karatiskinja (uzrasta: 18-20; visine: 163.92 $\pm 3.0$ cm; težine: $64.77 \pm 2.81$ kg)	Sa iskustvom 6 godina	8 nedelja pored karatea i švajcarske lopta	EMG	rad sa švajcarskom loptom ima pozitivnog učinka na snagu stomaka, leda i nogu, fleksibilnost u kićmi i statičko dinamičkom balansu.
Kibele et al., 2014 [8]	2 grupe skokovi i čučnjevi	33 studenta Eksperimentalna grupa: 20 (uzrasta $24.1 \pm 3.1$ ; visine: $182 \pm 5$ cm; težine: $76.1 \pm 8.9$ kg) Kontrolna grupa: 13 (uzrasta: $24.1 \pm 4.6$ ; visine: $179 \pm 5.3$ cm; težine: $75.8 \pm 8.3$ kg)	Sa iskustvom	7 nedelja, 2xnedeljno	-	poboljšanje performansi nekih vrsta skokova, balansa i snagu ekstenzora kolena
Singh et al., 2013 [20]	2 grupe Eksperimentalna 12 muškaraca košarka + švajcarska lopta Kontrolna grupa 12 muškaraca košarka	24 muškarca (uzrasta: $21.54 \pm 1.57$ ; visine: $178.2 \pm 5.6$ cm; težine: $66.2 \pm 5.41$ kg)	Bez iskustva	5 nedelja po 45 minuta na švajcarskoj lopti	-	korišćenje švajcarske lopte može uticati na poboljšanje u koordinacionim aktivnostima

**Table 1.** An overview of the research in which the statistical effect of exercise on unstable surfaces was expressed

Study	Group	Characteristics (N)	Sports internship	Experimental program	Equipment	Results
Campbell et al., 2014 [1]	1 group Bench press stable surface and Swiss ball	10 men, age $23.9 \pm 2.6$ ; weight: $82.8 \pm 10.2$ kg)	With 1 year experience	Bench press 50% RM and 25% 1RM	EMG	Muscular torso to provide stability shows an increased activity when exercising separate hand loads
Cug et al., 2012 [4]	1 group Crunch, folding of the rear logs, squats	60 students Experimental group (43 boys and 16 girls) Control group 17 students (9 boys and 8 girls) (ages 21.67-23.44; Height of boys 174 cm, Height of girls 164 cm, weight of boys: 71-77 kg, girls 57 kg)	No experience	10 weeks, 3 x weeks progressively raising	isokinetic load dynamometer	The trained group increased the weight of the hull extension by 20.1%, while the control group decreased it by 6.8%. The target group increased the weight of the hull torso flexion by 18.1%, while the control group decreased it by 0.4%. The proprioception in the knee joint increased by 44.7%.
Granacher et al., 2014 [6]	1 group Front, side and bottom part of the body	27 examinees 13 children age 13.7; height 168.6; weight: 53.1kg 14 girls age 13.8; height 169.6; weight 51.4kg	With experience	6 weeks, 3-4 workouts per week, - isometry 3x40-45 s, 3x20-23 repetitions	-	Significant exercise effect was achieved at the time of performing the exercises in the difference before and after treatment, balance and jumps. The study did not provide results in static exercises
Escamilla et al., 2010 [7]	1 group Pike push up, crunch, roll out (abdominal)	18 subjects 9 guys age $29.9 \pm 6$ ; height: $178.1 \pm 4.3$ cm; weight: $73.3 \pm 7.2$ kg) 9 girls age $27.7 \pm 7.7$ ; height: $165.0 \pm 7.0$ cm; weight: $61.1 \pm 7.8$ kg)	Without experience	5x8 on an unstable surface I 2 on a stable	EMG	The first three places in the engagement of musculature are dental exercises, crunch and roll out. At the last place, the effect was on the Swiss ball.
Sekendiz et al., 2010 [21]	1 group Swiss ball force torso, lower back and lower extermination	21 respondents (age $34 \pm 8.09$ , height: $163 \pm 6.91$ cm, weight: $64 \pm 8.69$ kg)	Without experience	5 weeks, 3x15 - 4x25 reps	-	A five-week training program with a Swiss ball causes a significant increase in endurance in the force of the hull extender than on the floor.
Kohler et al., 2010 [10]	1 group Thrust from the shoulders (shoulders and abdomen)	30 subjects 24 men and 6 women age $30 \pm 8$ , weight: $75 \pm 14$	1 year experience	3x3 and 2x10 (bench press / swiss ball)	EMG	When the instability increases, the load intensity decreases.
Lawrence & Carlson, 2015 [12]	1 group Back squat	15 trained men (age $24.2 \pm 3.4$ , height: $170 \pm 10$ cm, weight: $83.4 \pm 18.7$ kg)	With experience	10 X60 %1RM	-	Exercise on an unstable surface causes more muscular activation of muscles rectus abdominis, external oblique, and soleus
Marín & Hazell, 2014 [13]	1 group 4. type of backing (stable, unstable, vibration-free 30Hz and 50Hz,	28 students (age $21.7 \pm 1.3$ ; height: $176.7 \pm 0.3$ cm; weight: $74 \pm 6.4$ kg $\pm 0.3$ cm	Without experience	5 min warming, 10x folds, butt kicks, knee breast, squat and lateral lunge	EMG	Use of vibrations at 30Hz increased EMG muscle 20 to 40% of other types of testing
Marshall & Desai, 2010 [14]	1 group Planks and crunch, squat	14 respondents 7 guys and 7 girls of age $24.1 \pm 1.7$ ; height: $174 \pm 8$ cm; weight: $72.9 \pm 13.17$ kg	With experience	1 session exercise practice 2 sessions 3 tests	EMG	Increased muscle activity triceps brachii by 32.4%, vastus lateralis by 44.2% and rectus abdominis by 28.5% at the exercise bridge using the Swiss ball
Saeterbakken & Fimland, 2013 [18]	1 group Bench press Swiss ball	16 trained men (ages $22.5 \pm 2$ ; height: $182 \pm 6$ cm; weight: $82 \pm 7.8$ kg)	With experience	With experience 6RM load $85 \pm 15.6$ kg 72 hours of pause between tests	EMG	The highest threshold values on the chest are on a stable surface (floor), and at least on the Swiss ball
Nagla, E. (2011) [16]	1 group Karate strength of the stomach, back and leg, spinal flexibility and static dynamic balance.	12 respondents (age: 18-20; height: $163.92 \pm 3.0$ cm; weight: $64.77 \pm 2.81$ kg)	With 6 years experience	8 weeks in addition to karate and the Swiss ball	EMG	Work with the Swiss ball has a positive effect on the stomach, back and leg, spinal flexibility and static dynamic balance.

Kibele et al., 2014 [8]	2 groups Jumps and squats	33 students Experimental group: 20 (age $24.1 \pm 3.1$ , height: $182 \pm 5$ cm, weight: $76.1 \pm 8.9$ kg) Control group: 13 (age: $24.1 \pm 4.6$ ; height: $179 \pm 5.3$ cm; weight: $75.8 \pm 8.3$ kg)	With experience	7 weeks, Two days per week	-	Improving the performance of some types of jumps, balance, and strength of the knee extensor
Singh et al., 2013 [20]	2 groups Experimental 12 men basketball + Swiss ball Control group 12 men's basketball	24 men (ages: $21.54 \pm 1.57$ ; height: $178.2 \pm 5.6$ cm; weight: $66.2 \pm 5.41$ kg)	No experiences	5 weeks by 45 minutes on the Swiss balls	-	The use of Swiss balls can contribute to the improvement in the coordination activity

**Tabela 2.** Pregled istraživanja u kojima nije bilo statistički značajnog efekata vežbanja na nestabilnim površinama

Studija	Grupe	Karakteristike (N)	Sportski staž	Eksperimentalni program	Oprema	Rezultat
Goodman et al., 2008 [5]	2 grupe Kontrolna grupa: 1 RM benč pres, Kontrolna grupa: 1 RM švajcarska lopta, Pauza: 7dana	13 rekreativaca 10 momaka i 3 devojke uzrasta: $24.1 \pm 1.6$ visine: $176.7 \pm 3.0$ cm težine: $76.0 \pm 3.9$ kg	Bez iskustva	1 RM (benč pres/švajcarska lopta)	EMG	Rezultat istraživanja pokazuje da nema elektromiografske razlike prilikom rada na obe vrste podloge.
Chulvi-Medrano et al., 2010 [2]	1 grupa Mrtvo dizanje	31 student (uzrasta: $24.0 \pm 0.5$ ; visine: $170. \pm 8.0$ cm; težine: $79.08 \pm 2.37$ kg)	Višegodišnje iskustvo	5 sek. Izometrija + $5 \times 70\%$ RM	EMG	vrednosti maksimalne snage i mišićne aktivnosti prilikom mrtve vuče (deadlift) postižu značajnije rezultate prilikom korišćenja stabilne podlage
Chulvi-Medrano et al., 2012 [3]	1 grupa Pod, T-bow i BOSU lopta	30 ispitanika (uzrasta: $24.97 \pm 3.09$ ; visine: $175.43 \pm 30.31$ cm; težine: $80.6 \pm 6.94$ kg)	Sa iskustvom (3.33 ± 1.62g)	8 nedelja, 2x nedeljno trening	-	snaga koja je merena kroz jedan maksimalni ponavljanje i mičićna izdržljivost merena brojem skleova se nije povećala ni kod jedne grupe vežbanja
Koshida et al., 2008 [11]	2 grupe Kontrolna grupa 1: 1 RM benč pres Kontrolna grupa 2: 1 RM švajcarska lopta	20 ispitanika muškog pola (uzrasta: $21.3 \pm 1.5$ visine: $167.7 \pm 7.7$ cm težine: $75.9 \pm 17.5$ kg)	-	3x50% 1RM Snaga, sila, brzina	Akcelometar	ponavljaju na nestabilnoj podlozi su za 6% manji u parametru sile i po 10% u parametrima snage i brzine
Pirauá et al., 2017 [17]	1 grupa 3 protokola a) benč pres šipkom, b) stabilna površina letenje bučicama i benč pres šipkom, c) nestabilna površina letenje bučicama and barbell bench press.	15 muškaraca (uzrasta: $22.5 \pm 2.4$ ; visine: $173.6 \pm 7.1$ cm; težine: $76.03 \pm 9.02$ kg)	Sa iskustvom, 6 meseci	10 ponavljanja svaka vežba, 30% 1RM letenje bučicama, 60% od 1RM benč pres šipkom	EMG	svi oblici vežbanja povećavaju EMG mišića bez razlike
Saeterbakken & Fimland, 2013 [19]	1 group Čučanj na podu Power daska BOSU lopta	15 muškaraca (uzrasta: $23.3 \pm 2.7$ ; visine: $181 \pm 9$ cm; težine: $80.5 \pm 8.5$ kg)	Sa iskustvom	10 min zagrevanje/fleksiju 90 stepeni u zglobovu kolena za svaku podlogu, period pauze između promena podloge 4 minuta	EMG	najveću razliku poredi sa vežbama na fiksnoj podlozi ima rad sa BOSU lopatom
Wahl & Behm, 2008 [24]	2 grupe Eksperimentalna i kontrolna 1 RM benč pres i leg pres	16 ispitanika (uzrasta: $26.6 \pm 7.0$ visine: $176.7 \pm 8.0$ cm težine: $81.8 \pm 9.1$ kg)	Sportisti	2-3 ponavljanja na švajcarskoj lopti, Bosu lopta dina disk	EMG	kod vežbača sa dužim trenažnim stažom zahtevi nestabilnih podloga nisu doveli do statistički značajnih efekata treninga snage

**Table 2.** Survey of studies in which there were no statistically significant effects of exercise on unstable surfaces

Study	Group	Characteristics (N)	Sports internship	Experimental program	Equipment	Results
Goodman et al., 2008 [5]	2 groups Control group: 1 RM bench press, Control group: 1 RM Swiss ball, Break: 7 days	13 respondents 10 boys and 3 girls age: $24.1 \pm 1.6$ Height: $176.7 \pm 3.0$ cm: $76.0 \pm 3.9$ kg	No experiences	1 RM press / swiss ball	EMG	The result of the study shows that there is no electromyographic difference when working on both types of substrate.
Chulvi-Medrano et al., 2010 [2]	1 group Dead lift	1 students (ages: $24.0 \pm 0.5$ ; height: $170. \pm 8.0$ cm; weight: $79.08 \pm 2.37$ kg)	Multi-year experience	5 sec. Isometry + 5x70% RM	EMG	Values of maximum strength and muscle activity in deadlift achieve significant results when using a stable substrate.
Chulvi-Medrano et al., 2012 [3]	1 group Floor, T-bow and BOSU ball	30 subjects (ages: $24.97 \pm 3.09$ ; height: $175.43 \pm 30.31$ cm; weight: $80.6 \pm 6.94$ kg)	With experience ( $3.33 \pm 1.62$ y)	8 weeks, 2x week training	-	Measured through one maximum repetition and the muscular endurance measured with the number of joints did not increase in any group of exercises.
Koshida et al., 2008 [11]	2 groups Control group: 1: 1 RM bench press Control group2: 1 RM Swiss ball	20 male subjects (ages: $21.3 \pm 1.5$ height: $167.7 \pm 7.7$ cm weight: $75.9 \pm 17.5$ kg)	-	3x50% 1RM Power, force, velocity	Accelerometer	Repetitions on an unstable surface are 6% less in the force parameter and 10% in the parameters of power and speed.
Pirauá et al., 2017 [17]	1 group 3 protocols a) bench press, b) stable surface flying with pumpkins and bench press, c) unstable surface flying saucers and barbell bench press.	15 men (ages: $22.5 \pm 2.4$ ; height: $173.6 \pm 7.1$ cm; weight: $76.03 \pm 9.02$ kg)	With 6 months experience	10 repeats each exercise, 30% 1RM fly flies, 60% of 1RM bench press	EMG	All forms of exercise increase EMG muscle without any difference.
Saeterbakken & Fimland, 2013 [19]	1 group Squash on the floor of the Power Board BOSU Ball	15 men (aged: $23.3 \pm 2.7$ ; height: $181 \pm 9$ cm; weight: $80.5 \pm 8.5$ kg)	With experience	10 min warming up 90 times the flexion in the knee joint for each surface, the breakdown period between the substrate changes by 4 minutes	EMG	With the greatest difference compared to the exercises on the fixed surface, work with the BOSU ball.
Wahl & Behm, 2008 [24]	2 groups Experimental and control 1 RM bench press and leg press	16 respondents (age: $26.6 \pm 7.0$ grades: $176.7 \pm 8.0$ cm weight: $81.8 \pm 9.1$ kg)	Athletes	2-3 swinging on the Swiss ball, Bosu's ball dina disk	EMG	In the practice with a longer training experience, the demands of unstable backbones did not lead to statistically significant effects of power training.

**Tabela 3.** Pregled istraživanja u kojima je postignut jednak učinak efekata vežbama snage na nestabilnim i stabilnim površinama

Studija	Grupe	Karakteristike (N)	Sportski staž	Eksperimentalni program	Oprema	Rezultat
Sparks & Behm, 2010 [22]	1 grupa Benč pres, skokovi,balans, bacanje medicinke preko glave na jednoj nozi	18 ispitanika 10 muškaraca (uzrasta: $24.6 \pm 5.4$ ; visine: $176.8 \pm 6.2$ cm; težine: $80.2 \pm 8.4$ kg) 8 devojaka(uzrasta: $24.2 \pm 6.2$ ; visine: $170.4 \pm 6.6$ cm; težine: $64.1 \pm 10.3$ kg)	bez iskustva	8 nedelja 2 x 10 ponavljava za svaku vežbu, 3x nedeljno po 1 sat vežbanja	EMG	potvrđuje neuromišičnu adaptaciju korišćenjem nestabilnih podloga kod neutrenirajih rekreativaca
Kibele et al., 2009 [8]	2 grupe Eksperimentalna i kontrolna grupa ekstenziju nogu, statička i dinamička ravnoteža, pregib trupa, skok udalj, šatl ran, i sprint.	40 ispitanika 28 muškaraca (uzrasta: $23.0 \pm 2.4$ ; visine: $182.1 \pm 6.2$ cm; težine: $77.5 \pm 8.1$ kg) 12 devojaka (uzrasta: $22.0 \pm 1.8$ ; visine: $182.1 \pm 6.2$ cm; težine: $77.5 \pm 8.1$ kg)	bez prethodno trenažnog iskustva	7 nedelja 2x nedeljno	-	osim sprinta su sva ostala merenja pokazala poboljšanje rezultata. U testovima hopping test for time (6,2%) i situps (8,9%), rad sa opterećenjem na nestabilnim podlogama je pokazao statistički veće vrednosti
Shankar & Chaurasia, 2012 [23]	3 grupe Kontrolna grupa: pregibi trupa i ledna ekstenzija na podu Eksperimentalna pregibi trupa i ledna ekstenzija na švajcarskoj lopti	20 ispitanika Po10 u obe grupe (uzrasta: od 18 do 30 godina)	-	5 nedelja, 3x15 - 4x25 ponavlaja	-	snaga koja je merena kroz jedan maksimalni ponavljaj i mičićna izdržljivost merena brojem skleкова se nije povećala ni kod jedne grupe vežbanja

Maté-Muñoz et al. 2014 [15]	3 grupe Zadnji čučanj, benč pres, skokovi	33 studenta Kontrolna grupa 12 (uzrasta: $22.3 \pm 2.4$ ; visine: $176 \pm 7$ cm; težine: $75.4 \pm 9.9$ kg) Eksperimentalna grupa 1 :12 (uzrasta: $21.5 \pm 3.03$ ; visine: $178 \pm 5$ cm; težine: $75.7 \pm 9.2$ kg) Eksperimentalna 2 :12 (uzrasta: $21.8 \pm 1.1$ ; visine: $178 \pm 5$ cm; težine: $71.8 \pm 6.5$ kg)	bez iskustva	7 nedelja 2-3xnedeljno	-	nema razlika između eksperimentalnih grupa
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**Table 3.** An overview of the research in which the effect of power exercises on unstable and stable surfaces has been achieved equally

Study	Group	Characteristics (N)	Sports internship	Experimental program	Equipment	Results
Sparkes & Behm, 2010 [22]	1 group Bench press, jumps, balance, throwing the medicine over the head on one leg	18 respondents 10 men (ages: $24.6 \pm 5.4$ , height: $176.8 \pm 6.2$ cm, weight: $80.2 \pm 8.4$ kg) 8 girls (age: $24.2 \pm 6.2$ ; height: $170.4 \pm 6.6$ cm; weight: $64.1 \pm 10.3$ kg)	With experience	8 weeks 2 x 10 reps for each exercise, 3x per week after 1 hour of exercise	EMG	Confirms neuromuscular adaptation using unstable substrates in untrained recreation.
Kibele et al., 2009 [8]	2 groups Experimental and control group leg extension, static and dynamic equilibrium, crunch, jump out, shuttle run, and sprint.	40 respondents 28 men (ages: $23.0 \pm 2.4$ ; height: $182.1 \pm 6.2$ cm; weight: $77.5 \pm 8.1$ kg) 12 girls (age: $22.0 \pm 1.8$ ; height: $182.1 \pm 6.2$ cm; weight: $77.5 \pm 8.1$ kg)	Without previous training experience	7 weeks 2x per week	-	Apart from the sprint, all other measurements showed improved results. In hopping tests for time (6.2%) and situps (8.9%), work with stress on unstable substrates showed statistically higher values .
Shankar & Chaurasia, 2012 [23]	3 groups Control group: crunch and back extension on the floor Experimental crunch and back extension to the Swiss ball	20 respondents 10 in both groups (ages: 18-30 years)	With experience	5 weeks, 3x15 - 4x25 repetitions	-	The power measured through one maximum repetition and the mechanical endurance measured with the number of joints did not increase in any group of exercises.
Maté-Muñoz et al. 2014 [15]	3 groups Back squat, bench press, jumping	33 students Control group 12 (age: $22.3 \pm 2.4$ ; height: $176 \pm 7$ cm; weight: $75.4 \pm 9.9$ kg) Experimental group 1: 12 age: $21.5 \pm 3.03$ ; height: $178 \pm 5$ cm; weight: $75.7 \pm 9.2$ kg) Experimental 2: 12 age: $21.8 \pm 1.1$ ; height: $178 \pm 5$ cm; weight: $71.8 \pm 6.5$	With experience	7 weeks 2-3x per week	-	No difference between experimental groups.

In a transparent survey, 24 papers were processed. The papers are not older than 10 years. The sample of respondents is a young and middle age group that can be identified by age according to similar abilities. The fields encompassed are: power, force, role of postural muscles, movement pre-activation. The table contains a detailed description of the number of groups by works with exercises, the division of groups into control and experimental with the basic characteristics of age, weight and height, sports experience, equipment used, result and conclusion. Out of 24 papers: 16 papers were with one group in the experiment, 6 papers were with two groups in the experiment and 2 with three groups in the experiment. After the involvement of the musculature: 9 papers treated pectoral musculature, in 10 papers the involvement of the muscles of the lower limbs was processed, 6 papers dealt with the aspect of engaging the back musculature and the same abdomen, 8 papers treated chest musculature and two papers included shoulder musculature in their research. In the section of the work done according to the level of sporting experience and the previous training experience, we can distinguish: 9 papers with respondents who did not have any experience in the exercises, 13 papers with respondents who had different training experience and 2 papers where we did not find any information on the train-

U preglednom istraživanju obrađeno je 24 rada. Radovi su ne stariji od 10 godina. Uzorak ispitanika su mlada i srednja starosna grupa koja se može po starosti identifikovati po sličnim sposobnostima. Obuhvaćena polja su: snaga, sila, uloga posturalne muskulature, preaktivacija pokreta. Tabela sadrži detaljni opis broja grupa po radovima sa vežbama, podelu grupa na kontrolne i eksperimentalne sa osnovni karakteristikama uzrast, težina i visina, sportski staž, korišćenu opremu, rezultat i zaključak. Od 24 radova: 16 radova je sa jednom grupom u eksperimentu, 6 radova je sa dve grupe u eksperimentu i 2 rada sa tri grupe u eksperimentu. Po angažovanosti muskulature: u 9 radova je obrađena grudna muskulatura, u 10 radova je obrađivano angažovanje muskulature donjih ekstremiteta, 6 radova je u svom aspektu imalo angažovanje leđne muskulature i isto toliko abdomena, 8 radova je obradivalo grudnu muskulaturu i dva rada su obuhvatila u svom istraživanju ramenu muskulaturu. U rubrici obrađenih radova po nivou sportskog staža i predašnjeg vežbovnog iskustva možemo podeliti na: 9 radova sa ispitanicima koji uopšte nisu imali iskustva u vežbama, 13 radova sa ispitanicima koji su imali različitog trenažnog iskustva i 2 rada gde nismo našli nijedan podatak trenažnog iskustva. Po pitanju korišćenja dijagnostičke opreme prednjači elektromiografska analiza u 13 radova, izokinetičkim dinamome-

ing experience. Regarding the use of diagnostic equipment, electromyographic analysis was performed in 13 papers, the isokinetic dynamometer was used in 2 laboratories, the accelerometer in one paper and in 9 papers no measuring equipment was used.

## DISCUSSION AND CONCLUSION

Designing a training program is a very complex job and resistance training is certainly one of the most demanding, regardless of the type of surface used (stable or unstable). The main findings of this paper were to compare the effects of stress training on stable surfaces with stress-loading in unstable surfaces in power parameters, balance in healthy adolescents, young adults and old adults, students, women with and without experience in exercise. Proponents of stress training on unstable surfaces suggest that such exercises provide advantages over training on stable surfaces, due to the principle of training specificity (i.e., training on unstable devices with unstable requirements in tasks in the sport, fitness, and at the workplace), while a higher degree of instability gives greater stress and therefore a greater possibility in training adaptation of neuromuscular and equilibrium systems. Summarizing the results of the research in exercises on unstable substrates: we find the positive effects of exercise on unstable surfaces on the observed musculature in 16 papers [1, 4, 7, 8, 9, 10, 11, 12, 13, 14, 16, 18, 20, 21, 22, 23], four studies had no effect on musculature in [3, 5, 6, 24], two studies in which muscle values were more significant in exercises on stable surfaces than exercises on unstable surfaces [2, 19], two papers show that there is no difference between work on both types of substrate [15, 16]. On the basis of the derived conclusion of the effects of exercise in unstable conditions in comparison with the stable appearance, the statistical effect of exercise on unstable substrates was expressed in 13 studies [1, 4, 6, 7, 9, 10, 12, 13, 14, 16, 18, 20, 21], there were no statistically significant effects shown in 7 studies [2, 3, 5, 11, 17, 19, 24], while the same effect of the effects achieved by strength exercises on unstable and stable surfaces is found in 4 papers [8, 22, 23, 15].

Based on what has been said so far, it is to be concluded that the articles primarily suggest a positive effect of exercise on unstable substrates in non-active athletes. These are mostly positive effects in untrained and partially recreational people. In cases of research in a sample of respondents who do not have experience with exercises on unstable substrates, the emphasis is primarily on the activation of postural musculature in pre-activation, which largely determines the preparation for performing the movement. In static exercises, the effect

trom su se služili u 2 rada, akcelometrom u jednom radu i u 9 radova nije korišćena merna oprema.

## DISKUSIJA I ZAKLJUČAK

Dizajniranje trenažnog programa je veoma složen posao i trening sa otporom je sigurno jedan od najzahtevnijih, bez obzira na vrstu površine koja se koristi (stabilna ili nestabilna). Glavni nalazi ovog rada su bili da se uporede efekti treninga sa opterećenjem na stabilnim površinama sa treningom sa opterećenjem pri nestabilnim površinama u parametrima snage, ravnoteže kod zdravih adolescenata, mlađih odraslih i starih odraslih osoba, studenata, žena sa i bez iskustva u vežbanju. Zagovornici treninga sa opterećenjem na nestabilnim površinama predlažu da takve vežbe pružaju prednosti u odnosu na trening na stabilnim površinama, zbog principa specifičnosti treninga (tj. vežbanja na nestabilnim uređajima sa nestabilnim zahtevima zadatka u sportu, fitnesu i na radnom mestu), dok veći stepen nestabilnosti daje veći stres i time veću mogućnost u treningu adaptacija neuromišićnih i ravnotežnih sistema. Sumirajući rezultate istraživanja pri vežbanjima na nestabilnim podlogama: pozitivne uticaje vežbanja na nestabilnim površinama na praćenu muskulaturu nalazimo u 16 radova [1, 4, 7, 8, 9, 10, 11, 12, 13, 14, 16, 18, 20, 21, 22, 23], četiri istraživanja nisu imali efekta na muskulaturu u [3, 5, 6, 24], dva rada u kome su vrednosti muskulature bile značajnije u vežbama na stabilnim površinama u odnosu na vežbanje na nestabilnim površinama [2, 19], dva rada pokazuju da nema razlika između rada na obe vrste podloge [15, 16]. Na osnovu izvedenog zaključka efekata prilikom vežbanja u nestabilnim uslovima u poređenju sa stabilnim izgleda ovako: statistički efekat vežbanja na nestabilnim podlogama je bio izražen u 13 studija [1, 4, 6, 7, 9, 10, 12, 13, 14, 16, 18, 20, 21], da nije bilo statistički značajnih efekata pokazuju 7 studija [2, 3, 5, 11, 17, 19, 24], dok jednak učinak efekata postignutim vežbama snage na nestabilnim i stabilnim površinama nalazimo u 4 rada [8, 22, 23, 15].

Na osnovu do sada iznetog, da se zaključiti da radovi prvenstveno navode pozitivan efekat vežbanja na nestabilnim podlogama kod osoba koja nisu aktivni sportisti. Uglavnom se radi o pozitivnim efektima kod neutreniranih i delimično kod rekreativaca. U slučajevima istraživanja kod uzorka ispitanika koji nemaju iskustva sa vežbama na nestabilnim podlogama, pre svega je akcenat na aktivaciju posturalne muskulature u preaktivaciji koja umnogome određuje pripremu za izvođenje pokreta. Pri statičkim vežbama, efekat treninga snage na nestabilnim površinama nije statistički bitan. Nasuprot tome, kod osoba koje su utrenirane, skoro uopšte nema uticaja ova vrsta podloge, posebno imajući u vidu da opterećenje na nestabilnim podlogama mora da bude manje

of power training on unstable surfaces is not statistically significant. On the contrary, in those who are tired, there is almost no effect of this kind of substrate, especially given that the load on unstable substrates must be less due to the prevention of injuries. Typically, the authors focused on a load of about 50% of 1RM, and there were attempts to increase or decrease. In case of an increase in load, they indicated a lower number of repetitions and a higher degree of injury potential. In the case of smaller loads (25-30%), we find insufficient engagement of the musculature and do not automatically induce the necessary muscle activation for the statistically valid significance of hypertrophy. Due to the short time interval in the adjustment process, a certain number of studies per time represented by exercise did not find the statistical significance of exercise on unstable substrates. A number of works showed the same effect of engaging muscles in testing on both surfaces. Several studies point to the problem of difficult conditions for conducting treatment by exercising on unstable substrates due to a disturbed balance situation and the establishment of stability during exercise. From the factual situation one can see the contribution of the collected research in the additional enlightenment of the problem of exercise on unstable surfaces. A step forward will be to use the methodology of these research that will serve to innovate new training tools that will disturb the balance, with the aim of improving partial or total power effects.

The use of different exercises under unstable conditions in order to improve muscle strength, balance and coordination has been increasingly present over the last decade. Although there are results of several conducted studies that support the inclusion of certain exercises under unstable conditions in rehabilitation programs, there is not much reporting on their use in sports training. Also, research conducted during the rehabilitation period cannot be applied to the field of sports training due to different demands for manifesting muscular strength during everyday activities (low loads, slow movements) and sports activities (high load, dynamic movements).

Exercising the highest muscle strength is reduced under conditions of instability, but changing the balance of training on an unstable surface can activate muscles of the extremities and carcasses, thereby ensuring greater stability of the joints. Using unstable platform in strength training should enable the development of higher levels of muscle activation, through increased reliance on their stabilizing functions. The contribution of stress training in unstable conditions can be more pronounced in people who aim at health and rehabilitation and who do not

zbog prevencije od povređivanja. Obično su se autori orijentisali na opterećenje oko 50% 1RM, a bilo je pokušaja i da se poveća ili smanji. U slučaju povećanja opterećenja, ukazivali su na manji broj ponavljanja i veći stepen mogućnosti povreda. U slučaju manjih opterećenja (25-30%) nalazimo nedovoljno angažovanje muskulature i automatski ne izazivanje potrebne aktivacije mišića za statistički validnu značajnost hipertrofije. Određeni broj istraživanja po vremenu zastupljenog vežbanjem, zbog kratkog vremenskog interavala u procesu prilagodavanja, nije našao statističku značajnost vežbanja na nestabilnim podlogama. Jedan broj radova je pokazao isti efekat angažovanja muskulature pri testiranju na obe podlove. Nekoliko istraživanja upućuje na problem otežanih uslova sprovodenja tretmana vežbanjem na nestabilnim podlogama zbog narušenog ravnotežnog stanja i samog uspostavljanja stabiliteta prilikom vežbanja. Iz činjeničnog stanja se može uvideti doprinos prikupljenih istraživanja u dodatom prosvetljenju problema vežbanja na nestabilnim površinama. Korak napred će biti korišćenje metodologije ovih istraživanja koja će poslužiti inoviranju novih sredstava vežbanja kojim će se narušavati ravnoteža, a sve sa ciljem poboljšanja efekata snage parcijalno ili totalno.

Upotreba različitih vežbi pri nestabilnim uslovima u cilju poboljšanja mišićne snage, ravnoteže i koordinacije sve je prisutnija tokom poslednje decenije. Iako postoje rezultati nekoliko sprovedenih studija koji podržavaju uključivanje određenih vežbi pri nestabilnim uslovima u programe rehabilitacije, nema baš puno izveštaji o njihovoj upotrebi u sportskom treningu. Takođe, istraživanja sprovedena u periodu rehabilitacije se ne mogu primeniti na oblast sportskog treninga, zbog različitih zahteva za ispoljavanje mišićne snage tokom svakodnevnih aktivnosti (mala opterećenja, spori pokreti) i sportskih aktivnosti (veliko opterećenje, dinamički pokreti).

Upotreba različitih vežbi pri nestabilnim uslovima u cilju poboljšanja mišićne snage, ravnoteže i koordinacije sve je prisutnija tokom poslednje decenije. Iako postoje rezultati nekoliko sprovedenih studija koji podržavaju uključivanje određenih vežbi pri nestabilnim uslovima u programe rehabilitacije, retki su izveštaji o njihovoj upotrebi u sportskom treningu. Takođe, istraživanja sprovedena u periodu rehabilitacije se ne mogu primeniti na oblast sportskog treninga, zbog različitih zahteva za ispoljavanje mišićne snage tokom svakodnevnih aktivnosti (mala opterećenja, spori pokreti) i sportskih aktivnosti (veliko opterećenje, dinamički pokreti). Ispoljavanje najveće mišićne snage smanjeno je u uslovima nestabilnosti, ali promena ravnoteže pri treningu na nestabilnoj podlozi može da aktivira mišiće ekstremiteta i trupa i time obezbedi veću stabilnost zglobova. Korišćenje nestabilnih platformi u treningu snage treba da omogući razvoj viših nivoa aktivacije mišića, preko povećanog oslanjanja

participate in strenuous sports training and competitions. Due to all of the above, it is clear that many unresolved issues need to be addressed in this area. It is necessary to carry out a study in which the parameters of muscular contraction during various forms of training under unstable conditions, as well as long-term physiological adaptations, which are the result of this type of training, will be examined. Such knowledge can serve as a basis for the development of testing and training methods that would be applied in sports and rehabilitation. The results of the research by Panza and associates (2014), and Zemke and associates (2010) confirming the increase in energy consumption when breast-feeding on unstable substrates, further motivate the authors and draw attention to some new research work in this field, and above all in the sense conceiving of resistance training on unstable substrates in order to regulate body weight and loss of fat. Based on a relatively small number of studies, we believe that our findings are preliminary. Therefore, further research is needed to determine the overall effectiveness of training with load.

na njihove stabilizirajuće funkcije. Doprinos treninga sa opterećenjem pri nestabilnim uslovima može biti naglašeniji kod osoba kojima su cilj zdravlje i rehabilitacija i koji ne učestvuju u napornim sportskim treninzima i takmičenjima. Zbog svega prethodno navedenog, jasno je uočljivo da u ovoj oblasti treba odgovoriti na mnoga nerešena pitanja. Neophodno je sprovesti istraživanje u kojem će biti ispitani parametri mišićne kontrakcije tokom različitih oblika treninga pri nestabilnim uslovima, kao i dugoročne fiziološke adaptacije, koje su posledica takvog tipa treninga. Takva saznanja mogu poslužiti kao osnova za izradu metoda testiranja i treninga koji bi se primenjivali u sportu i rehabilitaciji. Rezultati istraživanja Panze i saradnika (2014), i Zemkove i saradnika (2010) koji potvrđuju povećanje utroška energije prilikom izvođenja potiska sa grudi na nestabilnim podlogama, dodatno motivišu autora i izazivaju pažnju na neke nove istraživačke radove u ovoj oblasti, a prije svega u smislu koncipiranja treninga sa otporom na nestabilnim podlogama u cilju regulisanja tjelesne težine, odnosno gubitka masti. Na osnovu relativno malog broja studija, smatramo da su naši nalazi preliminarni. Stoga je potrebno dalje istraživanje kako bi se odredila opšta efikasnost treninga sa opterećenjem na nestabilnim uslovima u poređenju sa drugim vrstama treninga. Jednako ili još važnije je potreba da se razjasne specifični efekti treninga sa opterećenjem na nestabilnim uslovima u poređenju sa drugim programima treninga snage (npr. treninga sa opterećenjem na nestabilnim uslovima korišćenjem velikih i malih opterećenja).

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Primljen: 10. april 2019. / Received: April 10, 2019.  
Prihvaćen: 27. maj 2019. / Accepted: May 27, 2019.

## LOWER LIMBS JOINT LOADING – CASE STUDY

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**Abstract:** Injury prevention plays an important role in modern sport. The most commonly injured joint in male and female football players is the knee joint. It has been reported that approximately 60-85% of football injuries occur in the lower limbs. The aim of this study is to present the methods of biomechanical assessment of lower limbs joint loading during specific tasks (single leg squat (SLS) and single leg landing (SLL)). In this experimental setup, Qualisys Tracking Motion system synchronised with AMTI force plates embedded into the floor was used. The marker setup Salford Lower Limb model was used to track pelvis and lower body movements. By analysing biomechanical parameters (range of motion, internal moments, power, ground reaction forces) in all three planes it is possible to identify the structures and the imbalances of the lower extremity that need intervention and further decrease the possibility of injury to the knee and to evaluate an appropriate moment of return to play. This method showed a very high reproducibility and it can be considered as a reliable tool in assessing lower limb performance tasks.

**Keywords:** ACL, Lower Limbs, Biomechanics, Screening.

### INTRODUCTION

Football is the most popular sport worldwide. Football consists of the movements in three-dimensional space and they require speed, agility, power and endurance (Fraude et al., 2013). Most football players possess the athletic abilities to perform these movements, however the risk of injury, contact and non-contact, is constantly present. It has been reported that approximately 60-85% of football injuries occur in the lower limbs (Inklaar, 1994). The most commonly injured joint in male and female football players is the knee. There has been a lot of research regarding knee injuries in female football players but not as much on the male football players (Weiss & Whatman, 2015). By analysing the performance for a given task using biomechanics, it might be possible to identify the structures of the lower extremity that need intervention and further decrease the possibility of injury to the knee as the most common injured joint. FIFA conducted a survey in 2006 which concluded that about 265 million people were playing football worldwide. As suspected, that also comes with injuries although some aspects of playing football can be very beneficial to people's health both physically and psychologically. However, because the injury rate is so high, playing football could also have a negative impact on the quality of life of players as well as long term consequences (Lohmander et al., 2004). It has been found that knee injuries are thought to be more severe in nature as well as more costly in comparison to other injury sites (Weiss, & Whatman, 2015). Due to high number of people playing football, the demand of injury prevention programs is high. A lot of research has been done investigating football injuries and a few factors have been established, e.g. approximately half of the injuries occur during player-to-player contact and the other half occurs during running, shooting, turning and heading (Rahnama et al., 2002). However, there is still a lot of information missing from the field. The ACL's primary function is to prevent the tibia from moving too far in front of the femur (Volpi, 2006 & Friel & Chu, 2013). The ligament originates on the medial side posteriorly on the lateral epicondyle of the femur. Anterior cruciate ligament tears are one of the most serious injuries an athlete can be exposed to (Roos et al., 1995). ACL ligament tears in men have not been researched enough (Silvers-Granelli et al., 2017). Moreover, there has been a lot of research and there is an extensive knowledge on ACL ligament tears in the female population. Knee injuries are very common in football, specifically anterior cruciate ligament tears or ACL as well as Patellofemoral pain syndrome or PFPS are reported to be the most common knee injuries (Weiss & Whatman,

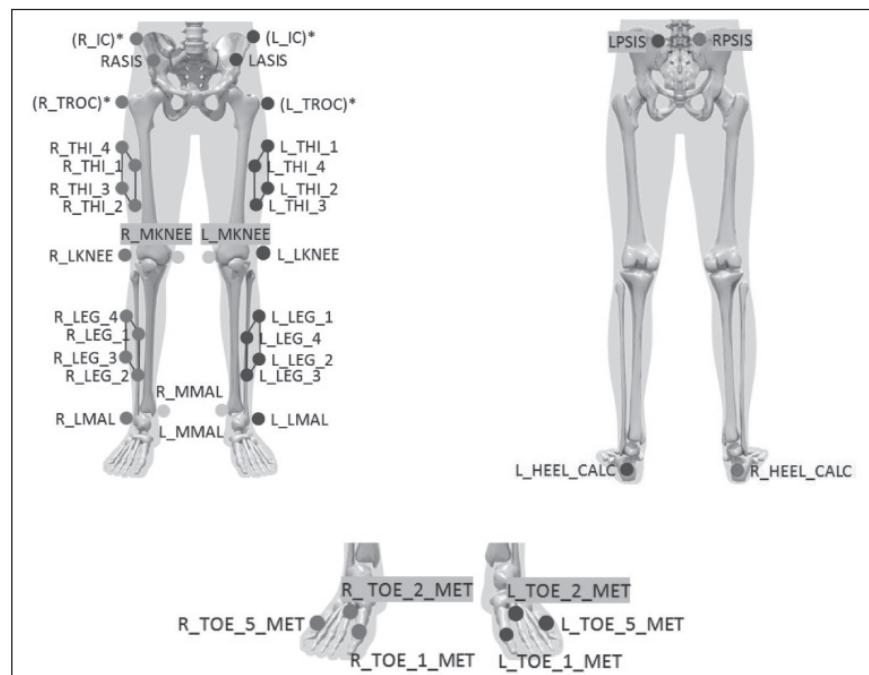
2015). The mechanisms of ACL injuries have been investigated quite a lot, however most of the research that has been carried out is regarding females since ACL tears are more common in females than males. In Weiss and Whatman's systematic review from 2015 it was found that increased abduction loading, and shallow knee flexion angles are the most common biomechanical variables associated with an ACL injury (Markolf et al., 1995; 1990). When an individual with excessive abduction movement in the knee performs a dynamic knee abduction, too much strain is put on the medial collateral ligament, medial patellofemoral ligament and the anterior cruciate ligament (Weiss & Whatman, 2015). Running, changes of direction, landing after a jump, pivoting on a planted foot, and cutting movements combined with deceleration are the movements that contribute most to ACL injuries. Small knee flexion during landing leads to a higher knee frontal plane loading and therefore increases the risk of injury to the ACL (Myer et al., 2011). It is possible that the biomechanics of the hip also contribute to ACL injuries (Weiss & Whatman, 2015). ACL injuries have been linked to excessive hip flexion among other factors. Since the hamstrings extend the hip and the quadriceps flexes the hip. It is possible that the hamstring strength decreases, and the activation of quadriceps increases the hip flexion and therefore decreases the flexion in the knee resulting in an increased risk of ACL injury. It aims to enhance lower limb alignment and landing techniques trying to avoid putting valgus load on the knee during movements.

The single leg squat (SLS) and single leg landing (SLL) manoeuvres are frequently used tasks to assess lower alignment (Herrington, 2014, Nakagawa et al., 2012, Willy and Davis, 2011). Both tests have biomechanical and neuromuscular similarities to a wide range of athletic movements and thus are involved in rehabilitation programmes of different sports designed to prevent injuries and enhance athletic performance (Alenezia et al., 2014, 2016). Development of the technology and use of motion capture systems in everyday clinical and sport scientific practise help to use different tests as the screening tools. The main difference between these two tests is that the SLL involves flight phase and provides better understanding of dynamic control of the movement. These tests were developed predominantly as the tests for the knee screening assessment in different groups with pathological symptoms, mostly linked to the patellofemoral pain (Carry et al., 2017; Herrington 2014; Levinger et al., 2017; Nakagawa et al., 2012).

The aim of this paper is to provide better understanding and rationale of biomechanical test as a successful tool for investigating asymmetries in lower limbs loading as a reliable measurement for the injury prevention screening and return-to-play estimation time. For the purpose of presenting this research, presented trials are collected from one semi-professional football player.

## METHODS

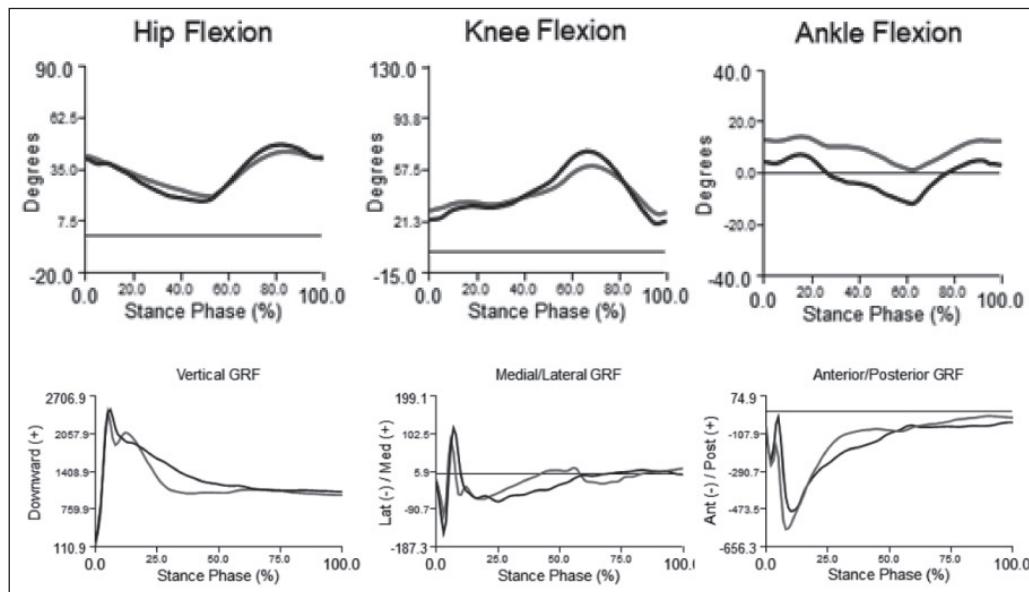
A twelve-camera motion analysis system (Qualisys, Sweden), sampling at 200 Hz, and a force platform embedded into the floor (AMTI, USA), sampling at 1000 Hz, were synchronised to collect kinematic and kinetic data during the support phase of SLS and SLL task. Where possible markers were placed directly onto the skin; to minimise movement artefacts resulting from loose clothing all participants wore tight-fitting shorts and tops. Before a session, participant was allowed to practise each of the four tasks until he felt comfortable; this was typically two to three trials. Participant started with five minutes of low intensity warm-up on a cycle ergometer. After familiarisation, participant was required to complete five successful repetitions of each task.



*Figure 1. Salford lower body marker set up*

### Data analysis

Biomechanical parameters (range of motion, internal moments, power, ground reaction forces) were calculated from the kinematic data using Visual 3D software. Joint kinematic angles were processed using an X-Y-Z Euler rotation sequence, where X equals flexion extension, Y abduction-adduction, varus-valgus and Z internal-external rotation. Joint kinetic data were calculated using three-dimensional inverse dynamics, and joint moment data were normalised to body mass and presented as external moments referenced to the proximal segment (Alenezia et al., 2014). Initial contact was defined as the instant after ground contact, when the vertical ground reaction force (GRF) was higher than 15 N, while the end of contact was defined as the point when the knee joint reaches its maximal flexion.



*Figure 2. Kinematic and kinetic data from single leg landing.*

### Discussion and conclusion

In this paper, we have shown a rationale and a novel method of using biomechanical, functional tests in order to provide a current profile of musculo-skeletal system and its adaptation during loading of the lower limbs. The presented results showed significant differences in ankle flexion between left and right limb during single leg landing. The reason for this might be decreased ability of ankle joint to sustain GRF upon landing. In the preliminary data analysis, this pattern was observed in athletes with previous history of ankle injuries or reduced strength of plantar flexors. Participant in this study displayed an altered, stiffer kinematic landing strategy and related alterations in landing kinetics, which might predispose for episodes of giving way and actual ankle sprains. Observing results from each individual player can help physical therapists and strength and conditioning coaches to understand the nature of the movement and to work on segmental development that are weak and unstable. This protocol has the advantage of offering improved anatomical relevance as it attempts to reduce skin movement artefacts by attaching cluster markers to the centre of segments rather than single markers on the joints, as in the Helen Hayes model (Alenezia et al., 2016). These results can only apply to certain laboratory settings and models, along with an individual's ability to place markers, which could affect the results obtained in other laboratories. It must be acknowledged that there may be differences between the laboratory environment and the actual performance of study tasks. The novelty of this research is that these tests can be used in both clinical and sport population in order to investigate potential asymmetries within limbs in dynamic and static activities and a chronic ankle and knee stability. Including EMG in this setup allows to investigate muscle activity and muscle activation pattern. Data obtained with EMG can indicate certain pattern how the muscles trigger during different phases of the movement and might show the differences during the rehabilitation process or implementation of new methods for developing strength and joint stability.

The single leg squat is often used as a tool to assess movement due to its perceived relationship to functional movement, yet the relationship between it and more dynamic tasks must be explored and considered (Warner et al., 2019)

Fast development of sport science and physiotherapy provides a massive base of different screening/functional tests and return-to-play test. Practice has shown that the single leg squat and single leg landing can be used as a reliable method to estimate loading of lower limbs. Limitation of this research is that more advanced biomechanical setup is needed for conducting these measurements.

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Primljen: 06. april 2019. / Received: April 06, 2019.  
Prihvaćen: 13. jun 2019. / Accepted: June 13 , 2019.

# MORPHOLOGICAL CHARACTERISTICS AS A PREDICTOR OF SUCCESSFUL RESULTS IN CADETS AGILITY TESTS IN FOOTBALL

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**Abstract:** The study was conducted on a sample of 50 cadets for determination of predictive values of selected morphological characteristics in the four agility test resultant performance. In the study, 12 variables were used to evaluate the morphological characteristics defined as predictor (input) set of variables. Criterion variables presented the following agility assessment tests: agility-forward-backward run with rotation (93639OK), 20-yard test (MAG 20Y), 4x5 meters run (AG4X5M), T-test (MAG T). For the determination of the predictive values of the selected morphological characteristics on the successful result in the agility assessment tests, four multiple regression analyses were applied to each test. The results of regression analysis show that the morphological characteristics observed in this study are relatively poorly correlated with the results in the cadet's agility evaluation. Statistically significant regression correlation was obtained between selected morphological characteristics and the 4 x 5 meters run with a change of direction at 90° and 180° (AG4X5M). There was no statistically significant correlation in the other agility test estimation and the selected morphological characteristics although the partial association of some morphological characteristics was noticed. The results obtained may be of benefit to coaches and other professionals working with younger age categories in football as guidance for more useful planning and programming of training work, as well in the choice of appropriate training methods.

**Keywords:** agility, football players, morphological characteristics, regression analysis.

# MORFOLOŠKE KARAKTERISTIKE KAO PREDIKTOR REZULTATSKE USPJEŠNOSTI U TESTOVIMA AGILNOSTI KOD KADETA U FUDBALU

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**Apstrakt:** Istraživanje je provedeno na uzorku 50 fudbalera kadetskog uzrasta s ciljem utvrđivanja prediktorskih vrijednosti odabranih morfoloških karakteristika na rezultatsku uspješnost u četiri testa za procjenu agilnosti. U istraživanju je primijenjeno 12 varijabli za procjenu morfoloških karakteristika definisanih kao prediktorski (ulazni) skup varijabli. Kriterijske varijable predstavljali su sljedeći testovi za procjenu agilnosti: Test agilnosti-trčanje naprijed-nazad sa okretom (93639OK), test 20 yardi (MAG 20Y), trčanje 4x5 metara (AG4X5M), T test (MAG T). Za utvrđivanje prediktivnih vrijednosti odabranih morfoloških karakteristika (mjera) na rezultatsku uspješnost u testovima za procjenu agilnosti pojedinačno na svaki test primjenjene su četiri multiple regresione analize. Rezultati regresionih analiza pokazuju da su morfološke karakteristike praćene u ovom istraživanju, relativno slabo povezane sa rezultatima u primjenjenim testovima za procjenu agilnosti kod kadeta u fudbalu. Statistički značajna regresiona povezanost dobijena je između odabranih morfoloških karakteristika i testa trčanje 4 x 5 metara sa promjenom smjera trčanja pod uglom od 90° i 180° (AG4X5M). Kod ostalih testova za procjenu agilnosti i odabranih morfoloških karakteristika nije utvrđena statistički značajna povezanost, iako se uočava parcijalna povezanost nekih morfoloških odlika. Dobijeni rezultati mogu biti od koristi trenerima i drugim stručnjacima koji rade u fudbalu sa mlađim uzrasnim kategorijama kao smjernica za svishodnije planiranje i programiranje trenažnog rada, kao i izboru adekvatnih trenažnih operatora i trenažnih metoda.

**Ključne riječi:** agilnost, fudbaleri, morfološke karakteristike, regresiona naliza.

## INTRODUCTION

Morphological characteristics are responsible for the growth and development of the human body. Morphological characteristics include active components (muscles) and inertial components (body mass, body height, fat tissue, etc.). Measurement and diagnosis of the state of morphological characteristics provide an insight into the growth and development of the respondents, but also enable the proper targeting of children in a particular sports branch and their monitoring of changes in the process of sports preparation. Morphological anthropometry is a method that involves measuring the human body, processing the obtained measures by applying appropriate statistical and mathematical procedures and finally interpreting the results obtained (Mišigoj-Duraković, 1995). The exact data on the morphological characteristics of athletes is one of the important problems in modern sports.

Agility is a complex motor ability that arises as a result of a complementary collaboration of various motor skills. It can be said that the success in complex motor activities is associated with the manifestation of agility, and the agility itself arises as a result of the conformity of different anthropological domains (morphological, motor, psychological). The complexity of the manifestation of agility makes the understanding of its significance more than the emphasis on the subtlety of the results of the movement in which it manifests itself. Its complexity is recognized in the necessity of a holistic understanding of the characteristics of a person, in respecting all potentials and limiting the functions of the locomotor system, in necessarily linking the interactions of the current characteristics, in the specific choice of means of preparation, in various protocols for its assessment, in the increased risk of injuries. Based on previous research results of various authors, agility is defined as a complex manifestation of motor skills, which depends on fast and efficient linking of direction changes and re-acceleration and deceleration with constant control of movement in vertical or horizontal direction (Drabik, J. 1996; Plisk, SS 2000; Verstegen, M., Marcello, B., 2001). Acceleration and deceleration of movement, in the horizontal and vertical directions, implies the manifestation of power as a motor characteristic, and the success in movements that require agility depends on the characteristics of the manifestation of strength - athletes who, in a shorter time, exercise force, that is, who exhibits greater strength, have the expected preconditions necessary for more efficient manifestation of agility.

Football is a complex, changing poststructural sports game, characterized by the cyclic and acyclic structure of the movement (Jerković, 1982; Bajrić, 2008; Mandić Je-

## UVOD

Morfološke karakteristike su odgovorne za rast i razvoj ljudskog tijela. Morfološke karakteristike obuhvataju aktivne komponente (mišiće) i inercione komponente (masa tijela, visina tijela, masno tkivo i dr). Mjerenje i dijagnosticiranje stanja morfoloških karakteristika daje uvid u rast i razvoj ispitanika, ali isto tako omogućuje pravilno usmjeravanje djece u određenu granu sporta i njihovo praćenje promjena u procesu sportske pripreme. Morfološka antropometrija je metoda koja obuhvata mjerenje ljudskog tijela, obradu dobijenih mjera primjenom odgovarajućih statističko-matematičkih procedura i na kraju interpretaciju dobijenih rezultata (Mišigoj – Duraković, 1995). Tačni podaci o morfološkim karakteristikama sportista predstavljaju jedan od važnih problema u savremenom sportu.

Agilnost je kompleksna motorička sposobnost koja nastaje kao posledica komplementarnog sadejstva različitih motoričkih sposobnosti. Može se reći da je uspješnost u složenim motoričkim aktivnostima povezana sa ispoljavanjem agilnosti, a sama agilnost nastaje kao rezultat usaglašenosti različitih antropoloških domenzija (morfoloških, motoričkih, psiholoških). Kompleksnost ispoljavanja agilnosti čini da razumijevanje njenog značaja zahvata više od isticanja suptilnosti rezultata kretanja u kome se ispoljava. Njena kompleksnost se prepoznaje u neophodnosti holističkog razumijevanja karakteristika čovjeka, u uvažavanju svih potencijala i ograničenja funkcija lokomotornog sistema, u nužnom povezivanju interakcija aktuelnih osobina, u specifičnom izboru sredstava pripreme, u različitim protokolima za njenu procjenu, u povećanom riziku od povređivanja i dr. Na osnovu dosadašnjih rezultata istraživanja različitih autora, agilnost se definije kao kompleksno ispoljavanje motoričkih sposobnosti od kojih zavisi brzo i efikasno povezivanje promjena smjera i ponovnog ubrzanja i usporenenja uz stalnu kontrolu kretanja u vertikalnom, odnosno u horizontalnom smjeru (Drabik, J. 1996; Plisk, S.S. 2000; Verstegen, M., Marcello, B., 2001). Ubrzanje i usporenje kretanja, u horizontalnom i vertikalnom smjeru, podrazumijeva ispoljavanje snage kao motoričkog svojstva, pa uspješnost u kretanjima koja zahtijevaju agilnost zavisi od karakteristika ispoljavanja jačine i snage – sportisti koji za kraće vrijeme ispolje silu, odnosno, koji ispolje veću snagu, imaju očekivane preuslove neophodne za efikasnije ispoljavanje agilnosti.

Nogomet je kompleksna promjenjiva polistruklarna sportska igra, koju karakterišu ciklične i aciklične struktura kretanja (Jerković, 1982; Bajrić, 2008; Mandić Jelaska, Katić, & Jelaska, 2013). Sa aspekta fizioloških

laska, Katić, & Jelaska, 2013). From the point of view of physiological processes, football is an aerobic-anaerobic sport that demands a high intensity of different activities from players. However, there is a clear lack of research concerned with determining the impact of morphological characteristics on the results in agility tests in soccer players. Therefore, in this paper, it is necessary to determine and explain the manifestation of agility from the aspect of the influence of morphological characteristics of the body (longitudinal, transversal, circular dimensionality and body weight, and subcutaneous fatty tissue).

In previous studies, it has been established that in the movements of the maximum possible intensity with the change of direction, morphological characteristics behave as an inertial factor, that is, they make it difficult to change the direction and direction of movement (Grbović, 2013, Šehić & Sekulić, 2013, Pehar, 2016, Bajrić et al., 2018).

## METHOD OF WORK

### *Sample respondents*

The research was conducted on a sample of 50 respondents - cadet age footballers (14-16 years). The respondents are football school students: FK "BORAC" Banja Luka, FK "BSK" Banja Luka and FK "KRUPA" Krupa na Vrbasu.

### *Sample variables*

Variables for estimating morphological characteristics 12 variables were used to evaluate the morphological characteristics defined as the predicate set of variables. Measurement of morphological variables was carried out in accordance with the conditions laid down in the International Biological Program (IBP).

#### *Variables for estimating longitudinal dimensionality*

1. Body height ..... (AVISTL)
2. Leg length ..... (ADJUST)
3. Hand length ..... (ADDRESS)

#### *Variables for estimating the transversal dimensionality of the skeleton*

1. Biocromial raps ..... (ABIARA)
2. Knee diameter ..... (ADIJKO)
3. Hock diameter ..... (ADIJSZ)

#### *Variables for estimating dimensionality and body mass*

1. Body weight ..... (ARREST)
2. Tummy circumference ..... (AOPNAT)
3. Middle chest circumference ..... (ASROGK)

#### *Variables for estimating subcutaneous fat tissue*

1. Leather abdominal set ..... (NABTRB)
2. Leatherback set ..... (NABLEĐ)
3. Leather skirt ..... (NABPOT)

procesa fudbal je aerobno-anaerobni sport koji od fudbaleru zahtijeva visok intenzitet različitih aktivnosti. Međutim, očigledan je nedostatak istraživanja koja su se bavila utvrđivanjem uticaja morfoloških karakteristika na rezultate u testovima agilnosti kod nogometnika. Zato je u ovom radu potrebno utvrditi i objasniti ispoljavanje agilnosti sa aspekta uticaja morfoloških karakteristika tijela (longitudinalna, transverzalna, cirkularna dimenzionalnost i težina tijela, te potkožno masno tkivo).

U dosadašnjim istraživanjima utvrđeno je da se u kretanjima maksimalno moguće intenziteta sa promjenom pravca i smjera, morfološke karakteristike ponašaju kao inercioni faktori, odnosno, one otežavaju promjenu smjera i pravca kretanja (Grbović, 2013; Šišić & Sekulić, 2013; Pehar, 2016; Bajrić i sar., 2018).

## METOD RADA

### *Uzorak ispitanika*

Istraživanje je provedeno na uzorku od 50 ispitanika – fudbalera kadetskog uzrasta (14-16 godina). Ispitanici su polaznici fudbalskih škola: FK „BORAC“ Banja Luka, FK „BSK“ Banja Luka i FK „KRUPA“ Krupa na Vrbasu.

### *Uzorak varijabli*

#### *Varijable za procjenu morfoloških karakteristika*

Za procjenu morfoloških karakteristika definisanih kao prediktorski skup varijabli primijenjeno je 12 varijabli. Mjerenje morfoloških varijabli izvršeno je u skladu sa uslovima predviđenim u Internacionalnom biološkom programu (IBP).

#### *Varijable za procjenu longitudinalne dimenzionalnosti*

1. Visina tijela.....(AVISTL)
2. Dužina nogu.....(ADUŽNO)
3. Dužina ruku.....(ADUŽRU)

#### *Varijable za procjenu transverzalne dimenzionalnosti skeleta*

1. Biakromialni rapson.....(ABIARA)
2. Dijametar koljena.....(ADIJKO)
3. Dijametar skočnog zgoba.....(ADIJSZ)

#### *Varijable za procjenu dimenzionalnosti i mase tijela*

1. Težina tijela.....(ATEŽTJ)
2. Obim natkoljenice.....(AOPNAT)
3. Srednji obim grudnog koša.....(ASROGK)

#### *Varijable za procjenu potkožnog masnog tkiva*

1. Kožni nabor trbuha.....(NABTRB)
2. Kožni nabor leđa.....(NABLEĐ)
3. Kožni nabor potkoljenice.....(NABPOT)

### *Variables for assessing agility (criterion variables)*

Estimation of agility was carried out with running tests, which are otherwise used to assess agility, but which differ in each other according to the way, structure and duration of movement.

1. Run 93639OK with turn ..... MAG9OK,
2. Test 20 yards ..... MAG 20Y,
3. Running 4 x 5 meters with a change of direction below 900 and 1800 ..... AG4X5M,
4. T - agility test ..... MAG T.

All measurement procedures and all test protocols were in accordance with the standard methodological requirements pertaining to this type of research. Respondents explained the purpose of the research, as well as the protocols for measuring morphological characteristics and carrying out agility tests.

### **Data processing methods**

Respondents were tested using the same protocols for the quantification of morphological characteristics and agility. All testing agility tests were repeated twice. Measurement of morphological characteristics was organized separately, independently of the testing of agility and was carried out in the early morning hours. Measurement of the predicted morphological characteristics and agility tests was organized and conducted in the sports hall of the ŠŠC "Gemit" in Banja Luka.

For all applied variables, the basic descriptive parameters were calculated. Three regression analyses were used to determine the size and significance of the influence of the selected morphological characteristics on the results in agility tests.

### **RESULTS AND DISCUSSION**

Morphological characteristics were analyzed from the aspect of longitudinal, transversal and circular dimensionality and body weight, and subcutaneous fatty tissue parameters. The analysis of morphological characteristics was based on the basic descriptive parameters (Table 1) on the minimum and maximum values of the observed characteristics, as well as on the parameters of the central data tendency - Mean and standard deviation (St. Dev.).

Table 2 shows the values of the basic central and dispersion parameters of variables for estimating agility, as well as the coefficients of curvature and elongation. Based on the displayed values of arithmetic mean and median parameters (Table 2), it can be seen that the test results move within the normal distribution. The values of the curvature coefficient, that is, the Skewness coeffi-

### *Varijable za procjenu agilnosti (kriterijske varijable)*

Procjena agilnosti vršena je testovima trčanja koja se, inače, koriste za procjenu agilnosti, ali koja se međusobno razlikuju po načinu, strukturi i trajanju kretanja.

1. Trčanje 93639OK sa okretom.....MAG9OK,
2. Test 20 jardi.....MAG 20Y,
3. Trčanje 4 x 5 metara sa promjenom smjera pod 90° i 180°.....AG4X5M,
4. T – test agilnosti.....MAG T.

Sve procedure mjerena i svi protokoli testiranja bili su u skladu sa standardnim metodološkim zahtjevima koji se odnose na ovu vrstu istraživanja. Ispitanicima je objašnjen cilj istraživanja, kao i protokoli za mjerjenje morfoloških karakteristika i izvođenje testova za procjenu agilnosti.

### **Metode obrade podataka**

Ispitanici su testirani po istim protokolima za kvantifikaciju morfoloških karakteristika i agilnosti. Svi protokoli testiranja za procjenu agilnosti su ponavljeni dva puta. Mjerjenje morfoloških karakteristika bilo je organizованo posebno, nezavisno od testiranja agilnosti i realizovano je u ranim prijepodnevnim časovima. Mjerjenje predviđenih morfoloških karakteristika i testova agilnosti organizovano je i sprovedeno u sportskoj sali ŠŠC "Gemit" u Banja Luci.

Za sve primjenjene varijable izračunati su osnovni deskriptivni parametri. Za utvrđivanje veličine i značaja uticaja odabranih morfoloških karakteristika na rezultate u testovima agilnosti primjenjene su tri regresione analize.

### **REZULTATI I DISKUSIJA**

Morfološke karakteristike su analizirane sa aspekta longitudinalne, transverzalne i cirkularne dimenzionalnosti i mase tijela, te pokazatelja potkožnog masnog tkiva. Analiza morfoloških karakteristika vršena je na osnovu osnovnih deskriptivnih parametara (Tabela 1) o minimalnim i maksimalnim vrijednostima posmatranih karakteristika, kao i na osnovu parametara centralne tendencije podataka - aritmetičke sredine (Mean) i standarde devijacije (St. Dev.).

U tabeli 2 prikazane su vrijednosti osnovnih centralnih i disperzionih parametara varijabli za procjenu agilnosti, kao i koeficijenti zakrivljenosti i izduženosti. Na osnovu prikazanih vrijednosti parametara aritmetičke sredine i medijane (tabela 2) može se vidjeti da se rezultati testiranja kreću u okviru normalnosti distribucije. Vrijednosti koeficijenta zakrivljenosti, odnosno Skewne-

**Tabela 1.** Osnovni deskriptivni parametri varijabli za procjenu morfoloških karakteristika /  
**Table 1.** Basic descriptive parameters of variables for the estimation of morphological characteristics

Variable	Min	Max	Rang	Mean	St. Dev.	Skewness	Kurtosis
AVISTL	1660.0	1950.0	290.0	1801.9	65.11	-.138	-.522
ADUŽNO	960.0	1230.0	270.0	1064.5	54.7	.698	.652
ADUŽRU	72.8	93.0	20.2	819.0	39.8	.144	.508
ABIARA	31.0	45.0	14.0	382.1	36.1	-.091	-.485
ADIJKO	7.9	9.9	2.0	88.94	4.67	-.176	-.635
ADIJSZ	5.2	8.0	2.8	68.15	6.27	-.269	-.188
ATEŽTJ	509.0	1003.0	494.0	691.03	9.42	.808	1.672
AOPNAT	460.0	690.0	230.0	543.5	47.93	1.011	1.802
ASROGK	744.0	1050.0	306.0	867.5	64.36	.679	.744
NABTRB	40.0	293.0	253.0	102.4	4.70	1.993	4.936
NABLEĐ	60.0	127.0	67.0	82.4	1.92	.455	-.732
NABPOT	60.0	147.0	87.0	81.3	2.06	.873	.589

**Tabela 2.** Osnovni deskriptivni parametri varijabli za procjenu agilnosti /  
**Table 2.** Basic descriptive parameters of variables for agility assessment

Variable	Min.	Max.	Rang	Mean	St. Dev.	Skewness	Kurtosis
MAG9OK	7,45	9,89	2,44	8,72	0,55	0,157	-0,098
MAG 20Y	4,71	6,11	1,40	5,35	0,33	0,125	-0,343
AG4X5M	5,68	6,78	1,09	6,22	0,25	-0,006	-0,325
MAG T	9,26	11,13	1,86	10,23	0,48	-0,272	-0,947

cient in the asymmetry of all variables is closer to zero. Based on the value of the skewness, it can be concluded that the complete set of variables for evaluating agility satisfies the assumption of the normal distribution of the results, that is, the values of asymmetry and elongation in the applied variables are within the limits that satisfy the hypothesis of the normal distribution of results.

### Regression analysis

In order to determine the predictive values of the selected morphological characteristics marked as the input or predictor system of variables on the result effectiveness in agility tests for cadet age players, marked as a criterion, four multiple regression analyzes were applied. Based on the size of multiple regression (R<sup>2</sup>), the common variance (R Square) is explained only if it is statistically significant. If the multiplication of correlation is statistically significant, the determination of the individual variables on the result effectiveness in the realization of agility tests for cadet age players has been made.

ss koeficijent kod asimetrija svih varijabli je bliži nuli. Na osnovu vrijednosti skewnes-a može se zaključiti da kompletni set varijabli za procjenu agilnosti zadovoljava pretpostavku o normalnosti distribucije rezultata, odnosno vrijednosti asimetričnosti i izduženosti kod primijenjenih varijabli se nalaze u granicama koje zadovoljavaju hipotezu normalnog rasporeda rezultata.

### Regresiona analiza

U cilju utvrđivanja prediktivnih vrijednosti odabranih morfoloških karakteristika označenih kao ulazni ili prediktorski sistem varijabli na rezultatsku uspješnost u testovima za procjenu agilnosti kod fudbalera kadetskog uzrasta, označenih kao kriterij, primijenjene su četiri multiple regresione analize. Na osnovu veličine multiple regresije (R<sup>2</sup>) objašnjena je zajednička varijansa (R Square) samo onda ako je statistički značajna. Ako je multipla korelacija statistički značajna pristupilo se utvrđivanju pojedinačnih varijabli na rezultatsku uspješnost u realizaciji testova za procjenu agilnosti kod fudbalera kadetskog uzrasta.

### Regression analysis of the criterion variable MAG9OK- running 93639m with a turn (frontal agility).

The results of the regression analysis of the criterion variable (MAG9OK), which evaluates the frontal agility-running of the given distances with rotation, are shown in Table 2. By looking at the given table it can be seen that the predictor system of variables did not show a statistically significant connection in the prediction of the criterion variable MAG9OK- running 93639m with a reversal, and no analysis of the relative impact of each individual predictor on the criterion will be made.

### Regresiona analiza kriterijske varijable MAG9OK- trčanje 93639m sa okretom (frontalna agilnost).

Rezultati regresione analize kriterijske varijable (MAG9OK), kojom se procjenjuje frontalna agilnost-trčanje zadatih distanci sa okretom prikazani su u tabeli 2. Uvidom u datu tabelu može se vidjeti da prediktorski sistem varijabli nije pokazao statistički značajnu povezanost u predikciji kriterijske varijable MAG9OK- trčanje 93639m sa okretom, te se neće pristupiti analizi relativnog uticaja svakog pojedinačnog prediktora na kriterij.

**Tabela 3.** Rezultati regresione analize kriterijske varijable MAG9OK- trčanje 93639m sa okretom /  
**Table 3.** Results of the regression analysis of the criterion variable MAG9OK- running 93639m with a turn

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,372a	,139	-,126	5.84069

**Predictors:** (Constant), NABPOT, ABIARA, ADUŽNO, ADIJSZ, NABTRB, ADIJKO, AOPNAT, NABLEĐ, AVISTL, ASROGK, ADUŽRU, ATEŽTJ

#### ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regresion	214.240	12	17.853	,523	.886b
Residual	1330.433	39	34.114		
Total	1544.673	51			

- a. Dependent Variable: MAG9OK
- b. Predictors: (Constant), NABPOT, ABIARA, ADUŽNO, ADIJSZ, NABTRB, ADIJKO, AOPNAT, NABLEĐ, AVISTL, ASROGK, ADUŽRU, ATEŽTJ

Model	Unstandardized Coefficients B Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	161.264	46.926	3.437	.001
AVISTL	-6.787E-5	.003	-,008	-,025
ADUŽNO	-3.000E-5	.002	-,003	-,012
ADUŽRU	-,005	.004	-,341	-,1.109
ABIARA	,000	.003	-,030	-,159
ADIJKO	-,023	.024	-,192	-,927
ADIJSZ	-,008	.019	-,087	-,399
ATEŽTJ	,060	.033	1.025	1.812
AOPNAT	-,005	.004	-,407	-,1.132
ASROGK	-,003	.003	-,302	-,953
NABTRB	-,013	.027	-,111	-,490
NABLEĐ	,042	.063	,145	,664
NABPOT	-,032	.053	-,119	-,596

**Legenda:** R – koeficijent multiple korelacije; R2 - koeficijent determinacije, Beta – standardizovani regresioni koeficijenti; t – t test; Sig. – statistička značajnost /

**Legend:** R - multi-correlation coefficient; R2 - determination coefficient, Beta - standardized regression coefficients; t - t test; Sig. - statistical significance

### Regression analysis of the criterion variable MAG 20Y - test running 20 yards (change of direction of movement by reversal, reverse run)

The results of the regression analysis of the criterion variable (MAG20Y), which evaluates the agility by changing the direction of rotation, reverse run, are shown in Table 3. By looking at the given table it can be

### Regresiona analiza kriterijske varijable MAG 20Y – test trčanje 20 yardi (promjena smjera kretanja okretom, povratno trčanje)

Rezultati regresione analize kriterijske varijable (MAG20Y), kojom se procjenjuje agilnost promjenom smjera kretanja okretom, povratno trčanje prikazani su u tabeli 3. Uvidom u datu tabelu može se vidjeti da pre-

**Tabela 4.** Rezultati regresione analize kriterijske varijable MAG20Y- trčanje 20 yardi/

**Table 4.** Results of regression analysis of the criterion variable MAG20Y- running 20 yards

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.553a	.306	.093	3.19820

**Predictors:** (Constant), NABPOT, ABIARA, ADUŽNO, ADIJSZ, NABTRB, ADIJKO, AOPNAT, NABLEĐ, AVISTL, ASROGK, ADUŽRU, ATEŽTJ

### ANOVA

Model	Sum of Squares	df	Mean Square	f	Sig.
1 Regresion	176,167	12	14,681	1,435	.192b
Residual	398,910	39	10,228		
Total	575,077	51			

a. Dependent Variable: MAG 20Y

b. Predictors: (Constant), NABPOT, ABIARA, ADUŽNO, ADIJSZ, NABTRB, ADIJKO, AOPNAT, NABLEĐ, AVISTL, ASROGK, ADUŽRU, ATEŽTJ

Model	Unstandardized Coefficients B Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	63,642 25,695		2.477	.018
AVISTL	.002 .001	.448	1.560	.127
ADUŽNO	.000 .001	.041	.191	.850
ADUŽRU	-.003 .002	-.354	-1.285	.206
ABIARA	.002 .002	.186	1.101	.278
ADIJKO	-.025 .013	-.341	-1.840	.073
ADIJSZ	.000 .010	-.007	-.038	.970
ATEŽTJ	.025 .018	.706	1.392	.172
AOPNAT	-.004 .002	-.636	-1.971	<b>.056</b>
ASROGK	-.001 .001	-.124	-.436	.665
NABTRB	.016 .015	.231	1.132	.265
NABLEĐ	-.047 .034	-.270	-1.375	.177
NABPOT	.003 .029	.016	.092	.927

**Legenda:** R – koeficijent multiple korelacije; R2 - koeficijent determinacije, Beta – standardizovani regresioni koeficijenti; t – t test; Sig. – statistička značajnost /

**Legend:** R - multi-correlation coefficient; R2 - determination coefficient, Beta - standardized regression coefficients; t - t test; Sig. - statistical significance

seen that the predictor system of the selected morphological variables does not show a statistically significant relationship in the prediction of the criterion variable MAG20Y- reversing direction, reverse run. However, a statistically significant partial impact on the MAG20Y

diktorski sistem odabranih morfoloških varijabli ne pokazuje statistički značajnu povezanost u predikciji kriterijske varijable MAG20Y- promjena smjera kretanja okretom, povratno trčanje. Međutim, statistički značajan parcijalni uticaj na kriterijsku varijablu MAG20Y poka-

criterion variable showed the variability of the circumference of tonsillitis (AOBNAT, 056), and the variable diameter of the knee was also significant (ADJKO, 0739).

#### Regression analysis of the criterion variable

#### AG4X5M - running 4 x 5 meters with a change in the direction of running at an angle of 90° and 180° (angle changes in direction of movement)

The results of the regression analysis of the criterion variable AG4X5M, which evaluates the agility with angular changes in the direction of movement, the movement with the change of the direction of movement at an angle of 90 and 180 degrees are shown in Table 4. By looking at the given table it can be seen that the regression analysis of the criterion variable AG4X5M gives satisfactory information on the significance and magnitude of the impact of the applied morphological variables on the speed of movement with angular changes in direction. The prediction system of selected morphological characteristics explained 42% of the common variability of the criterion variable. The value of the multi-correlation coefficient is relatively high and amounts to ( $R =$

zala je varijabla obim natkoljenice (AOBNAT, 056), a na samoj granici značajnosti je i varijabla dijametar koljena (ADJKO, 0739).

#### Regresiona analiza kriterijske varijable

#### AG4X5M – trčanje 4 x 5 metara sa promjenom smjera trčanja pod uglom od 90° i 180° (ugaone promjene smjera kretanja)

Rezultati regresione analize kriterijske varijable AG4X5M, kojom se procjenjuje agilnost sa ugaonim promjenama smjera kretanja, kretanje sa promjenom smjera kretanja pod uglom od 90 i 180 stepeni prikazani su u tabeli 4. Uvidom u datu tabelu može se vidjeti da regresiona analiza kriterijske varijable AG4X5M daje zadovoljavajuće informacije o značaju i veličini uticaja primijenjenih morfoloških varijabli na brzinu kretanja sa ugaonim promjenama smjera. Prediktorskim sistemom odabranih morfoloških karakteristika objašnjeno je 42% zajedničkog varijabiliteta kriterijske varijable. Vrijednost koeficijenta multiple korelacije je relativno visok i iznosi ( $R = .65$ ), i u visokoj statističkoj signifikantnosti strogog

**Tabela 5.** Rezultati regresione analize kriterijske varijable AG4X5M-sa promjenom smjera pod uglom 90° i 180° /  
**Table 5.** Results of regression analysis of the criterion variable AG4X5M-with change of direction at an angle of 90° and 180°

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate			
1	.651a	.423	.246	2.18795			
<b>ANOVA</b>							
Model		Sum of Squares	df	Mean Square	f	Sig.	
1 Regresion		137,052	12	11,421	2,386	.020b	
Residual		186,698	39	4,787			
Total		323,750	51				

a. Dependent Variable: AG4X5M

b. Predictors: (Constant), NABPOT, ABIARA, ADUŽNO, ADIJSZ, NABTRB, ADJKO, AOPNAT, NABLEĐ, AVISTL, ASROGK, ADUŽRU, ATEŽTJ

Model	Unstandardized Coefficients B Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	83,188 17,579		4,732	.000
AVISTL	.001 .001	.297	1.135	.263
ADUŽNO	.000 .001	.099	.498	.621
ADUŽRU	-.002 .002	-.278	-1.107	.275
ABIARA	.002 .001	.350	2.265	.029
ADJKO	-.026 .009	-.474	-2.806	.008
ADIJSZ	.000 .007	-.003	-.015	.988
ATEŽTJ	.031 .012	1.165	2.517	.016
AOPNAT	-.003 .002	-.490	-1.665	.104
ASROGK	-.003 .001	-.789	-3.045	.004
NABTRB	.021 .010	.385	2.071	.045
NABLEĐ	-.029 .023	-.219	-1.223	.229
NABPOT	.011 .020	.093	.572	.571

a. Dependent Variable: AG4X5M

.65), and in the high statistical significance of a strict criterion, it is .020. By looking at the value of the individual effects of morphological variables on the speed of movement with angular changes in the direction of movement (AG4X5M), the following interesting information can be noted: The statistical statistically significant influence of the predictor variables on the criterion variable has made the following variables:

- variable ABIARA - bi-chromium range. The value of the partial coefficient BETA is .350, which is significant at the level  $p = .029$ .
- variable ADIJKO - knee diameter. The value of the partial coefficient BETA is -.474, which is significant at the level  $p = .008$ .
- variable ATEŽTJ – the weight of the body. The value of the partial coefficient BETA is 1.165, which is significant at the level  $p = .016$ .
- variable ASROGK – a middle volume of the chest. The value of the partial coefficient BETA is -.789, which is significant at the level  $p = .004$ .
- variable ANATRB-abdomen. The value of the partial coefficient BETA is .385, which is significant at the level  $p = .045$ .

kriterija i iznosi .020. Uvidom u vrijednost pojedinačnih uticaja morfoloških varijabli na brzinu kretanja sa ugaonim promjenama smjera kretanja (AG4X5M) mogu se primijetiti sljedeće interesantne informacije: Parcijalni statistički značajan uticaj prediktorskih varijabli na kriterijsku varijablu ostvarile su sljedeće varijable:

- varijabla ABIARA – biakromijalni raspon. Vrijednost parcijalnog koeficijenta BETA iznosi .350, što je značajno na nivou  $p = .029$ .
- varijabla ADIJKO – dijametar koljena. Vrijednost parcijalnog koeficijenta BETA iznosi -.474, što je značajno na nivou  $p = .008$ .
- varijabla ATEŽTJ – težina tijela. Vrijednost parcijalnog koeficijenta BETA iznosi 1.165, što je značajno na nivou  $p = .016$ .
- varijabla ASROGK – srednji obim grudnog koša. Vrijednost parcijalnog koeficijenta BETA iznosi -.789, što je značajno na nivou  $p = .004$ .
- varijabla ANATRB – nabor trbuha. Vrijednost parcijalnog koeficijenta BETA iznosi .385, što je značajno na nivou  $p = .045$ .

**Tabela 6.** Rezultati regresione analize kriterijske varijable MAGT-kombinovana agilnost /  
**Table 6.** Results of the regression analysis of the criterion variable MAGT-combined agility

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.593a	.352	.152	4,44285

#### ANOVA

Model	Sum of Squares	df	Mean Square	f	Sig.
1 Regresion	417,951	12	34,829	1,764	.090b
Residual	769,818	39	19,739		
Total	1187,769	51			

a. Dependent Variable: MAGT – T

b. Predictors: (Constant), NABPOT, ABIARA, ADUŽNO, ADIJSZ, NABTRB, ADIJKO, AOPNAT, NABLEĐ, AVISTL, ASROGK, ADUŽRU, ATEŽTJ

Model	Unstandardized Coefficients B Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	86,472 35,695		2,423	.020
AVISTL	.005 .002	.624	2,249	<b>.030</b>
ADUŽNO	-.003 .002	-.334	-1.593	.119
ADUŽRU	.003 .003	-.222	.833	.410
ABIARA	-.002 .002	-.165	-1.007	.320
ADIJKO	-.006 .019	-.061	-.342	.734
ADIJSZ	-.019 .015	-.244	-1.294	.203
ATEŽTJ	.009 .025	.181	.370	.714
AOPNAT	-.001 .003	-.107	-.343	.733
ASROGK	.004 .002	-.552	-2.009	<b>.052</b>
NABTRB	.048 .020	.466	2.363	<b>.023</b>
NABLEĐ	-.022 .048	-.086	-.452	.654
NABPOT	.011 .040	.048	.277	.783

a. Dependent Variable: MAGT

### Regression analysis of the criterion variable

#### MAGT - T test agility (combined agility)

The results of the regression analysis of the criterion variable (MAGT), which evaluates the combined agility with multiple agility types, are shown in Table 5. By looking at the given table it can be seen that the predictor system of the selected morphological variables does not show a statistically significant association of the selected morphological variables in the prediction of the criterion variable MAGT-T agility test (combined agility). However, statistically significant partial impact on the criterion variable MAG20Y is observed in the following variables: body height (AVISTL, 030), middle chest circumference (ASROGK, 052) and skin abdomen (ANATRB, 023). Although statistically significant influence of the entire system of predictor variables on the combined agility test has not been achieved, one must not neglect the individual influence of morphological features on the resultant success of combined agility.

From the aspect of the aim of the research, it is important to determine and explain the magnitude and significance of the influence of the selected morphological characteristics on the resultant performance in agility tests as a complex motor characteristic. On the basis of the obtained results of regression analysis, the relatively weak influence of the selected morphological characteristics in this study on the results in the treated agility assays can be noted. The statistically significant influence of the applied morphological characteristics of the four applied agility tests is noticed only in the movement speed test with angular motion direction changes (AG4X5M). However, at global level, the influence of the applied morphological characteristics on the agility test MAG 20Y - running with changing direction of rotation, reverse run and MAG T - running with several types of agility has not been statistically significant, but the partial influence of some morphological features is evident. These are: AOPNAT, body height (AVISTL), abdominal set (NABTRB) and middle chest circumference (ASROGK), and at the very border of statistical significance is the measure of knee diameter (ADJKO). The applied morphological features did not achieve statistically significant correlation with agility tests (MAG9OK) running 9, 3, 6, 3 and 9-meter short shots with rotation, either globally or partially.

The obtained results can be explained from the aspect of the specificity of the tested sample of the respondents, their age categories, i.e., knowledge of the laws of growth and development in relation to the age period - heterochronism of development (Šišić & Sekulić, 2013; Bajrić

### Regresiona analiza kriterijske varijable MAGT –

#### T test agilnosti (kombinovana agilnost)

Rezultati regresione analize kriterijske varijable (MAGT), kojom se procjenjuje kombinovana agilnost sa više tipova agilnosti, prikazani su u tabeli 5. Uvidom u datu tabelu može se vidjeti da prediktorski sistem odabralih morfoloških varijabli ne pokazuje statistički značajnu povezanost odabralih morfoloških varijabli u predikciji kriterijske varijable MAGT- T test agilnosti (kombinovana agilnost). Međutim, uočljiv je statistički značajan parcijalni uticaj na kriterijsku varijablu MAG20Y sljedećih varijabli: visina tijela (AVISTL, 030), srednji obim grudnog koša (ASROGK, 052) i kožni nabor trbuha (ANATRB, 023). Iako nije postignut statistički značajan uticaj cjelokupnog sistema prediktorskih varijabli na kombinovani test agilnosti, ne smije se zanemariti pojedinačni uticaj morfoloških odlika na rezultatsku uspješnost kombinovane agilnosti.

Sa aspekta cilja istraživanja značajno je da se utvrdi i objasni veličina i značaj uticaja odabralih morfoloških karakteristika na rezultatsku uspješnost u testovima za procjenu agilnosti kao kompleksnog motoričkog svojstva. Na osnovu dobijenih rezultata regresionih analiza može se konstatovati relativno slab uticaj odabralih morfoloških karakteristika u ovom istraživanju na rezultate u tretiranim testovima za procjenu agilnosti. Statistički značajan uticaj primijenjenih morfoloških karakteristika od četiri primijenjena testa agilnosti, uočljiv je jedino kod testa brzine kretanja sa ugaonim promjenama smjera kretanja (AG4X5M). Međutim, na globalnom nivou, uticaj primijenjenih morfoloških karakteristika na test agilnosti MAG 20Y - trčanje sa promjenom smjera kretanja okretom, povratno trčanje i MAG T - trčanje sa više tipova agilnosti, nije utvrđen statistički značajan uticaj, ali je uočljiv parcijalni uticaj nekih morfoloških odlika kao što su: opseg natkoljenice (AOPNAT), tjelesna visina (AVISTL), nabor trbuha (NABTRB) i srednji obim grudnog koša (ASROGK), a na samoj granici statističke značajnosti je i mjeru dijametar koljena (ADJKO). Primijenjene morfološke odlike nisu ostvarile statistički značajnu povezanost sa testom agilnosti (MAG9OK) trčanje kratkih dionica od 9, 3, 6, 3 i 9 metara sa okretom, niti na globalnom niti na parcijalnom nivou.

Dobijeni rezultati mogu se objasniti sa aspekta specifičnosti ispitivanog uzorka ispitanika, njihove uzrasne kategorije tj. poznavanjem zakonitosti rasta i razvoja u odnosu na uzrasni period – heterohronost razvoja (Šišić & Sekulić, 2013; Bajrić i sar., 2018). Starosna dob ispitanika – kadeta je u rasponu od dvije godine (14-16 godina) što može biti jedan od razloga ovako dobijenih rezultata. U

et al., 2018). The age of the respondents - cadets ranges from two years (14-16 years old), which can be one of the reasons for these results. Overall, the results of this study clearly show that the influence of the selected morphological characteristics on the results in agility tests is different, that is, informativeness in terms of measured properties obtained in various agility tests is not the same.

The correlation between selected indicators for the assessment of morphological characteristics and applied agility tests is similar to those obtained by other researchers (Pearson, 2001; Grbović, 2013; Spasić, 2013; Pehar, 2016; Sekulić et al., 2013; Bajrić et al., 2018).

## CONCLUSION

The obtained results of the research contribute to solving the set goal and are in the function of obtaining significant information on the size and significance of the influence of the selected morphological characteristics on the results in the agility tests in cadets in football. Although the results of the research generally point to the relatively low influence of the selected morphological characteristics on the agility of the football cadets, a significant influence of some morphological characteristics on certain agility tests is evident, depending on the presence and duration of the acceleration and deceleration phases, as well as the changes in the direction of movement. A significant influence of the selected morphological characteristics is visible in the AG4X5M agility test with a change in the direction of running at an angle of 90° and 180°.

Bearing in mind the wide spectrum and the high level of complexity of different structures of soccer movements (in relation to the intensity, duration, complexity, as well as in relation to the openness and closeness of motion conditions), the authors of this paper consider that the influence of morphological characteristics on agility tests is not entirely possible to explain without respect to other anthropological characteristics of the footballers (motor, functional, cognitive, conative), that is, without taking their interactions into account. Similarly, the explanation of agility as a complex motor characteristic implies an appreciation of morphological and psychological characteristics and motor skills and abilities (Lačić & Bajrić, 2003; Marković, & Bradić, 2008).

However, the results obtained can be of benefit to trainers who work with younger age categories of footballers from the aspect of better quality and more meaningful programming of the contents of the training work of the football players.

The authors of this paper are aware that this research is one of the few studies that deals with the problem of

cjelini posmatrano, rezultati ovog istraživanja jasno ukazuju da je uticaj odabranih morfoloških karakteristika na rezultate u testovima za procjenu agilnosti različit, odnosno da informativnost u pogledu mjerenoj svojstva dobijena u različitim testovima za procjenu agilnosti nije ista.

Povezanost izabralih pokazatelja za procjenu morfoloških karakteristika i primjenjenih testova za procjenu agilnosti slična je sa rezultatima do kojih su došli i drugi istraživači (Pearson, 2001; Grbović, 2013; Spasić, 2013; Pehar, 2016; Sekulić i sar., 2013; Bajrić i sar., 2018).

## ZAKLJUČAK

Dobijeni rezultati istraživanja doprinose rješavanju postavljenog cilja i u funkciji su dobijanja značajnih informacija o veličini i značaju uticaja odabranih morfoloških karakteristika na rezultate u testovima za procjenu agilnosti kod kadeta u fudbalu. Iako rezultati istraživanja generalno ukazuju na relativno slab uticaj odabranih morfoloških karakteristika na agilnost kod kadeta u fudbalu, ipak je vidljiv značajan uticaj nekih morfoloških karakteristika na određene testove agilnosti, u zavisnosti od zastupljenosti i trajanja faza ubrzanja i usporena, kao i od promjena smjera kretanja. Značajan uticaj odabranih morfoloških karakteristika vidljiv je kod testa agilnosti **AG4X5M**-sa promjenom smjera trčanja pod uglom 90° i 180°.

Imajući u vidu širok spektar i visok nivo kompleksnosti različitih struktura kretanja u fudbalu (u odnosu na intenzitet, trajanje, složenost, kao i u odnosu na otvorenost i zatvorenost uslova kretanja), autori ovog rada smatraju da uticaj morfoloških karakteristika na testove agilnosti nije moguće u potpunosti objasniti bez uvažavanja i drugih antropoloških karakteristika fudbalera (motoričkih, funkcionalnih, kognitivnih, konativnih), odnosno, bez uzimanja u obzir njihovih međusobnih interakcija. Isto tako, objašnjenje agilnosti, kao kompleksnog motoričkog svojstva, podrazumijeva uvažavanje i morfoloških i psiholoških karakteristika i motoričkih sposobnosti i vještine (Lačić & Bajrić, 2003; Marković, & Bradić, 2008).

Ipak, dobijeni rezultati mogu biti od koristi trenerima koji rade sa mlađim uzrasnim kategorijama fudbalera sa aspekta kvalitetnijeg i svrshishodnjeg programiranja sadržaja trenažnog rada fudbalera.

Autori ovog rada su svjesni da ovo istraživanje predstavlja jednu od rijetkih studija koje se bavi problemom istraživanja povezanosti morfoloških karakteristika i agilnosti kod fudbalera kadetskog uzrasta, pa dobijene rezultate treba uzeti sa odgovarajućom rezervom, ali koji se mogu koristiti u nekim narednim istraživanjima.

researching the correlation between morphological characteristics and agility in cadet age footballers, and the results obtained should be taken with appropriate reserves, but can be used in some subsequent research.

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Primljen: 21. februar 2019. / Received: February 21, 2019.

Prihvaćen: 04. april 2019. / Accepted: April 04 , 2019.

## STUDENTS' LEVEL OF STRESS AS RELATED TO SOME INDICATORS OF LIFESTYLE

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**Abstract:** A 15-item questionnaire for assessment of stress was applied on a sample of 332 students (age from 19 to 27, 184 males and 148 females). It has been found that over 40% of students have elevated stress levels. The empirical results significantly deviated from the normal distribution. Two groups of participants stood out; the greater group had very elevated levels of stress, while the smaller group had very low average values. When answering questions related to stress, respondents evaluated three elements of lifestyle: the quantity and quality of everyday physical activity, subjective feeling of health and regularity of health checks. Results show that students are not active enough physically and that they rarely check their health. The analysis of variance showed that the highest level of stress is present in students who rated themselves as passive sports lovers, while athletes, amateurs and unexpectedly those who are anti-sports expressed significantly lower levels of stress. Significantly higher levels of stress were present in students who rated their health as poor, while respondents who regularly check their health had the lowest level of stress. Men had higher levels of stress than women.

**Keywords:** students, stress, physical activity, lifestyle, health.

### INTRODUCTION

Stress occurs as a result of person's reactions to life's circumstances in which he or she operates. In literature it is often defined as interaction of an individual and the environment (Lazarus & Folkman, 2004). In the context of human emotions and conflicts (Svićević, 2003) stress is connected to specific mechanisms in the central nervous system. There is positive and negative stress (Watson &

## NIVO STRESA STUDENATA U ODNOSU NA NEKE POKAZATELJE ŽIVOTNOG STILA

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**Apstrakt:** Na uzorku od 332 studenata koji studiraju oblast sporta i turizma (starosti 19-27 godina, 184 muškog i 148 ženskog pola) konstruisan je 15-ajtemske upitnik za procenu stresa. Njegovom primenom utvrđeno je da preko 40% studenata ima povećan nivo stresa. Empirijski rezultati značajno su odstupali od normalne distribucije. Izdvojile su se dve grupe ispitanika od kojih je veća imala veoma visok nivo stresa, dok je manja imala veoma niske prosečne vrednosti. Prilikom rešavanja upitnika o stresu, ispitanici su izvršili samoprocenu tri elementa životnog stila: količinu i kvalitet dnevne fizičkih aktivnosti, subjektivni osećaja zdravlja i redovnost zdravstvene kontrole. Rezultati pokazuju da studenti nedovoljno učestvuju u doziranim fizičkim aktivnostima i da veoma retko kontrolišu svoje zdravlje. Analiza varijanse je pokazala da najviši nivo stresa imaju studenti koji su sebe označili kao pasivne ljubitelje sporta, dok su sportisti, rekreativci i neočekivano antisportisti ispoljili značajno niži nivo stresa. Signifikantno veći nivo stresa imali su i studenti koji su svoje opšte zdravlje ocenili kao slabo, dok su najniži stres imali ispitanici koji redovno kontrolišu svoje zdravlje. Muškarci su imali viši nivo stresa od svojih koleginica.

**Ključne riječi:** studenti, stres, fizičke aktivnosti, životni stil, zdravlje.

### UVOD

Stres se javlja kao posledica reagovanja pojedinca na životne okolnosti u kojima deluje. U literaturi se često definiše kao interakcija pojedinca i okoline (Lazarus & Folkman, 2004). Stres se u kontekstu ljudskih emocija i konflikata (Svićević, 2003) vezuje za odredene mehanizme u centralnom nervnom sistemu. Postoji pozitivni i negativni stres (Watson & Pennebaker, 1989). Distres

Pennebaker, 1989). Distress is a term for the stress that has harmful or unpleasant health effects: headaches, stomach problems, etc. It provokes feelings of anger, sadness or fear in people. The person feels like they are under pressure and this makes them nervous. Positive stress motivates people to give their best in a given situation. It can make people feel both nervous and excited. This research deals with the level of negative stress in students in the context of an active lifestyle model (Sharrkey & Gaskill, 2013).

The student population is a growing part of society and perhaps most affected by current life events. This problem is especially pronounced in the recent years since the universities in Serbia abolished compulsory physical education. Some researches done in Serbia (Nešić & Kuburović, 2011; Nešić & Kovačević, 2011; Međedović, Perić & Ahmetović, 2013; Ahmetović, Perić, Međedović, Đokić & Romanov, 2014) indicate a lack of physical activities and a very poor knowledge about healthy habits among youth.

Some studies (Stepanović, Videnović & Plut, 2009; Grandić & Letić, 2009; Nešić, Perić, Ahmetović & Zubanov, 2014) show an increase in negative habits among students which present a health risk: improper and irregular diet, sedentary lifestyle, smoking, alcohol consumption, drug use. These studies clearly show that young people and especially students do not lead lifestyles that are sufficiently healthy.

The sources of stress are external (environmental impact) and internal (own emotions). According to a study of American Psychological Association (Norman et al., 2014) which was conducted on a large number of respondents, the most common sources of stress in students are school obligations, exams and a lack of time for hobbies. Although it was confirmed that the level of stress greatly depends on students' personality and previous habits, the effects of stress in the majority of students are very similar and are expressed in the form of: anxiety, impaired communication with colleagues, insomnia, headaches, stomach problems and so on. It is very significant that physical activity has been identified as one of the most common mechanisms of combating stress. After music, which is in 48% of cases used for relieving stress, the second most common anti-stressor was exercise or walking (used by about 43% of students). Plenty of researches (Godin & Kok, 1996; Pierro, Mannetti & Livi, 2003; Kvaak, Meyer & Tverdal, 2004; Nešić & Kovačević, 2011; Myint et al., 2007; Sharrkey & Gaskill, 2013) demonstrated a positive connection of other healthy habits, in addition to moderate physical activity, to low levels of stress among students (the absence of smoking and alcohol, a proper diet, regular health checks). On the basis of these results the attitude that stress can be managed was formed, namely, that it can be influ-

je termin za stres koji ima štetan ili neprijatan učinak po zdravlje: glavobolje, stomačne tegobe i sl. On kod osoba izaziva osećanje ljutnje, tuge ili straha. Osoba se oseća kao da je pod pritiskom i to je čini nervoznom. Pozitivan stres motiviše ljude da daju svoj maksimum u određenoj situaciji. On može učiniti da se osoba istovremeno oseća i nervozno i uzbudeno. Ovo istraživanje bavi se nivoom negativnog stresa kod studenata, u kontekstu modela aktivnog životnog stila (*active lifestyle*) (Sharrkey & Gaskill, 2013).

Studentska populacija je sve brojniji deo društva i možda je najviše na udaru aktuelnih životnih pojava. Ovaj problem naročito je izražen poslednjih godina od kada je na univerzitetima u Srbiji ukinuto obavezno fizičko vežbanje. Neka od istraživanja rađena u Srbiji (Nešić & Kuburović, 2011; Nešić & Kovačević, 2011; Međedović, Perić & Ahmetović, 2013; Ahmetović, Perić, Međedović, Đokić & Romanov, 2014) ukazuju na nedovoljnu zastupljenost fizičkog vežbanja omladine, ali i na veoma nizak nivo znanja o zdravim životnim navikama kod mlađih. Pojedine studije (Stepanović, Videnović & Plut, 2009; Grandić & Letić, 2009; Nešić, Perić, Ahmetović & Zubanov, 2014) u kazuju na trend porasta negativnih životnih navika kod studenata koje su rizične po zdravlje: nepravilna i neredovna ishrana, sedentarni način života, pušenje, konzumiranje alkohola, upotreba narkotika. Ova istraživanja nedvosmisleno pokazuju da zdravi stilovi života nisu u dovoljnoj meri zastupljeni kod mlađih, posebno studenata.

Izvori stresa su spoljašnji (uticaj okoline) i unutrašnji (sopstvene emocije). Prema podacima studije američke asocijacije psihologa (*American Psychological Association*) (Norman at al., 2014) sprovedene na velikom broju ispitanika, najčešći izvori strasa kod studenata su školske obaveze, ispiti i nedostatak vremena za hobi. Iako je utvrđeno da nivo stresa dosta zavisi od strukture ličnosti studenata i prethodnih navika, posledice pojave stresa kod većine studenata su veoma slične i ispoljavaju se u vidu: nervoze, poremećene komunikacije sa kolegama, nesanice, glavobolje, stomačnih problema itd. Veoma je značajno da je fizička aktivnost identifikovana kao jedan od najčešćih mehanizama borbe protiv stresa. Nakon muzike koja je u 48% slučajeva korišćena u otklanjanju stresa, drugi najčešće korišćeni antistresor bio je vežbanje i ili pešačenje (koristi ih oko 43% studenata). Dosta je istraživanja (Godin & Kok, 1996; Pierro, Mannetti & Livi, 2003; Kvaak, Meyer & Tverdal, 2004; Nešić & Kovačević, 2011; Myint et al., 2007; Sharrkey & Gaskill, 2013) u kojima je, osim za doziranu fizičku aktivnost, dokazana pozitivna veza i drugih zdravih ži-

enced by a healthy lifestyle. The subject of this study was to examine relations between some elements of a healthy lifestyle and students' stress levels.

The main goal of this research was to identify stress levels in students that were included in the sample. For its realization, it was necessary to construct a doubly valid, reliable and discriminative instrument. It is a questionnaire that is applicable in everyday (field) work with students, and not only in this research but also in the future similar researches. Special attention was paid to numerical expression of stress levels enabling the comparison of this research results to research results in other countries and application of parametrical statistical procedures. The difference in the levels of stress among participants of different social backgrounds related to health culture was precisely quantified in this research.

### METHODS AND MATERIALS

This empirical research is of transversal character. By applying a questionnaire that was intentionally designed for this, 332 students (184 men and 148 women) from Serbian province of Vojvodina were evaluated for stress. The age of respondents ranged between 19 and 27 years. The sample was formed by random selection of students from 6 colleges. According to the Republic Institute for Statistics ([webrzs.stat.gov.rs](http://webrzs.stat.gov.rs)), the total number of students in Serbia is around 229.000, indicating that the confidence interval on the sample of respondents was 5.37 with a confidence level of 95% ([Sample size calculator of surveysystem.com](http://Sample size calculator of surveysystem.com)). These parameters of the sample are completely acceptable for the purposes of this anthropological study.

In previous pilot studies a 10-item questionnaire proposed by American Psychological Association (Norman et al., 2014) with a 10 point scale was tested on several groups of students. All the trials that preceded this study didn't result in a sufficiently high Cronbach's alpha (it was in the range from 0.32 to 0.42), so the questionnaire was expanded with additional 14 items taken from DASS questionnaire (Antony, Bieling, Cox, Enns, Swinson, 1998), which has been designed as a scale for stress assessment in young adults. Respondents expressed their feelings by selecting one out of five positions on the Likert scale where score 0 represented total rejection and score 4 full acceptance of these claims. After several pilot studies and metrics testing of that expanded and adapted questionnaire, out of 24 statements only 15 items were kept which met metric requirements. Metrics of the questionnaire was tested via two methods: (1) Scale reliability analysis based on Cronbach's alpha (Table 1) and (2) Factor analysis, Principal components analysis (PCA), with direct Oblimin

votnih navika sa niskim nivoom stresa kod studenata (odsustvo pušenja i alkohola, pravilan način ishrane, redovne kontrole zdravlja). Na osnovu toga formiran je stav da se stres može kontrolisati, tj. da se na njega može uticati primenom zdravih stilova života. Relacije nekih elementa zdravog stila života i nivoa stresa studenata bile su predmet ove studije.

### METODE I MATERIJAL

Ovo je empirijsko istraživanje transferzalnog karaktera. Primenom namenski konstruisanog upitnika izvršena je procena stresa 332 studenata (184 muškarca i 148 žena) srpske pokrajine Vojvodina, koji studiraju fakultete iz oblasti sporta i turizma. Starost ispitanika bila je u rasponu od 19 do 27 godina. Uzorak je formiran slučajnim izborom studenata 6 fakulteta. Prema podacima Republičkog Zavoda za statistiku ([webrzs.stat.gov.rs](http://webrzs.stat.gov.rs)), ukupan broj studenata u Srbiji iznosi oko 229.000, što pokazuje da je *Confidence Interval* na primjenom uzorku ispitanika bio 5,37 sa nivoom pouzdanosti od 95% ([Sample Size Calculator of SurveySystem.com](http://Sample Size Calculator of SurveySystem.com)). Navedeni parametri uzorka potpuno su prihvatljivi za potrebe ovakve antropološke studije.

U prethodnim pilot studijama na nekoliko uzorka studenata bio je testiran upitnik od 10 ajtema koje je predložila američka asocijacija psihologa (*American Psychological Association*) (Norman et al., 2014). Kako je u svim probama koje su prethodile ovoj studiji, dobijena nedovoljno visoka vrednost Kronbahovog alfa koeficijenta (*Cronbach's Alpha* je bila u opsegu od 0,32-0,42), upitnik je proširen sa dodatnih 14 ajtema preuzetih iz *DASS questionnaire* (Antony, Bieling, Cox, Enns & Swinson, 1998) koji je konstruisan kao skala za individualnu procenu stresa kod mladih osoba. Ispitanici su svoju procenu iskazivali izborom jedne od pet pozicija na skali Likertovog tipa, gde je ocena 0 predstavljala potpuno odbacivanje, a ocena 4 potpuno prihvatanje iznete tvrdnje. Nakon nekoliko probnih istraživanja i provere metrike tog proširenog i adaptiranog upitnika, od 24 tvrdnje zadržano je samo 15 ajtema koji su ispunili metrijske zahteve. Metrika upitnika procenjena je primenom dva postupka: (1) analiza pouzdanosti skale (*Scale Reliability Analysis*) koja je zasnovana na Kronbahovom alfa koeficijentu (*Cronbach's Alpha*) (Tabela 1) i (2) faktorskoj analizi (*Factor Analysis, Principal Components Analysis - PCA*), sa *Direct Oblimin* metodom rotacije (Tabela 2). Sva statistička zaključivanja sprovedena su na nivou značajnosti od 0,05 (*Sig. < ,05*). Dobijeni rezultati pokazuju da skala ima dobru unutrašnju saglasnost, na šta ukazuje Kronbahov alfa koeficijent koji je značajno veći od pre-

min method of rotation (Table 2). All statistical inference was carried out at the level of significance of 0.05 (Sig. < .05). The results show that the scale has good internal consistency, which is demonstrated by Cronbach's alpha coefficient that is significantly higher than the recommended theoretical value of 0.7 (De Vellis, 2003). All 15 items had high internal consistency.

In order to assess the validity of the stress questionnaire, 15 items were subjected to principal component analysis (PCA). Before PCA, the suitability of data for a factor analysis was assessed. The examination of the correlation matrix showed a lot of coefficients of 0.3 value or higher. Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) was 0.915, which exceeds the recommended value of 0.6 (Kaiser, 1970, 1974). Bartlett's test of sphericity (Bartlett, 1954) also reached statistical significance. All this points to factorability of a correlation matrix.

The analysis of the main components obtained after Oblimin rotation, revealed the presence of two components with Eigenvalues over one, explaining 55.393% and 7.038% of the variance. The obtained Scree plot showed the existence of a clear breaking point already after the first component (Figure 1). Based on Cattell's criterion (1966) it was decided to retain only one component. This was supported by the results of a parallel analysis with one component whose characteristic values exceed the appropriate threshold values obtained by an equally large matrix of random numbers (15 variables x 332 respondents). This single component solution explained a significant part of the total variance. All 15 variables gave significant factor weight to the only extracted component which proved that the stress questionnaire has high validity and can be applied as an independent scale for assessing the levels of stress. The hierarchical structure of the Component Matrix

poručene teorijske vrednosti 0,7 (De Vellis, 2003). Svih 15 ajtema imalo je visoku unutrašnju saglasnost.

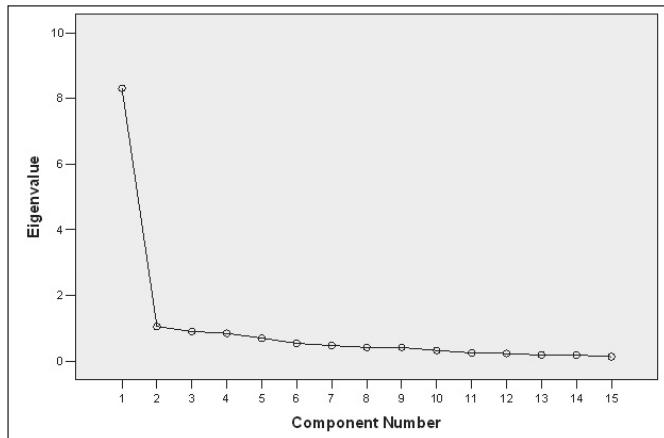
S ciljem da se proceni validnost upitnika, 15 ajtema podvrgnuto je analizi glavnih komponenti (PCA). Pre sprovodenja PCA, bila je ocenjena prikladnost podataka za faktorsku analizu. Pregledom korelace matrice evidentirano je mnogo koeficijenata vrednosti 0,3 i više. Kajzer-Majer-Olkinov koeficijent adekvatnosti uzorka (*Kaiser-Meyer-Olkin Measure of Sampling Adequacy - KMO*) bio je 0,915 što znatno premašuje preporučenu vrednost 0,6 (Kaiser, 1970, 1974). Bartletov test sferičnosti (*Bartlett's test of sphericity*) (Bartlett, 1954) takođe je dostigao statističku značajnost. Sve to ukazuje na faktorabilnost korelace matrice.

Analiza glavnih komponenti dobijenih nakon Oblimin rotacije, otkrila je prisustvo dve komponente sa karakterističnim korenovima (*Eigenvalues*) preko jedan, koje objašnjavaju 55,393% i 7,038% varijanse. Dobijeni dijagram preloma (*Scree plot*) pokazao je postojanje jasne tačke loma već iza prve komponente (Slika 1). Na osnovu Kattel-ovog kriterijuma (1966) odlučeno je da se zadrži samo jedna komponenta. To su podržali i rezultati paralelne analize sa jednom komponentom čije karakteristične vrednosti premašuju odgovarajuće vrednosti praga dobijene pomoću jednakovelične matrice slučajnih brojeva (15 varijabli x 332 ispitanika). To jednofaktorsko rešenje objasnilo je značajan deo ukupne varijanse. Svi 15 varijabli dalo je značajnu faktorsku težinu jedinoj ekstrahovanoj komponenti čime je dokazano da Upitnik o stresu (*Stress questionarie*) ima visoku validnost i da se može primenjivati kao samostalna skala za procenu nivoa stresa. Hjерархијска struktura matrice sklopa pokazuje da je ekstrahovani faktor najviše saturiran ajtemima koji se odnose na opšti osećaj nervne napetosti prou-

**Tabela 1.** Statistika pouzdanosti za upitnik o stresu / **Table 1.** Reliability Statistics for Stress questionnaire

<b>Q</b>	<b>Izjave / Statements</b>	<b>Cronbach's Alpha if Item Deleted</b>
1.	Tokom dana često osećam napetost. / I often feel tension during the day.	.930
2.	Lako se iznerviram. / I easily lose temper.	.932
3.	Teško mi pada da ustajem rano. / It is hard for me to get up early.	.935
4.	Tokom dana me hvata drhtavica. / I sometimes shake during the day.	.933
5.	Kad me uhvati glad. brzo se unervožim. / When I'm hungry, I quickly become nervous.	.939
6.	Stalno mi se čini da nemam dovoljno vremena. / I always feel like I don't have enough time.	.935
7.	Imam česte nesanice. / I often suffer from insomnia.	.938
8.	Često imam osećaj da mi srce lupa bez razloga. / I often feel my heart beating louder for no reason.	.936
9.	Da se ne plašim posledica. rado bih prebio/la neke ljude. / If I wasn't scared of consequences, I would love to beat some people.	.932
10.	Već duže planiram da odem kod lekara. ali nemam vremena. / I've been planning to visit a doctor for a while, but I don't have time.	.933
11.	Mislim da sam svakodnevno pod povećanim stresom. / I think I am under a lot of stress on a daily basis	.933
12.	Pred početak nekog posla uvek se osećam napeto. / Before starting a new task, I always feel tensed.	.933
13.	Mrzi me da se spremam za sportske aktivnosti. / I hate getting ready for sports activities.	.935
14.	Stalno mi se čini da nisam dovršio/la neki posao ili obavezu. / I always have a feeling as if I haven't finished some task or duty.	.933
15.	Osećam kako brzo gubim strpljenje. / I feel that I'm quickly losing patience.	.932
<b>Cronbach's Alpha</b>		<b>.941</b>

shows that the extracted factor is most saturated by items related to the overall feelings of nervous tension caused by the social environment, and least saturated by the claims related to the presence of insomnia and hunger.



**Figure 1.** Scree Plot for Stress questionnaire

In addition to the stress questionnaire, an instrument that was used on respondents included questions related to three indicators of quality of life: (1) presence and type of daily physical activity, (2) assessment of their own health and (3) regularity of health checks. Respondents answered by choosing one of the multiple choice options. For evaluation of physical activity five items were offered: an anti-sport person, a passive sports lover (an observer of sports events, betting, etc.), occasional irregular activity (a would-be athlete), a moderately and highly active amateur and an active athlete. For assessment of own health four options were available: poor, satisfactory, good and excellent health. For evaluation of health check the choice was one out of these three options: never, rarely, and regularly. For each sub-sample the average value of stress was calculated, and to test their mutual differences One-Way ANOVA and Independent Samples T-test were applied. All statistical procedures were carried out in the application program SPSS.

## RESULTS

On the basis of scalar values (from 0 to 4) by which students expressed their attitude towards the claims stated in 15 items, the average level of stress was calculated for each respondent. The scope of statistical series ranged from 0.2 (minimum) to 3.53 (maximum). The common arithmetic mean (mean = 2.4655) indicates increased stress levels with the average homogeneity which is portrayed by moderately low values of standard deviation. A distribution of 332 scalar averages (Figure 2) revealed itself to be a bimodal distribution. Two groups of respondents stood out - one (much more numerous) in which

zrokovani socijalnim okruženjem, a najmanje tvrdnjama koje se odnose na prisustvo nesanice i gladi.

**Table 2.** Factor Analysis for Stress questionnaire.

Item hierarchy	Component Matrix	Comunalities
Q01	.858	.771
Q04	.838	.704
Q02	.797	.667
Q09	.788	.646
Q11	.787	.637
Q15	.786	.644
Q12	.777	.617
Q14	.775	.618
Q10	.774	.629
Q06	.715	.555
Q03	.705	.649
Q13	.688	.476
Q08	.677	.651
Q05	.563	.372
Q07	.562	.726

KMO Measure of Sampling Adequacy = .915  
Bartlett's Test of Sphericity = 3521,554 Sig. = ,000

Osim upitnika o stresu, instrument koji su ispitanici rešavali sadržao je i pitanja o tri pokazatelja kvaliteta života: (1) zastupljenost i tip dnevnih fizičkih aktivnosti, (2) procena sopstvenog zdravlja i (3) redovnost kontrolisanja zdravlja. Ispitanici su odgovore davali izborom jedne od više ponuđenih mogućnosti. Za ocenu fizičke aktivnosti u ponudi je bilo pet stavki: antisportista, pasivni ljubitelj sporta (posmatrač sportskih događaja, klađenje isl), povremena neredovna aktivnost (sportista na rečima), umeren rekreativac, jak rekreativac i aktivni sportista. Za procenu sopstvenog zdravlja u ponudi su bile četiri solucije: slabo zdravlje, zadovoljava, dobro i odlično. Kontrola zdravlja vrednovana je izborom jedne od tri alternative: nikad, retko, redovno. Za svaki subuzorak je izračunata prosečna vrednost stresa, a za testiranje njihovih međusobnih razlika primenjena je jednofaktorska analiza varijanse (One-Way ANOVA) i T-test nezavisnih uzoraka. Sve statističke procedure realizovane su u aplikacionom programu SPSS.

## REZULTATI

Na osnovu skalarnih vrednosti (od 0 do 4) kojima su studenti iskazivali svoj stav prema tvrdnjama u 15 ajema, za svakog ispitanika je izračunat prosečan nivo stresa. Opseg statističke serije se kretao od 0,2 (Minimum) do 3,53 (Maximum). Zajednička aritmetička sredina (Mean = 2,4655) ukazuje na povećan nivo stresa uz prosečnu homogenost o kojoj govore umereno niske vrednosti standardne devijacije. Distribucija 332 skalarna pro-

there were respondents with higher levels of stress and another one (much smaller) formed by respondents with significantly lower stress levels (Figure 2). A detailed review of the original database revealed an alarming fact that even 42.77% of respondents have increased stress levels (greater than the scalar value of 2.5). The highest stress level (above the scalar value of 3) was recorded in 10.24% of the respondents. The group with the lowest levels of stress (scalar value less than 1) made 6.02% of the respondents which primarily included athletes and amateurs. This data called for testing of the significance of differences between arithmetic means of certain subsamples.

The results of ANOVA and T-test indicated a statistically significant difference related to all the monitored criteria. When it comes to movement habits (physical activity), Post Hoc tests (Tukey HSD) revealed that the only source of variability is a significantly higher average value of stress in the group of passive sports lovers. The remaining four groups (anti-sport, moderate and highly active amateurs and active athletes) do not differ significantly statistically. On the basis of the average scalar values, it was noted that elevated stress (values exceeding 2.5) is primarily present in students who are inactive or very rarely and irregularly physical active (Table 3).

Comparing the average values in relation to the self-assessment of health, it was found that those who assessed their health as poor or satisfactory had statistically higher levels of stress in comparison to their colleagues who rated their health as good or excellent (Table 4). Post Hoc test (Tukey HSD) pointed to polarization of the sample, whereby between two sub-samples of negative and two sub-samples of a positive pole there were no statistically significant differences. Despite increased feelings of stress in most respondents, a total of 86.14% of the surveyed students rated their health as good or excellent, while only 13.86% as poor or satisfactory.

ANOVA revealed that the stress in respondents who never or rarely go to preventive health checks is not significantly different. The only source of variability was a lower stress level in students who regularly check their health (Table 5). Only 31.93% of students from Vojvodina said they regularly checked their health. This alarming rate is likely to be even lower given that the respondents in these anthropological studies often give socially acceptable answers in order to improve their self-image.

The results of T-test revealed that male students are under higher levels of stress than female students (Table 6). This difference was statistically significant, which can be accepted with reservations due to the relatively small

seka (Slika 2) otkriva bimodalni raspored. Izdvojile su se dve grupe ispitanika – jedna (mnogo brojnija) u kojoj se nalaze ispitanici sa višim nivoom stresa i druga (izrazito manja) koju su formirali ispitanici sa značajno manje izraženim stresom (Slika 2). Detaljnijim pregledom izvorne baze podataka, uočen je zabrinjavajući podatak da čak 42,77% ispitanika ima povećan nivo stresa (veći od skalarne vrednosti 2,5). Najviši nivo stresa (iznad skalarne vrednosti 3) registrovan je kod 10,24% ispitanika. Grupu sa najnižim nivoom stresa (skalarna vrednost niža od 1) formiralo je 6,02% ispitanika među kojima su prvenstveno sportisti i rekreativci. Ovaj podatak otvorio je potrebu da se testira značajnost razlika između aritmetičkih sredina pojedinih subuzoraka.

Rezultati ANOVA i T-testa ukazali su na postojanje statistički signifikantne razlike u odnosu na sve praćene kriterijume. Kada su u pitanju kretne navike (nivo fizičke aktivnosti), Post Hoc test (Tukey HSD) otkrio je da je jedini izvor varijabiliteta signifikantno veća prosečna vrednost stresa u grupi pasivnih ljubitelja sporta. Preostale četiri grupe (antisportisti, prosečni i jaki rekreativci, kao i aktivni sportisti) nisu se među sobom statistički značajno razlikovale. Na osnovu prosečnih skalarnih vrednosti ipak je konstatovano da povećan stres (vrednosti preko 2,5) imaju prvenstveno studenti koji su neaktivni ili su veoma retko i neradovno fizički aktivni (Table 3).

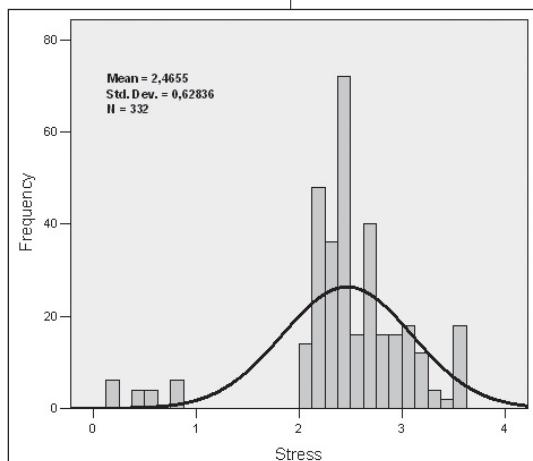
Upoređivanjem prosečnih vrednosti u odnosu na samoprocenu zdravlja, utvrđeno je da statistički veći nivo stresa imaju oni koji su svoje zdravlje ocenili kao slabo ili zadovoljavajuće u odnosu na svoje kolege koje su zdravlje proglašili dobrom ili odličnim (Tabela 4). Post Hoc test (Tukey HSD) ukazao je na polarizaciju uzorka, pri čemu između dva subuzorka sa negativnog kao i dva sa pozitivnog pola nije bilo statistički značajnih razlika. Uprkos povećanom osećanju stresa kod većine ispitanika, ukupno 86,14% anketiranih studenata je svoje zdravlje ocenilo kao dobro ili odlično, a samo 13,86% kao slabo ili zadovoljavajuće.

ANOVA je otkrila da se stres ispitanika koji nikad ili retko idu na preventivne preglede značajno ne razlikuje. Jedini izvor varijabiliteta bio je niži nivo stresa kod studenata koji redovno kontrolišu svoje zdravlje (Tabela 5). Samo 31,93% vojvođanskih studenata izjavilo je da redovno kontroliše zdravlje. Ovaj zabrinjavajući podatak verovatno je i niži kada se zna da ispitanici u ovakvim antropološkim studijama često daju socijalno poželjne odgovore u želji da ulepšaju sliku o sebi.

Rezultati T-testa otkrili su da muškarci imaju veći nivo stresa od studentkinja (Tabela 6). Ova razlika je bila statistički signifikantna, što se može prihvati s rezervom obzi-

number of respondents and the fact that the significance is very close to the limit value of 0.05 (sig. = .045).

rom na relativno mali broj ispitanika i na signifikative koja su bili veoma blizu granične vrednosti od 0,05 (Sig. = ,045).



**Figure 2.** Frequencies and Descriptives for Student Stress

**Table 3.** Descriptives and ANOVA za ispitanike sa različitim kretnim navikama

Subsample	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Antisportisti / Anti-sport	36	<b>2.30</b>	.101	.017	2.20	2.40
Pasivni ljubitelji sporta / Passive sports lovers	36	<b>3.00</b>	.541	.090	2.47	3.53
Sportista na rečima / Would-be athletes	20	<b>2.55</b>	.295	.066	2.20	2.93
Umereni rekreativci / Moderate amateurs	118	<b>2.51</b>	.707	.0651	.20	3.27
Jaki rekreativci / Highly active amateurs	80	<b>2.26</b>	.649	.073	.20	3.00
Aktivni sportisti / Active athletes	42	<b>2.39</b>	.527	.081	.80	3.40
Ukupno / Total	332	<b>2.4655</b>	.62836	.03449	.20	3.53

F = 8.602\*; Sig. = .000

**Table 4.** Descriptives and ANOVA za ispitanike sa različitom samoprocenom zdravlja

Ocena zdravlja / Health evaluation	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Slabo / Poor	8	<b>3.08</b>	.354	.125	2.73	3.53
Zadovoljava / Satisfactory	38	<b>3.13</b>	.434	.070	2.40	3.53
Dobro / Good	122	<b>2.33</b>	.671	.061	.20	3.40
Odlično / Excellent	164	<b>2.39</b>	.527	.041	.20	3.20
Ukupno / Total	332	<b>2.4655</b>	.62836	.03449	.20	3.53

F = 23.410\*; Sig. = .000

**Table 5.** Descriptives and ANOVA za ispitanike sa različitim navikama kontrole zdravlja

Kontrola zdravlja / Health check	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Nikad / Never	60	<b>2.79</b>	.701	.090	.20	3.53
Retko / Rarely	166	<b>2.46</b>	.625	.048	.20	3.20
Redovno / Regularly	106	<b>2.29</b>	.510	.049	.47	3.27
Ukupno / Total	332	<b>2.4655</b>	.62836	.03449	.20	3.53

F = 13.521\*; Sig. = .000

**Table 6.** Descriptives and T-test za ispitanike različitog pola

Pol / Gender	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Muški / Male	184	<b>2.53</b>	.597	.044	.53	3.53
Ženski / Female	148	<b>2.39</b>	.659	.054	.20	3.40
Ukupno / Total	332	<b>2.4655</b>	.62836	.03449	.20	3.53

t = 2.016\*; Sig. = .045

## DISCUSSION

This study offered the research practice a stress assessment questionnaire with good metrics that has been tested on population of students. Although the original idea of the authors was to use a previously standardized instrument of American Psychological Association (Norman et al., 2014), test analyses did not confirm the expected scale reliability. The new questionnaire for assessing stress levels of students (SSQ-15) consists of 15 items and has a high internal consistency (Cronbach's alpha over 0.9). A stable single-factor structure allows it to be used as a unique measuring scale where the value of 0 indicates complete absence of stress and the maximum value of 4 indicates very high stress. Through this instrument, it was found that a high percentage of students from the Serbian province of Vojvodina have elevated stress levels. Compared to the US population where the number of students with elevated feelings of stress in 2014 was estimated at 37% (Norman et al., 2014), the feeling of stress is more pronounced in students from Vojvodina and it is at the level of 42%. In addition to fluctuations in the sample, which is always a potential parasitic factor, this difference is likely to be explained by a larger number of stress sources that students in Serbia are exposed to. There is, first of all, a very low economic power of Serbian society and a still volatile political situation. Most of the students in Serbia are aware that it is very difficult to find a job with a university degree and the time one needs to find a job is very much influenced by their ties to the political elite.

Scalar averages greater than 2.5 indicate elevated stress levels. Based on this criterion, it was concluded that the increase in physical activity helps stress levels decrease. An acceptable stress level was primarily noted in highly active amateurs and active athletes. The highest values were registered in the subsample of passive sports lovers. These are usually those who watch sport on TV or monitor sports results at bookmakers. Instead of having a relaxing effect, their contact with sports further intensified the excitement stirring strong fan emotions whose direction depends on the performance of others. Being an anti-sport person and consciously accepting a life without physical activity turned out to be healthier, than to be a sports fan. The level of stress in respondents who view themselves as anti-sport oriented was below 2.5 and wasn't statistically significantly different from the feelings of stress expressed by amateurs and active athletes. These data are consistent with the findings in similar studies carried out in other countries. Thus, for example, 39% of young people in the United States claim that their

## DISKUSIJA

Ova studija je istraživačkoj praksi ponudila upitnik za procenu stresa sa dobrom metrikom koja je proverena na populaciji studenata. Iako je prvobitna ideja autora bila da se posluže prethodno standardizovanim instrumentom *American Psychological Asociation* (Norman et al., 2014), probne analize nisu potvrđile očekivanu pouzdanost skale (*Scale Reliability*). Novi upitnik za procenu nivoa stresa studenata (SSQ-15) sastoji se od 15 ajtema koji su pokazali visoku unutrašnju saglasnost (*Cronbach's Alpha* preko 0,9). Stabilna jednofaktorska struktura omogućava da se instrument koristi kao jedinstvena skala na kojoj vrednost 0 pokazuje potpuno odsustvo stresa, a maksimalna vrednost 4 označava veoma visok stres. Koristeći se ovim instrumentom, utvrđeno je da veoma visok procenat studenata iz srpske pokrajine Vojvodina ima povećan nivo stresa. U poređenju sa američkom populacijom u kojoj je broj studenata sa povećanim osećanjem stresa u 2014-oj godini procenjen na 37% (Norman et al., 2014), kod vojvodanskih studenata koji studiraju sport i turizam je osećaj stresa više izražen i kreće se na nivou od 42%. Osim fluktuacijom uzorka koja je uvek potencijalni parazitarni faktor, ove razlike se verovatno mogu objasniti većim brojem izvora stresa sa kojima se susreću vojvođanski studenti. Tu se, pre svega, radi o veoma niskoj ekonomskoj moći srpskog društva u celini, kao i još uvek nestabilnim političkim prilikama. Najveći broj studenata u Srbiji je svestan da je veoma teško naći posao sa fakultetskom diplomom i da na brzinu nalaženja posla veliki uticaj ima bliskost sa političkim elitama.

Na povećan nivo stresa ukazivale su skalarni prosečci veći od 2,5. Polazeći od ovog kriterijuma, zaključeno je da sa povećanjem fizičke aktivnosti opada nivo stresa. Prihvatljiv stres iskazali su prvenstveno jaki rekreativci i aktivni sportisti. Najveće vrednosti registrovane su u subuzorku pasivnih ljubitelja sporta. To su obično oni koji u kontakt sa sportom dolaze preko TV ili praćenjem sportskih rezultata na kladionicama. Njihov kontakt sa sportom je, umesto relaksirajućeg efekta, dodatno pojačavao uzbuđenje budeći jake navijačke emocije čiji smer zavisi od učinka drugih. Pokazalo se da je zdravije biti antisportista i svesno prihvatići život bez fizičkih aktivnosti, nego biti sportski navijač. Nivo stresa kod ispitanika koji su sebe prikazali kao antisportistu bio je ispod 2,5 i nije se statistički značajno razlikovao od osećaja stresa rekreativaca i aktivnih sportista. Ovi podaci su u skladu sa zaključcima sličnih istraživanja realizovanih u drugim zemljama. Tako, na primer, 39% mlađih ljudi u SAD tvrdi da im osećaj stresa raste u periodima kada su im tokom prethodnog meseca dana izostale fizičke ak-

feelings of stress become stronger when they don't engage in physical activity during a previous month, and 50% report that they feel much healthier when they exercise regularly (Norman et al., 2014). All this shows that moderate physical activity can help relieve stress.

The link between stress and subjective feeling of health is indicated by the relative similarity of the number of respondents with the highest levels of stress and those who rated their health as poor (about 13%). This number is slightly lower than the information cited for economically developed countries. Thus Norman et al. (2014) report that about 20% of young adult Americans rate their health as satisfactory or poor, and 80% as good or excellent. Whether students from Vojvodina are actually healthier is difficult to prove. What is more important than this information is that about 2/3 of respondents do not have a habit to regularly check their health, either through annual medical check-ups or through occasional preventive consultation with their doctor. Apparently, in the Republic of Serbia, a lot of work needs to be done on increasing students' health culture.

## CONCLUSION

Two most significant pieces of data obtained in this study are: (1) stress is highly prevalent among students and (2) systematical physical activity is a significant factor of discrimination on those who have high and low levels of stress. Data related to levels of stress in the sample confirmed the results of previous researches that were carried out in the USA and developed European countries which indicate that studying is a highly stressful activity (due to obligations related to exams, lack of free time, financial issues, job uncertainty after graduation, etc.). The research showed that students who are physically active (in sports recreation) mostly have lower levels of stress. This confirms the hypothesis about significance of sports and recreation in overcoming of stress and lowering its damaging effects. Similar results occurred in researches undertaken in other developed countries (the USA and EU) in which music and physical activities have been prevalent in students' free time. This information indicates that it would be possible to generalize data obtained in this study, and that studying in all countries has similar social characteristics.

A special significance of this study is its contribution to the advancement of methodology of evaluation (qualification) of stress. Based on the instruments used in previous researches which were carried out in different environments, a very stable 15-item questionnaire was constructed which is easily applicable in the field. The claims from the questionnaire proved to be clear to the participants and they motivated them sufficiently to give fast and honest answers. The

tivnosti, a 50% izjavljuje da se osećaju mnogo zdravije kada redovno vežbaju (Norman et al., 2014). Sve ovo pokazuje da se pomoću dozirane fizičke aktivnosti može upravljati stresom.

Na vezu između stresa i subjektivnog osećaja zdravlja ukazuje relativna sličnost broja ispitanika sa najvećim nivoom stresa i onih koji su svoje zdravlje ocenili kao slabo (oko 13%). Ovaj broj je nešto niži od podataka koji se navode za ekonomski razvijenije zemlje. Tako Norman et al. (2014) navode da oko 20% mlađih odraslih amerikanaca svoje zdravlje ocenjuje kao zadovoljavajuće ili slabo, a oko 80% kao dobro ili odlično. Da li su vojvođanski studenti zaista zdraviji teško je dokazati. Od tog podatka mnogo je značajnije to što oko 2/3 ispitanika nema naviku da redovno kontroliše svoje zdravlje, bilo kroz jednogodišnje sistematske pregledе, bilo kroz povremene preventivne konsultacije sa svojim lekarom. Po svemu sudeći, u Republici Srbiji je neophodno dosta raditi na povećanju zdravstvene kulture studenata.

## ZAKLJUČAK

Dva najznačajnija rezultata dobijena u ovoj studiji su: (1) stres je veoma učestao među studentima i (2) redovna fizička aktivnost je značajan faktor koji diferencira one koji imaju visok i nizak nivo stresa. Podaci koji se odnose na nivo stresa u uzorku potvrđili su rezultate prethodnih istraživanja koja su provedena u SAD i razvijenim evropskim zemljama i ukazuju da se studiranje može doživeti kao veoma stresna aktivnost (zbog obaveza vezanih za ispite, nedostatak slobodnog vremena, finansijska pitanja, neizvesnost dobijanja posla nakon diplomiranja, itd.). Istraživanje je pokazalo da studenti koji su fizički aktivni uglavnom imaju niži nivo stresa. To potvrđuje hipotezu o značaju sporta i rekreacije u prevazilaženju stresa i snižavanju njegovih štetnih efekata. Slični rezultati se uočavaju u istraživanjima koja su sprovedena u drugim razvijenim zemljama (SAD i EU) u kojima su muzika i fizičke aktivnosti prevladavale kao aktivnosti u slobodnom vremenu učenika. Ove informacije ukazuju na moguću generalizaciju istraživačkih podataka dobijenih u ovoj studiji, odnosno pokazuju da studiranje u gotovo svim zemljama ima slične socijalne karakteristike.

Poseban značaj ove studije je njen doprinos unapređenju metodologije vrednovanja (kvalifikacije) stresa. Na osnovu instrumenata koji su korišćeni u prethodnim istraživanjima koja su sprovedena u različitim okruženjima, napravljen je veoma stabilan upitnik od 15 stavki koji je moguće realtivno lako i efikasno primeniti na terenu. Tvrđnje iz upitnika pokazale su se jasnim učesnicima ankete i bile su dovoljno egzaktne za motivisanje na da-

claims aren't saturated with specific social or cultural characteristics of participants, but they contain general conditions typical of students' everyday life in any environment. Therefore, it is realistic to expect for the questionnaire to be used in further research in any country in the world. It is especially significant that the factor analysis of the results that were obtained via the use of this questionnaire, revealed only one component of stress (general factor). This shows that the questionnaire measures general markers of stress and that it can be further developed with regards to the specific manifestations of stress.

vanje brzih i iskrenih odgovora. Ajtemi upitnika nisu zasićeni specifičnim društvenim ili kulturnim karakteristikama učesnika, ali sadrže opšte uslove karakteristične za svakodnevni život studenata u bilo kom okruženju. Stoga je realno očekivati da se upitnik pokaže korisniku u dalmajim istraživanjima u bilo kojem akademskom okruženju. Posebno je značajno da faktorska analiza dobijenih korišćenjem ovog upitnika otkriva samo jednu komponentu stresa (opšti faktor). Ovo pokazuje da upitnik meri opšte markere stresa, te da se može dalje razvijati i unapređivatis obzirom na specifičnost manifestacije stresa.

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Primljen: 27. mart 2019. / Received: March 27, 2019  
Prihvaćen: 10. april 2019. / Accepted: April 10, 2019

# PSYCHOLOGICAL CHARACTERISTICS FACTOR OF SUCCESS IN KARATE ATHLETES

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**Abstract:** A survey was conducted with two sub-samples of respondents, karate athletes representatives (members of the national team) and karate athletes competitors in the kumite (sports fight). The survey was conducted on a stratified sample of 32 respondents divided into two groups, 16 karate representatives and 16 karate competitors, males, seniors from the Republic of Macedonia. The main purpose of the research is to determine the differences in the psychological characteristics between the two sub-samples of the respondents. In the research, a total of 13 variables for the assessment of psychological characteristics were applied: for estimation of emotional characteristics six (6) variables, three (3) variables for assessment of the motivational dispositions, for assessment of the specific intellectual characteristics (3) three variables and one variable for assessing the general intellectual characteristic. The basic statistical parameters are determined using the basic descriptive statistics for the two groups of respondents separately, while for determining the differences in the arithmetic means of the psychological characteristics, a T-test for small independent samples was applied. From the analysis of the data from the basic descriptive statistical parameters, it was established that in all applied variables, homogeneity of the results as well as normal distribution was obtained, with very small deviations present in two variables. The results of the T - test obtained in the survey show statistically significant differences in the entire analyzed space between the two groups, with the exception of two variables (L - social desire and P - psychotism), i.e. differences were found in 11 variables from a total of 13 examined variables.

**Keywords:** psychological characteristics, karate competitors, karate representatives, descriptive statistics, T-test.

## INTRODUCTION

Modern researches in sports science, which include sport psychology, are directed into the determination of the general and common disposition of athletes' personalities that appear in sports in general or in certain sports disciplines and cause athletes to behave in the same or similar manner (Aleksovska-Velichkovska, L. and Kostovski, Z. 2008). It is not disputed that the results obtained from a number of surveys reflect the fact that it is not possible to identify a single general model of a successful athlete, implicitly expected by researchers (Singer et al., 1977; Vealey, 1994, Wann, 1997). The value of researches of this kind in the field of karate sports consists in finding and determining the differences according to which the competitors are separated from the representatives and which are important for achieving the top results. In order to achieve the desired goal, as many information as possible is required, which will be properly incorporated and used in the process of building the personality of the karate athlete. Determining the differences between the examined groups that relate to the situational motor stereotypes (situational karate tests) it is also important in karate sports, since modern karate competitions consist of two individually important karate disciplines kumite and kata. Due to the fact that they are based on different selections of motion techniques, their kinematic and kinetic parameters, they differ in their anthropometric and physical performance. Kumite competitors are characterized by the complex technical structure and specific competences of competitors in the area of combined attack techniques (Chaabène, H., et all. 2014).

## METHODS OF WORK

For the needs of the research, a total of 13 variables were used to assess the psychological characteristics of karate athletes divided into 4 spaces, of which: three variables for assessing the motivational dispositions - P2, F +,

F2, Motive for Sports Achievement (MSP), six variables for assessment of the emotional characteristics - anxiety (TAI), aggressiveness (T-15), extroversion / introversion, neuroticism, psychotism, social desire (EPQ), three variables for assessing specific intellectual abilities - F1, F2, S1 and one variable for assessing the general intellectual ability - IQ Test.

The sample of variables was conducted on a deliberate sample of 32 respondents, divided into two sub-samples, of which 16 karate competitors and 16 karate representatives, males, seniors from Republic of Macedonia. The research was conducted in the club premises in which athletes perform their training on a daily basis.

According to the characteristics and size of the selected sample, the data obtained from the survey were processed by adequate statistical methods. For the purpose of the research, the following were calculated: arithmetic mean-Mean, standard deviation-SD, minimum-Min and maximum - max result, Skew - symmetry of the distribution of the results, Kurt - homogeneity of the results in a certain variable, KS - Kolmogorov - Smirnov method which determines the normal distribution of the results and the T-test for small independent samples for analyzing the differences between the arithmetic means of the two groups of respondents.

## RESULTS AND DISCUSSION

Analyzing the data from the basic descriptive statistical parameters of the psychological variables among the competitors presented in Table 1, we conclude that the standard deviation in all examined variables is of normal values, i.e., they are less than 1/3 of the arithmetic means. The lower and upper limits of the range in which the results are moving (Min. - Max.) are expected in relation to the treated variables. Statistically significant deviation of the asymmetry of Skew results is evident only in two variables: progressive matrices (PM = 1.20) and perceptual structure conservation speed (F2 = 1.39), while in the test (S1 = 1.01) which it measures the ability to predict spatial relations, a value is obtained above the upper limit. In the remaining variables, the displayed results are within the limits of the recommended values. By analyzing the values of the degree of curvature of the Gaussian curve, we conclude that most of the applied variables are distributed along the width of the horizontal axis. The normal distribution of the results obtained by the Kolmogorov-Smirnov method shows that there is no deviation in any of the psychological variables.

**Table 1.** Descriptive statistical parameters of the psychological characteristics of the respondents - competitors and representatives

COMPETITORS								REPRESENTATIVES									
	M	Std. Dev.	Min.	Max.	Skew.	Kurt.	K-S	Sig		M	Std. Dev.	Min.	Max.	Skew.	Kurt.	K-S	Sig
PM	51.56	1.75	50.00	56.00	<b>1.20</b>	1.26	0.76	0.62	PM	55.13	2.45	51.00	59.00	-0.04	-1.07	0.52	0.95
F1	28.81	2.23	25.00	33.00	0.06	-0.48	0.63	0.82	F1	31.94	1.65	30.00	34.00	0.21	-1.69	0.86	0.45
F2	17.00	1.93	15.00	22.00	<b>1.39</b>	1.84	1.00	0.27	F2	20.56	1.93	17.00	24.00	0.27	-0.59	0.96	0.32
S1	20.94	2.11	18.00	26.00	<b>1.01</b>	0.80	0.95	0.32	S1	26.63	1.82	24.00	29.00	0.11	-1.44	0.79	0.57
TAI	35.75	3.40	30.00	41.00	-0.39	-0.81	0.57	0.90	TAI	30.31	2.44	27.00	35.00	0.53	0.08	0.56	0.92
P	2.75	0.86	1.00	4.00	-0.18	-0.32	0.96	0.32	P	2.31	<b>0.87</b>	1.00	4.00	-0.02	-0.55	0.89	0.41
N	11.31	2.24	7.00	16.00	0.08	0.38	0.62	0.84	N	9.25	2.54	4.00	14.00	-0.46	0.42	0.84	0.48
E	11.00	2.13	7.00	15.00	0.05	-0.18	0.53	0.94	E	13.06	1.91	10.00	16.00	-0.23	-1.13	0.63	0.83
L	11.56	2.50	7.00	15.00	-0.30	-1.03	0.62	0.84	L	11.13	2.25	6.00	14.00	-0.74	0.15	0.86	0.46
P2	20.56	2.31	17.00	25.00	0.35	-0.74	0.75	0.62	P2	23.13	1.36	21.00	25.00	-0.07	-1.19	0.71	0.69
F+	3.94	1.29	2.00	6.00	0.34	-0.58	0.92	0.36	F+	3.00	<b>1.10</b>	1.00	5.00	0.00	-0.80	0.78	0.58
F-	7.13	1.20	5.00	9.00	0.25	-0.63	0.92	0.37	F-	8.63	1.15	7.00	11.00	0.56	-0.40	1.08	0.20
T-15	32.81	4.52	26.00	40.00	0.11	-1.25	0.54	0.93	T-15	27.63	4.27	21.00	38.00	0.94	1.15	0.73	0.66

This table also presents the basic descriptive statistical parameters of the psychological variables among the representatives. It can be noted that in all applied variables homogeneity of results as well as normal distribution (K-S) were obtained without departing from any of the psychological variables. The values of the standard deviation (Std. Dev), in the variables psychotism (P = 0.87) and the variable (F + = 1.10) that examines the degree of positive emotional engagement and emotional self-control in situations of sports achievement, show very little deviation, while

the remaining results of the values of the standard deviation are one third in relation to the arithmetic means, which indicates that the grouping of the results moves mainly around its own arithmetic means. The displayed values of the minimum and maximum results move within the expected range in terms of the treated variables. A statistically significant deviation of the asymmetry of the Skew results was not noticed in any of the variables whose values generally range around zero, which tells us that this is a normal distribution of data. The degree of curvature of the Gaussian curve (Kurt.) is platy curtic, indicating that the distribution of the results is dispersing along the x axis.

From the analysis of the obtained results from the variables of the psychological characteristics of the respondents - competitors and representatives presented in the table no. 2, statistically significant differences were found in the entire analyzed space between the two groups, with the exception of two variables (L - social desire and P - psychotism). The value of the standard deviation (Std.Dev) in the variable psychotism ( $p = 0.87$ ) shows very little deviation, while the remaining results of the values of the standard deviation are one third in relation to the arithmetic means. The levels of two-sided significance Sig. (2-tailed) are in the range from 0.00 to 0.03 indicating that the difference between these two groups, competitors and representatives is due precisely to the level of psychological preparedness that is considered relevant in achieving success. The values of the t-tests in the variables are greater than 1.96 at the level of .05.

**Table 2.** T-tests of the psychological characteristics of the respondents -competitors and representatives

Variables	Groups	N	Mean	Std. Dev.	t	df	Sig. (2-tailed)
PM	1.00	16	51.56	1.75	-4.74	30.00	<b>0.00</b>
	2.00	16	55.13	2.45			
F1	1.00	16	28.81	2.23	-4.51	30.00	<b>0.00</b>
	2.00	16	31.94	1.65			
F2	1.00	16	17.00	1.93	-5.22	30.00	<b>0.00</b>
	2.00	16	20.56	1.93			
S1	1.00	16	20.94	2.11	-8.16	30.00	<b>0.00</b>
	2.00	16	26.63	1.82			
TAI	1.00	16	35.75	3.40	5.20	30.00	<b>0.00</b>
	2.00	16	30.31	2.44			
P	1.00	16	2.75	0.86	1.43	30.00	0.16
	2.00	16	2.31	0.87			
N	1.00	16	11.31	2.24	2.43	30.00	<b>0.02</b>
	2.00	16	9.25	2.54			
E	1.00	16	11.00	2.13	-2.88	30.00	<b>0.01</b>
	2.00	16	13.06	1.91			
L	1.00	16	11.56	2.50	0.52	30.00	0.61
	2.00	16	11.13	2.25			
P2	1.00	16	20.56	2.31	-3.83	30.00	<b>0.00</b>
	2.00	16	23.13	1.36			
F+	1.00	16	3.94	1.29	2.22	30.00	<b>0.03</b>
	2.00	16	3.00	1.10			
F-	1.00	16	7.13	1.20	-3.61	30.00	<b>0.00</b>
	2.00	16	8.63	1.15			
T15	1.00	16	32.81	4.52	3.34	30.00	<b>0.00</b>
	2.00	16	27.63	4.27			

Statistically significant differences that occur in variables that present the psychological characteristics and are in favor of the representatives represent a very good indicator of the existence of a specific psychological structure relevant to achieving sports success and according to which the competitors from the representatives are separated. In this case, the higher score in psychotism (P) in the group of respondents-competitors is a good result compared

to the representatives who show greater self-confidence and have a lower level of psychoticism. Not having a statistically significant difference in variable L (social desire) is linked to the attempts of the subjects to deliberately control their results, desire, and attempts to suppress or express certain emotional manifestations.

## CONCLUSION

The survey was conducted on a deliberate sample of 32 respondents, 16 karate representatives and 16 karate competitors, males, seniors (according to WKF) from Republic of Macedonia. For the realization of this research, a total of 13 variables were used to assess the psychological characteristics of karate athletes. The research yields results that lead to the following conclusions:

According to the data obtained by testing the two-way t-test for small independent samples of the comparative arithmetic means of the variables representing the psychological characteristics of the respondents - competitors and representatives, statistically significantly differ in the entire analyzed space with the exception of two variables:

- L - social desire ( $p = 0.61$ )
- P - psychoticism ( $p = 0.16$ )

There are statistically significant differences in the general intellectual abilities between the respondents - competitors and representatives who are in favor of the representatives.

There are statistically significant differences in the specific intellectual abilities (sports intelligence) between the respondents - competitors and representatives who are in favor of the representatives. Statistically significant differences that occur in the variables presenting the psychological characteristics, and are in favor of the representatives, represent a very good indicator of the existence of a specific psychological structure, relevant for achieving sports success, and according to which the competitors from the representatives are separated. The general and specific intellectual abilities, in fact, are those that separate top athletes from the average. Intelligence mostly develops with movement and creative activity. One of the aspects of the problem of many studies of cognitive abilities is the determination of the cognitive characteristics of sports figures. In that sense, it can be said that as in this research and in many others, the same or similar results were obtained, according to which top athletes possess much more developed cognitive functions than others (Holjevac, 1975; Gabrijelic, 1977; Bosnar & Horga, 1981; Bosnar & Shnajder 1983, etc.), taken by Mikic (1996). The connection between the level of cognitive development and success in sports has been proven by numerous studies involving our own. The correlation of motor and cognitive abilities is relatively high, as is shown by the results of multivariate researches (Brace 1948, Kirkendall & Gruber 1970, Mejovsek 1977, Ismail, Kane & Kirkendall 1976, Momirovic, Gredelj & Hosek 1980, Momirovic & Horga 1982, etc.).

There are statistically significant differences in the emotional characteristics of the respondents - competitors and representatives. In this case, the resulting lower score among the respondents - representatives, in the variable anxiety, aggressiveness, psychoticism and neuroticism (compared to the respondents-competitors), is a good indicator and they show greater self-confidence, suppression of negative, and expression of positive emotional manifestations. Anxiety connects to genetics and is one of the most important limiting factors for competitive efficiency and it is very difficult to be influenced Mikic (1996). According to Cox (1998), aggression is also considered as an obstacle to athletes, which consequence is reduced achievement.

There are statistically significant differences in the motivational dispositions between the respondents - competitors and representatives. The statistically significant differences that appear in the variables that represent the motivational dispositions are in favor of the representatives, represent a very good indicator of the existence of a specific psychological structure, relevant for achieving sports success, and according to which the competitors from the representatives are separated. It can be said that the concept of the need for achievement is most relevant and therefore a large number of researchers are dealing exactly with the motive of sports achievement. These obtained results can be compared with other studies (Havelka & Lazarevic 1980), where similar results have been obtained; according to which emotional processes that come to the fore in a situation of sports achievement have a great influence on the level of success. The data from the survey on the success of emotional engagement, self-control and emotional stability in situations of sports achievement shows that there is a significant difference between the examined samples. Compared to the research performed by Jovanovic (Jovanovic, 1986), also with karate competitors (most successful, intermediate successful and least successful), results were obtained where the most successful ones differ from the other two groups for better emotional stability and self-control in conditions of competition.

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Primljen: 15. januar 2019. / Received: January 15, 2019  
Prihvaćen: 25. februar 2019. / Accepted: February 25, 2019

## THE REASONS WHY YOUNG PEOPLE AVOID ENGAGING IN SPORTS AND ATHLETIC ACTIVITIES

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**Abstract:** This paper mainly refers to attitudes about the reasons for the avoidance of sports and sports activities of young people who have never been involved in these activities. In this survey involving 226 university and high school students, 110 stated that they had never been involved in sport or any sporting activities. They are surely the most reputed to answer these questions. Of the offered reasons (causes) that are responsible for avoiding and non-participation in sports and sports activities, in the first place is the lack of interest which is stated by about 90% of the respondents. Secondly, the reason why respondents do not deal with sports and sports activities are the obligations at school and at the faculty, and this was confirmed by 85% of respondents. Laziness follows, about this they were very self-critical and sincere, confirming in a percentage of 84.5% that this was one of the reasons for their abstinence from sports and sports activities. Immediately behind laziness are television, there are computers and cell phones with about 80%, and so on. The results showed that male and female, then smokers and non-smokers, do not differ significantly in attitudes about these reasons. It is the same with those who consume, occasionally consume and do not consume alcohol. There is a partial difference between high school students and university students in attitudes to some causes, as well as between those who live in the city, suburban village and village.

**Keywords:** avoidance, reasons, young people, sport, sports activities.

### INTRODUCTION

Despite all the positive effects of sports, sport exercise and practice, much of today's population is not included in these activities for various reasons. What is very worrying is that quite a large number of young people are not involved in sport or sporting activities of any kind. Physical activity is one of the basic vital human needs, and

## RAZLOZI ZBOG KOJIH MLADI IZBJEGAVAJU DA SE BAVE SPORTOM I SPORTSKIM AKTIVNOSTIMA

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**Apstrakt:** Ovaj rad se uglavnom odnosi na stavove o razlozima izbjegavanja sporta i sportskih aktivnosti mlađih ljudi koji nikad nisu bili uključeni u te aktivnosti. U ovom istraživanju od 226 anketiranih studenata i srednjoškolaca, 110 se izjasnilo da se nisu nikad bavili ni sportom, niti bilo kakvim sportskom aktivnostima. Oni i jesu najpozvaniji da odgovore na ta pitanja. Od ponudjenih razloga(uzroka) koji su odgovorni za izbjegavanje i neučestvovanje u sportu i sportskim aktivnostima na prvom mjestu je odsustvo interesa za koje se izjasnilo oko 90% anketiranih. Drugi po značaju razlog zbog kog se ispitanici ne bave sportom i sportskim aktivnostima su obaveze u školi i na fakultetu i to je potvrđilo 85% anketiranih ispitanika. Dalje slijedi lijenos, gdje su bili veoma samokritični i iskreni, potvrdivši u procentima od 84.5%, da je to jedan od razloga njihove apstinencije od sporta i sportskih aktivnosti. Odmah iza lijenosu su televizija, računari i mobiteli oko 80% i td. Rezultati su pokazali da se muški i ženski pol, zatim pušači i nepušači, ne razlikuju značajno u stavovima oko ovih razloga. Isto je i sa onima koji konzumiraju, povremeno konzumiraju i ne konzumiraju alkohol. Djelimična razlika postoji između srednjoškolaca i studenata u stavovima o nekim uzrocima, kao i između onih koji stanuju u gradu, prigradskom naselju i selu.

**Ključne riječi:** izbjegavanje, razlozi, mladi, sport, sportske aktivnosti.

### UVOD

I pored svih pozitivnih efekata bavljenja sportom, sportskim vježbanjem i aktivnostima, veoma veliki dio današnje populacije zbog raznih razloga se ne uključuje u te aktivnosti. Ono što veoma zabrinjava je to da se prilično veliki dio mlađih ljudi ne uključuje ni u sport, niti u sportske aktivnosti bilo kakvog oblika. Fizička ak-

movement is the basis of the functioning of life. Irregular body position and long-term physical inactivity often lead to various disorders and imbalances in the body.

A large number of studies have considered the relationship between physical activity in younger age and its short-term and long-term effects on health. (Hallal et al., 2006; Rennie et al., 2006; Must and Tubor; 2005; Hills et al., 2007; Froberg and Andersen, 2005; Rodriguez, 2006, according to the Institute for Sport and Sport Medicine of the Republic of Serbia, 2016.)

It is important to emphasize that physically active children are getting more and more likely to keep their habits of exercising throughout their lives. By involvement in physical activity, preconditions are created to become healthy adults (Hasselstrom et al., 2002). Physical activity established during the early years is important, because it can provide the greatest likelihood of impact on mortality and longevity. Also, there is a need for guidelines for physical activities, on the basis of evidence, for children of all ages ( Hills et al., 2007). Proper development, acquisition of physical fitness (strength, speed), good looks (a positive image of the body), together with the needs for companionship, gaining new friends, fun and learning sport skills - are the main motives for the children of prepubescent and early pubertal age to involve in sport (Bačanac, Petrović, Manojlović, 2011). Unfortunately, many teenagers today are less physically active because most of their free time is spent in front of the computer. While they were more interested in different games during early school age and puberty, in their late adolescence they spend most of their time on different social networks (Facebook, Twitter and others) (Bačanac, Petrović, Manojlović, 2011).

Rather than neglecting a child's engagement in sport, the school should meet a young athlete's needs and enable him or her to successfully engage in sports through an appropriate schooling scheme, appropriate workload, support in update for missed classes due to training and competition, general classroom and school environment supporting the specialty and guide-aid in mastering the school curriculum (Milanović, 2005). The success and future of each nation depends on the young generations that need to acquire not only an enviable level of knowledge and skills through education, but also a significant level of physical abilities. In achieving these physical and mental abilities the participation of young people in sport or physical activity has the greatest significance (Chiu et al., 2016). Unfortunately, there is no doubt that children do not achieve the recommended levels of moderate to high intensity of daily physical activity (Jago et al., 2011;

tivnost je jedna od osnovnih vitalnih čovjekovih potreba, a pokret i kretanje su osnova funkcijanja života. Dugotrajna fizička neaktivnost i nepravilan položaj tijela veoma često dovode do raznih poremećaja i disbalansa u organizmu.

Veliki broj studija su razmatrale odnose između fizičke aktivnosti kod mlađih uzrasta i njene kratkoročne i dugoročne posledice po zdravlje. (Hallal et al., 2006; Rennie et al., 2006; Must and Tubor; 2005; Hills et al., 2007; Froberg and Andersen, 2005; Rodriguez, 2006, prema Zavod za sport i medicinu sporta Republike Srbije, 2016.)

Veoma je bitno naglasiti da fizički aktivna djeca stiču i češće zadržavaju navike da vježbaju tokom cijelog života. Bavljenjem fizičkom aktivnošću stvaraju se preduslovi da postanu zdrave odrasle osobe (Hasselstrom et al., 2002). Važna fizička aktivnost uspostavljena tokom ranih godina može pružiti najveću vjerovatnoću uticaja na smrtnost i dugovječnost. Takođe postoji potreba za smjernicama fizičke djelatnosti na osnovu dokaza za djecu svih uzrasta ( Hills et al., 2007). Pravilan razvoj, sticanje fizičke kondicije (snage, brzine), lijep izgled (pozitivna slika tijela), zajedno sa potrebama za druženjem, sticanjem novih prijateljstava, zabavom i učenjem sportskih vještina - predstavljaju osnovne motive zbog kojih se djeca prepubertetskog i rano pubertetskog uzrasta uključuju u sport (Bačanac, Petrović, Manojlović, 2011). Nažalost, mnogi današnji tinejdžeri su sve manje fizički aktivni, jer većinu slobodnog vremena provode ispred kompjutera. Dok su ih tokom ranog školskog i pubertetskog uzrasta više zanimale različite igrice, u periodu kasne adolescencije oni svoje vrijeme uglavnom troše na različite društvene mreže (facebook, twiter i drugo) (Bačanac, Petrović, Manojlović, 2011).

Umjesto da se zanemaruje djetetovo bavljenje sportom, škola bi trebala izaći mladom sportašu u susret kako bi mu omogućila uspješno bavljenje sportom kroz prikidan režim školovanja, odgovarajuće radno opterećenje, potporu u nadoknađivanju propuštenog radi treninga i natjecanja, opće razredno i školsko ozračje koje podupire iskazivanje posebnosti i pouku-pomoći u savladavanju školskog programa (Milanović, 2005). Uspjeh i budućnost svake nacije zavisi od mlađih generacija koje kroz školovanje treba da steknu ne samo zavidan nivo znanja i vještina, već i značajan nivo fizičkih sposobnosti. U dostizanju tih fizičkih i mentalnih sposobnosti mladih u sportu ili fizičkoj aktivnosti ima najveći značaj (Chiu et al., 2016). Nažalost, nema sumnje da djeca ne postižu preporučene nivo dnevne fizičke aktivnosti umjerenog do visokog intenziteta (Jago et al., 2011; Pearce et al.,

Pearce et al., 2012). To date, various researches have been carried out to identify reasons, as well as the barriers, for participation of young people in physical activity and sport. According to these studies, it is possible to identify some common reasons for participation such as "health" (Brunet & Sabiston, 2011; Egli, Bland, Melton & Czech, 2011) and "pastime" (Cheng et al., 2003; Kondrić, Sindik, Furjan-Mandić, & Schiefler, 2013). It should be emphasized that the results of research have shown that there are different motives between girls and boys to participate in sports activities (Eagli et al., 2011; Guedes, Santos Legnani, & Legnani, 2013; Santos Legnani, Pinto Guedes, Legnani, Cordeiro Barbosa Filho, & de Campos, 2011). Maureen Weiss and Caja Ferrer expressed the view that, in addition to the already mentioned barriers to inclusion in sports, which are reflected in the lack of time, there is also a lack of entertainment, problems with the coach, the obligation to attend the training sessions, emphasized need for winning and greater interest in other activities (2002). One of the barriers to youth participation in sports is the lack of parental interest in sport, their concern for safety in training and competition, maintaining balance between sports and other areas of life, as well as costs (Maniam, 2017), since higher incomes of parents increase the likelihood that children will participate in sports (Nezhad, Rahmati, & Nezhad, 2012). However, the role of the parents is more important in the childhood phase compared to the adolescent phase, and this is particularly influenced by the mother (Chan, Lonsdale, & Fung, 2012). Many young people do not participate in sports activities because they feel that current physical activity is sufficient, they give an excuse that they do not have anyone with whom they would be "active", followed by preference for watching TV or playing electronic games (Wilson, 2006). It must also be taken into account that the position of physical education in higher education differs from that in primary and secondary schools where physical education is given place in the curriculum (Cerar et al., 2017).

The aim of this paper was to determine which reasons, in the opinion of those who did not deal with sports, were most responsible for dropping out of sports and sports activities. The research was conducted in accordance with ethical standards of the University of Banja Luka and the legal regulations of Bosnia and Herzegovina.

## METHODS

In the survey sample, 226 high school students, and undergraduate and master students in Banja Luka were included. These are pupils from the first to the fourth grade of the Secondary School of Economics from Banja Luka

2012). Do danas su provedena različita istraživanja kako bi se identifikovali razlozi za sudjelovanje, kao i potencijale barijere, mladim u fizičkoj aktivnosti i sportu. Shodno tim istraživanjima moguće je utvrditi neke uopštene razloge za sudjelovanje, kao što su „zdravlje“ (Brunet & Sabiston, 2011; Egli, Bland, Melton, & Czech, 2011) i „razonoda“ (Cheng et al., 2003; Kondrić, Sindik, Furjan-Mandić, & Schiefler, 2013). Potrebno je naglasiti da su rezultati istraživanja pokazali da postoje različiti motivi između djevojaka i momaka za učestvovanje u sportskim aktivnostima (Eagli et al., 2011; Guedes, Santos Legnani, & Legnani, 2013; Santos Legnani, Pinto Guedes, Legnani, Cordeiro Barbosa Filho, & de Campos, 2011) Maureen Weiss i Caja Ferrer iznijeli su mišljenje da pored već spomenute barijere uključivanju u sport, a koja se ogleda u nedostaku vremena, tu su još i nedostatak zabave, problemi sa trenerom, obaveza dolaska na treninge, naglašavanje potrebe za pobjedovanjem i veće interesovanje za druge aktivnosti (2002). Jedna od barijera učešća mladih u sportu je nedostatak roditeljskog interesa za sport, njihova briga da li je trening i takmičenje sigurno, održavanje ravnoteže između sporta i drugih oblasti života, kao i troškovi (Maniam, 2017), jer što su viši prihodi roditelja veća je vjerovatnoća da će djeca učestvovati u sportu (Nezhad, Rahmati, & Nezhad, 2012). Međutim, uloga roditelja je važnija u fazi detinjstva u poređenju sa fazom adolescenata, a tu posebno do izražaja dolazi uticaj majke (Chan, Lonsdale, & Fung, 2012). Mnogi od mladih ljudi ne učestvuju u sportskim aktivnostima zato jer smatraju da trenutna fizička aktivnost je dovoljna, izgovor da nemam nikoga sa kim bi bio „aktivan“, nakon čega slijedi preferencija za gledanje TV-a ili igranje elektronskih igara (Wilson, 2006). Takođe, mora se voditi računa da se položaj fizičkog vaspitanja u visokom obrazovanju razlikuje se od onog u osnovnim i srednjim školama gde je fizičkom vaspitanju dano mjesto u nastavnom planu i programu (Cerar et al., 2017).

Cilj ovog rada bio je da se utvrdi koji su to razlozi, po mišljenju ispitanika koji se nisu bavili sportom, najviše odgovorni za odustajanje od sporta i sportskih aktivnosti. Istraživanje je sprovedeno u skladu sa etičkim standardima Univerziteta u Banja Luci i zakonskom regulativom Bosne i Hercegovine.

## METHODS

U uzorak ispitanika istraživanjem je obuhvaćeno 226 učenika srednjoškolaca i studenata osnovnog i master studija u Banjoj Luci. To su srednjoškolaci od prvog do četvrtog razreda Škole učenika u privredi iz Banje Luke i studenti Banjalučkog univerziteta (Fakultet fizič-

and students of the University of Banja Luka (Faculty of Physical Education and Sports, Faculty of Civil Engineering and Faculty of Philosophy). Young people, who have never been involved in sport, or any sporting or recreational activities, are those to which this research relates.

As can be seen at first glance, this was a targeted or deliberate sample that was competent to answer the questions posed by this topic. If one takes a random sample of the populations, with respect to this issue, it could lead to less valid and less reliable responses, ratings, and attitudes. (Mijanovic, Vojvodic 2008) The sample of variables are questions related to gender, occupation, age, alcohol consumption, smoking, and place of residence, as well as, issues related to attitudes about young people leaving sporting lifestyle (sports, sports and recreational activities, fitness, gym) or they were not even involved in it. The respondents expressed their views on the extent to which the listed reasons (causes) influence their avoidance of sport and sport activities. These are: 1. Obligations (school, study), 2. Job, 3. Lack of interests, 4. Laziness, 5. Lack of talent, 5. TV, computers, mobile phones, 6. Sport is no longer in fashion, 7. Social environment, people I spend time with, 8. Insufficient funds, lack of money. In the selection of variables, special attention was paid to the reliability of the type of internal consistency, which was satisfactory (Cronbach alpha  $\alpha = .63$ ), to enable the research objective to be achieved. A five-point Likert scale was used to examine the views, where five possible views are offered: I generally disagree, disagree, partially agree with, agree, and completely agree.

To determine how each of the above reasons, in the opinion of the respondents, participates in neglecting sports and sports activities, the percentages, the absolute and the cumulative frequencies of each cause are computed individually. It was tested if there are significant differences in attitudes about the reasons that lead to the avoidance and neglect of sports and sports activities between the sexes, then university students and secondary school pupils, smokers and non-smokers. In the end, the mentioned variables were computed to determine whether the place of residence and consumption of alcohol in the opinion of the respondents affect the sport and sport activities. In order to establish these differences, the non-parametric statistical methods of Man-Whitney U test and Kruskal-Wallis H test were used, which are nonparametric alternatives to t and single-factor analysis of variance of different groups. Statistical analysis were carried out using the IBM SPSS 22 statistical program, while all statistically significant differences were commented at  $p < 0.05$  level of significance.

kog vaspitanja i sporta, Građevinski fakultet i Filozofski fakultet). Mladi koji se nikad nisu bavili ni sportom, ni bilo kakvim sportskim i rekreativnim aktivnostima, jesu oni na koje se ovo istraživanje odnosi.

Kao što se može vidjeti na prvi pogled, ovdje se radilo o ciljanom, odnosno namjernom uzorku koji je kompetentan da odgovori na postavljena pitanja iz ove problematike. Ako bi se uzeo uzorak po principu slučajnosti iz populacije stanovništva po navedenoj problematici, moglo bi da dovede do manje valjanih i manje pouzdanih odgovora, ocjena i stavova. (Mijanović, Vojvodić 2008.)

Uzorak varijabli predstavljaju pitanja vezana za pol, zanimanje, godine starosti, konzumiranje alkohola, pušenje i mjesto stanovanja, kao i pitanja vezana za stavove o razlozima zbog kojih mladi odustaju od sportskog načina života (sport, sportske i rekreativne aktivnosti, fitnesi, te-retane itd.) ili se njima nisu ni bavili.

Ispitanici su iznosili svoje stavove o tome u kojoj mjeri nabrojani razlozi (uzroci) utiču na njihovo izbjegavanje sporta i sportskih aktivnosti. To su: 1. obaveze (škola, studiranje), 2. posao, 3. odsustvo interesa, 4. lijepost, 5. netalentovanost, 5. televizor, računari, mobilni telefoni, 6. sport više nije u modi, 7. društvo u kojem se krećem, 8. nedostatak novca. Kod izbora varijabli posebna pažnja se obratila da one imaju pouzdanost tipa interne konzistencije, koja je bila zadovoljavajuća (Cronbach alfa  $\alpha = .63$ ), a da omoguće ostvarenje cilja istraživanja. Za ispitivanje stavova upotrebljena je petostepena Likertova skala gdje se nudi pet mogućih stavova: uopšte se ne slažem, ne slažem se, djelimično se slažem, slažem se, potpuno se slažem.

Za utvrđivanje koliko pojedinačno svaki od navedenih razloga, po mišljenju ispitanika, učestvuje u zanemarivanju sporta i sportskih aktivnosti, uradjeni su procenti, apsolutne i kumulativne frekvencije svakog uzroka pojedinačno.

Da se vidi postoje li značajne razlike u stavovima o razlozima koji dovode do izbjegavanja i zanemarivanja sporta i sportskih aktivnosti između polova, zatim studenata i srednjoškolaca, pušača i nepušača. Na kraju, da se utvrdi da li mjesto stanovanja, te konzumacija alkohola po mišljenju ispitanika utiče na bavljenje sportom i sportskim aktivnostima. Da bi se ustanovile ove razlike korištene su neparametrijske statističke metode Man-Vitnijev U test i Kruskal-Volosov H test koji su neparametrijske alternative t testu i jednofaktorskoj analizi varijanse različitih grupa. Statističke analize provedene su pomoću statističkog programa IBM SPSS 22, dok su sve statistički značajne razlike komentirane na nivou značajnosti  $p < 0.05$ .

## RESULTS AND DISCUSSION

Of the 226 surveyed university students and secondary school pupils, 110 stated that they were never engaged in sports, or any sports activities or recreation, which was almost half of all surveyed, more precisely 48.67% of them, and research is related to them. In the age of 15+, only 50% of young people reach the recommended level of physical activity (Women's Sport and Fitness Foundation, 2011). Research, and in sports well-developed countries such as Australia, did not show much better results, as 40% of young adolescents aged 15 and over did not participate in sports activities (Sports and Physical Recreation: A Statistical Overview, 2012).

**Tabela 1.** Distribucija frekvencija i procenti - pol, zanimanje, pušenje, alkohol i mjesto boravka /  
**Table 1.** Distribution, frequency and percentage - gender; occupation, smoking, alcohol and place of residence

Varijable / Variable		f	%
Pol / Gender	Muško / Male	76	65.5
	Žensko / Female	40	34.5
Zanimanje / Occupation	Student / Student	61	52.6
	Učenik / Pupil	55	47.4
Pušenje / Smoking	Pušač / Smoker	19	16.4
	Nepušač / Non smoker	97	83.6
Konzumira alkohol / Consumes alcohol	Da / Yes	22	19.0
	Ponekad / Sometimes	55	47.4
	Ne / No	39	33.6
Mjesto boravka / Place of residence	Grad / City	52	44.8
	Prigradsko naselje / Suburb	40	34.5
	Selo / Village	24	20.7

**Tabela 2.** Stavovi o razlozima zanemarivanja sporta i sportskih aktivnosti /  
**Table 2.** Attitudes about the reasons for neglecting sports and sports activities

Varijable / Variable	Uopšte se ne slažem / Strongly disagree		Ne slažem se / Disagree		Neodlučan sam / Indecisive		Slažem se / Agree		Potpuno se slažem / Completely agree		Ukupno / Total	
	f	%	f	%	f	%	f	%	f	%	N	%
1	2	1.8	14	12.7	27	24.5	49	44.5	18	16.4	110	100
2	7	6.4	21	19.1	26	23.6	47	42.7	9	8.2	110	100
3	3	2.7	9	8.2	23	20.9	52	47.3	23	20.9	110	100
4	5	4.5	12	10.9	11	10.0	58	52.7	24	21.8	110	100
5	12	10.9	34	30.9	33	30.0	29	26.4	2	1.8	110	100
6	7	6.4	15	13.6	20	18.2	50	45.5	18	16.4	110	100
7	51	46.4	38	34.5	15	13.6	6	5.5	-	-	110	100
8	13	11.8	36	32.7	28	25.5	30	27.3	3	2.7	110	100
9	11	10.0	24	21.8	20	18.2	37	33.6	18	16.4	110	100

**Legend:** 1- Disregarding sports and sports activities due to obligations (school, study), 2- Disregarding sports and sporting activities due to job, 3- Disregarding sports and sports activities due to lack of interest, 4- Disregarding sports and sports activities due to laziness, 5- Disregarding sports and sports activities due to lack of talent, 6-Neglected sports and sp. activities due to television, computers, cell phones, 7- Disregarding sports and sports activities because sport is not in fashion, 8- Disregarding sports and sports activities due to the social environment, 9- Disregarding sports and sports activities due to lack of money

## REZULTATI I DISKUSIJA

Od 226 anketiranih studenata i srednjoškolaca 110 se izjasnilo da se nisu nikad bavili ni sportom, niti bilo kakvim sportskom aktivnostima i rekreacijom što skoro polovinu od svih anketiranih, preciznije 48,67% i na njih odnosi ovo istraživanje. U uzrastu od 15+ godina samo 50% mladih dostiže preporučeni nivo fizičke aktivnosti (Women's Sport and Fitness Foundation, 2011). Istraživanja, i u tako sportski razvijenim zemljama kao što je Australija, nisu pokazala puno bolje rezultate, jer 40% mladih adolescenata u dobi od 15 i više godina nije učestvovalo u sportskim aktivnostima ("Sports and physical recreation: A statistical overview", 2012).

Among the reasons (causes) that are responsible for the avoidance of and non-participation in sports and sports activities, in the opinion of the respondents, the lack of interest in sports, with 90% of the respondents' votes, was in the first place. The second by importance is obligations in the school and at the faculty, which is confirmed by 85% of the respondents. Laziness followed, where they were very self-critical and sincere, confirming in a percentage of 84.5% that this was one of the reasons for their abstinence from sports and sports activities. Immediately behind laziness are television, computers and cell phones comprising about 80% and so on. Other authors in articles on a similar subject came to approximately equal results. Research has shown that there are barriers to inclusion of young people in physical activities and sport (Mugwedi & Mulibana, 2014; Peters et al., 2014). Before others, these are lack of time, schooling, lack of motivation, a health problem, unhealthy friends to participate in sports activities, lack of facilities and weather conditions (Buckworth & Dishman, 2002, Nolan & Surujal, 2011, Shifman, Moss, Andrade, Eichel, & Forrester, 2011; Thatcher, 2009). Ljubičić, Antelković, Antelković (2016) investigated why the young people massively leave the athletics in Croatia and came to the conclusion that, according to the subjective opinion of the respondents, the most common reasons for giving up are of the motivational nature, followed by the requirements of the school (faculty or employment), which were too high, as well as severe injuries.

### ***Differences in attitudes about engagement in sports and sports activities***

The results of the Man Whitney test have shown that the gender is not a source of significant differences in attitudes about the reasons for avoiding sports and sports activities, which is somewhat unexpected and the reason is unclear, especially given the results of similar studies. When it comes to gender differences in the observation of a motivational climate, the obtained results show that girls, to a greater extent, estimate that others significantly create a learning-oriented motivational climate. Girls observe that a mother and father, as well as a coach and a playmates, create motivational climate that is more focused on learning, while boys realize that playmates create motivational climate for achievement, as previously demonstrated (Vesković, Valdevit, & Đorđević-Nikić, 2013)

Table 3 shows the results of Man-Whitney U test, which relates to an assumption that pupils and students have different attitudes about the influences on engagement in sport and spots activities. Their attitudes are significantly different regarding the fact that sports and sports activities are neglected due to: obligations (school, study)

Od ponudjenih razloga(uzroka) koji su odgovorni za izbjegavanje i neučestvovanje u sportu i sportskim aktivnostima po mišljenju ispitanika, na prvom mjestu je odsustvo interesa za sport za koje se izjasnilo oko 90% anketiranih. Drugi po značaju su obaveze u školi i na fakultetu i to je potvrđilo njih 85%. Dalje slijedi lijenos, gdje su bili veoma samokritični i iskreni, potvrdivši u procentima od 84.5%, da je to jedan od razloga njihove apstinencije od sporta i sportskih aktivnosti. Odmah iza lijenosu televizija, računari i mobiteli oko 80% i tako dalje. Do približnih rezultata došli su i drugi autori u radovima na sličnu temu. Istraživanja su pokazala da postoje i barijere uključivanju mladih u fizičku aktivnost i sport (Mugwedi & Mulibana, 2014; Peters et al., 2014). Prije svega, to su nedostatak vremena, obaveze u školi, nedostatak motivacije, zdravstveni problem, nezainteresovanost prijatelja da učestvuju u sportskim aktivnostima, nedostatak objekata i vremenski uslovi (Buckworth & Dishman, 2002; Nolan & Surujal, 2011; Shifman, Moss, D'Andrade, Eichel, & Forrester, 2011; Thatcher, 2009). Ljubičić, Antelković, Antelković (2016) su istraživali zbog čega mladi masovno napuštaju atletiku u Hrvatskoj i došli do zaključka da su prema subjektivnom mišljenju ispitanika najčešći razlozi odustajanja motivacijske prirode, zatim zahtjevi škole (fakulteta ili zaposlenja) koji su bili preveliki, te ozljede teže prirode.

### ***Razlike u stavovima o bavljenju sportom i sportskim aktivnostima***

Rezultati Man-Vitnijevog testa su pokazali da pol nije izvor značajnih razlika u stavovima o razlozima izbjegavanja sporta i sportske aktivnosti, što je pomalo neočekivano i razlog je nejasan, pogotovo imajući u vidu rezultate sličnih istraživanja. Kada su u pitanju polne razlike u opažanju motivacione klime, dobijeni rezultati pokazuju da djevojčice, u većoj mjeri, procjenju da drugi značajno kreiraju motivacionu klimu usmjerenu na učenje. Djevojčice opažaju da majka i otac, kao i trener i saigrači, u većoj mjeri kreiraju motivacionu klimu usmjerenu na učenje, dok dječaci opažaju da saigrači kreiraju motivacionu klimu usmjerenu na postignuće, što su i ranija istraživanja pokazala (Vesković, Valdevit, & Đorđević-Nikić, 2013).

U tabeli 3. su prikazani rezultati Man-Vitnijevog U testa koji se odnosi na pretpostavku da učenici i studenti imaju različite stavove o tome šta utiče na bavljenje sportom i sportskim aktivnostima. Njihovi stavovi se značajno razlikuju u tome da se sport i sportske aktivnosti zanemaruju zbog: obaveza (škola, studiranje)  $p=0.048$ , odsustva interesa  $p=0.005$ , lijenosu  $p=0.000$ , netalen-

**Tabela 3.** Zanimanje kao izvor razlika u stavovima o bavljenju sportom, sportskim aktivnostima /  
**Table 3.** Occupation as a source of difference in attitudes about sports and sports activities

Varijable / Variable	zanimanje / Occupation	N	Mean Rank	Sum of Ranks Man Whitney U test
1	učenik / pupil	57	50.03	2851.50 .048
	student / student	53	61.39	3253.50
	Ukupno / Total	110		
2	učenik / pupil	57	50.12	2857.00.053
	student / student	53	61.28	3248.00
	Ukupno / Total	110		
3	učenik / pupil	57	47.86	2728.00 .005
	student / student	53	63.72	3377.00
	Ukupno / Total	110		
4	učenik / pupil	57	45.42	2589.00 .000
	student / student	53	66.34	3516.00
	Ukupno / Total	110		
5	učenik / pupil	57	49.98	2849.00 .050
	student / student	53	61.43	3256.00
	Ukupno / Total	110		
6	učenik / pupil	57	53.25	3035.50 .418
	student / student	53	57.92	3069.50
	Ukupno / Total	110		
7	učenik / pupil	57	59.74	3405.00 .119
	student / student	53	50.94	2700.00
	Ukupno / Total	110		
8	učenik / pupil	57	53.14	3029.00 .403
	student / student	53	58.04	3076.00
	Ukupno / Total	110		
9	učenik / pupil	57	55.13	3142.50 .897
	student / student	53	55.90	2962.50
	Ukupno / Total	110		

**Legend: Variable:** 1- obligations-school, study 2-job, 3- lack of interest 4- laziness, 5- lack of talent, 6- TV, computers, cell phones, 7- sport is not in fashion, 8- social environment, 9- lack of money , Mean Rank- mean value of ranks, Sum of Ranks- sum of values in ranks

p=0.048, lack of interests p=0.005, laziness p=0.000, lack of talent p=0.050 and due to job p=0.053. Analysing the results of mean values of ranks, with respect to attitudes on causes where there is significant difference between students and secondary school pupils, it can be observed that students in larger extent confirm their attitude, regarding all causes where they differ significantly from pupils.

Table 4 shows the results of the Man-Whitney U test that relate to the assumption that smokers and non-smokers have different attitudes about the reasons that affect engagement in sports and sports activities. The analysis of the results showed that smokers and non-smokers have a statistically significant difference in attitude only in the cases related to the obligations at school and at university p = 0.035. In all other reasons, their attitudes do not differ significantly.

tovanosti p=0.050 i zbog posla p=0.053. Posmatrajući rezultate srednjih vrijednosti rangova u stavovima o razlozima gdje postoji značajna razlika izmedju studenata i srednjškolaca, vidimo da studenti na višem nivou potvrđuju svoj stav kod svih uzroka u kojima se značajno razlikuju od učenika.

U tabeli 4. prikazani su rezultati Man-Vitnijevog U testa koji se odnosi na pretpostavku da pušači i nepušači imaju različite stavove o razlozima koji utiču na bavljenje sportom i sportskim aktivnostima. Analizom rezultata utvrđeno je da pušači i nepušači imaju statistički značajan različit stav samo u slučaju kad je u pitanju razlog koji se odnosi na obaveze u školi i na fakultetu **p = 0.035**. U svim ostalim razlozima njihovi stavovi se značajno ne razlikuju.

**Tabela 4.** Pušenje kao izvor razlika u stavovima o bavljenju sportom, sportskim aktivnostima /  
**Table 4.** Smoking as a source of differences in attitudes about sports and sports activities

Variable / Variables	Pušenje / Smoking	N	Mean Rank	Sum of Ranks Man Whinney U Test
1	pušač / Smoker	27	44.87	1211.50 .035
	nepušač / Non-smoker	83	58.96	4893.50
	Ukupno / Total	110		
2	pušač / Smoker	27	49.54	1337.50 .239
	nepušač / Non-smoker	83	57.44	4767.50
	Ukupno / Total	110		
3	pušač / Smoker	27	47.20	1274.50 .096
	nepušač / Non-smoker	83	58.20	4830.50
	Ukupno / Total	110		
4	pušač / Smoker	27	47.98	1295.50 .124
	nepušač / Non-smoker	83	57.95	4809.50
	Ukupno / Total	110		
5	pušač / Smoker	27	54.17	1462.50 .795
	nepušač / Non-smoker	83	55.93	4642.50
	Ukupno / Total	110		
6	pušač / Smoker	27	51.35	1386.50 .410
	nepušač / Non-smoker	83	56.85	4718.50
	Ukupno / Total	110		
7	pušač / Smoker	27	56.61	1528.50 .822
	nepušač / Non-smoker	83	55.14	4576.50
	Ukupno / Total	110		
8	pušač / Smoker	27	55.81	1507.00 .951
	nepušač / Non-smoker	83	55.40	4598.00
	Ukupno / Total	110		
9	pušač / Smoker	27	60.72	1639.50 .313
	nepušač / Non-smoker	83	53.80	4465.50
	Ukupno / Total	110		

**Legend: Variable:** 1- obligations-school, study 2-job, 3- lack of interest 4- laziness, 5- lack of talent, 6- TV, computers, cell phones, 7- sport is not in fashion, 8- social environment, 9- lack of money , Mean Rank- mean value of ranks, Sum of Ranks- sum of values in ranks

Table 5 shows the results of the Kruskal-Wallis H test, which refers to the assumption that the place of residence (city, suburban settlement, village) can influence attitudes about the reasons for neglecting and avoiding sports and sports activities. By inspecting these results, it can be concluded that the place of residence significantly influences the different view that young people ignore sports and sports activities due to work, on the level of **p = 0.043**. By subsequent analysis of the average (middle) ranking value and the use of the Man-Whitney test, it was confirmed that the source of differences in attitudes is between those who live in the city and those from the village and is **p = 0.016**. It is interesting that those who live in a city confirm their position that the job is responsible for avoiding sports and sports activities higher than those from the village.

The place of residence also significantly influences the attitude that sports and sports activities are avoided and neglected due to lack of interest, where a significant difference was also obtained, **p = 0.042**. As in the previous case, by subsequent analysis of the middle values of the ranks and the Man-Whitney test, it is found that this difference

U tabeli 5 prikazani su rezultati Kruskal-Volosovog H testa koji se odnosi na pretpostavku da mjesto boravka (grad, prigradsko naselje, selo) može uticati na stavove o razlozima zanemarivanja i izbjegavanja sporta i sportskih aktivnosti. Uvidom u ove rezultate može se zaključiti da mjesto boravka značajno utiče na razliku stavova mladih zanemaruju sport i sportske aktivnosti zbog posla, na nivou značajnosti **p=0.043**. Naknadnom analizom prosječnih (srednjih) vrijednosti rangova i upotrebom Man-Vitnijevog testa, potvrđeno je da se izvor razlika u stavovima nalazi izmedju onih koji borave u gradu i onih sa sela i da iznosi **p=0.016**. Interesantno je da oni koji žive u gradu na višem nivou od onih sa sela, potvrđuju svoj stav da je posao odgovoran za izbjegavanje sporta i sportskih aktivnosti.

Mjesto boravka takođe značajno utiče i na stav da se sport i sportske aktivnosti izbjegavaju i zanemaruju zbog odsustva interesa, gdje je takođe dobijena značajna razlika koja iznosi **p=0.042**. Kao i u prethodnom slučaju, naknadnom analizom srednjih vrijednosti rangova i Man-Vitnijevog testa, utvrđeno je da se ta razlika očituje

**Tabela 5.** Mjesto življenja kao izvor razlika u stavovima o u stavovima o bavljenju sportom, sportskim aktivnostima /  
**Table 5.** Place of living as a source of differences in attitudes about sports, sports activities

Varijable / Variables	Mjesto zivljenja / Place of living	N	Mean Rank Kruskal-Wallis H-test
1	grad / city	39	60.24
	prigradsko naselje / suburb	33	49.38 .310
	selo / village	38	55.95
	ukupno / Total	110	
2	grad / city	39	63.94
	prigradsko naselje / suburb	33	55.74 .043
	selo / village	38	46.63
	ukupno / Total	110	
3	grad / city	39	65.08
	prigradsko naselje / suburb	33	51.44 .042
	selo / village	38	49.20
	ukupno / Total	110	
4	grad / city	39	59.13
	prigradsko naselje / suburb	33	56.59 .446
	selo / village	38	50.83
	ukupno / Total	110	
5	grad / city	39	63.45
	prigradsko naselje / suburb	33	56.17 .057
	selo / village	38	46.76
	ukupno / Total	110	
6	grad / city	39	59.15
	prigradsko naselje / suburb	33	53.20 .640
	selo / village	38	53.75
	ukupno / Total	110	
7	grad / city	39	54.19
	prigradsko naselje / suburb	33	52.39 .562
	selo / village	38	59.54
	ukupno / Total	110	
8	grad / city	39	63.90
	prigradsko naselje / suburb	33	56.71 .034
	selo / village	38	45.83
	ukupno / Total	110	
9	grad / city	39	58.71
	prigradsko naselje / suburb	33	58.32 .368
	selo / village	38	49.76
	ukupno / Total	110	

**Legend: Variable:** 1- obligations-school, study 2- job, 3- lack of interest 4- laziness, 5- lack of talent, 6- TV, computers, cell phones, 7- sport is not in fashion, 8- social environment, 9- lack of money , Mean Rank- mean value of ranks, Sum of Ranks- sum of values in ranks

was evident between the city and village inhabitants ( $p = 0.030$ ), but also between the city and the suburban settlement (0.032). There is no significant difference between those living in the suburbs and those from the village.

The assumption that the place of residence (city, suburban settlement, village) can significantly influence

izmedju žitelja grada i sela ( $p=0.030$ ), ali i izmedju grada i prigradskog naselja (0.032). Značajna razlika ne postoji izmedju izmedju koji žive u prigradskom naselju i onih sa sela.

Prepostavka da mjesto boravka (grad, prigradsko naselje, selo) može značajno uticati i na stavove koji se

the attitude that the society in which they live is the reason for neglecting and avoiding sports and sports activities is proved to be correct because Kruskal-Wallis H test showed statistically significant difference at significance level **p = 0.034**. Subsequent analysis of the middle values of the ranks and the use of the Man-Whitney test confirmed that the source of this difference in attitude among those living in the city and those from the village, is **p = 0.011**. In other combinations, these differences are not statistically significant. It should also be said that those who live in the city at a higher level confirm their position that the society in which they move affects the neglect and avoidance of sports and sports activities, which is logical.

## CONCLUSION

Finally, when analysing the results of this research, a few important moments should be emphasized. A poll of 226 high school and university students showed that a large proportion of the surveyed youth (high school and university students) never dealt with, nor did they participate in sports and sports activities (around 48.67%). The reasons why they have never dealt with sports and sports activities are many, and only some are covered by this research. Of the reasons (causes) that are responsible for avoidance and non-participation in sports and sports activities, the lack of interest in these activities is in the first place, which about 90% of respondents stated. When asked whether the absence of young people's interest in these activities is sociological, psychological or otherwise, this research will not provide an answer. This issue should be dealt with by sociologists, psychologists, economists and various ministries in government (Ministry of Sports and Youth, Ministry of Education, Ministry of Health, etc.). This research put emphasis on the reasons or causes that young people mentioned for which they did not engage in sports and sports activities and therefore made the first step to solving this problem. The results showed that male and female sex, then smokers and non-smokers do not differ significantly in attitudes about these reasons. It is the same with those who consume, occasionally consume, and do not consume alcohol. There is a partial difference between high school students and university students in attitudes about some causes, as well as between those who live in the city, suburbs and the village. Summarizing the results of the research, some more, and some less, all of the reasons or causes of avoiding sports and sports activities are high in the hierarchy of those that high school students and university students have recounted as such.

odnose na to da je društvo u kojem se kreću, razlog zanemarivanja i izbjegavanja sporta i sportskih aktivnosti se pokazala kao ispravna, jer je Kruskal-Volosov H test pokazao statistički značajnu razliku na nivou značajnosti **p=0.034**. Naknadnom analizom srednjih vrijednosti rangova i upotrebom Man-Vitnijevog testa potvrđeno je da je izvor te razlike u odnosu u stavovima, izmedju onih koji žive u gradu i onih sa sela i ona iznosi  $p=0.011$ . U drugim kombinacijama te razlike nisu statistički značajne. Treba reći i to da oni koji žive u gradu, na višem nivou potvrđuju svoj stav da društvo u kojem se kreću utiče na zanemarivanje i izbjegavanje sporta i sportskih aktivnosti, što je i logično.

## ZAKLJUČAK

Na kraju, kad se analiziraju rezultati ovog istraživanja, treba naglasiti nekoliko bitnih momenata. Anketa koja je obuhvatila 226 sredjoškolaca i studenata je pokazala da se veliki dio anketirane omladine (sredjoškolci i studenti) nikad nije bavilo, niti učestvovalo u sportu i sportskim aktivnostima (oko 48.67%). Razloga zbog kojih se oni nikad nisu bavili sportom i sportskim aktivnostima ima više, a samo neki su obuhvaćeni ovim istraživanjem. Od ponudjenih razloga(uzroka) koji su odgovorni za izbjegavanje i neučestvovanje u sportu i sportskim aktivnostima na prvom mjestu je odsustvo interesa te aktivnosti, za koje se izjasnilo oko 90% anketiranih. Na pitanje da li je odsustvo interesa mladih za ove aktivnosti sociološke, psihološke ili neke druge prirode, ovo istraživanje neće dati odgovor. Tim pitanjem treba da se bave sociolozi, psiholozi, ekonomisti i razna ministarstva u vlasti (ministarstvo sporta i omladine, ministarstvo prosvjete, ministarstvo zdravlja i td.) Ovo istraživanje je stavilo akcenat i istaklo razloge ili uzroke koje su mladi naveli, zbog kojih se oni ne uključuju u sport i sportske aktivnosti i samim tim napravilo prvi korak rješavanju tog problema. Rezultati su pokazali da se muški i ženski pol, zatim pušači i nepušači, ne razlikuju značajno u stavovima oko ovih razloga. Isto je i sa onima koji konzumiraju, povremeno konzumiraju i ne konzumiraju alkohol. Djelimična razlika postoji izmedju sredjoškolaca i studenata u stavovima o nekim uzrocima, kao i izmedju onih koji stanuju u gradu, prigradskom naselju i selu.

Sumirajući rezultate istraživanja, neki više, a neki manje, svi navedeni razlozi ili uzroci izbjegavanja sporta i sportskih aktivnosti su visoko u hijerarhiji onih koje su sredjoškolci i studenti apostrofirali kao takve.

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Primljen: 01.maj 2019. / Received: May 01, 2019  
 Prihvaćen: 10.jun 2019. / Accepted: June 10, 2019

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ISSN 2232-8211



9 772232 821005