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## RAZLIKE U METABOLIČKO-ENERGETSKIM POTENCIJALIMA FUDBALERA KADETSKOG UZRASTA U ODNOSU NA TAKMIČARSKI NIVO

## DIFFERENCES IN METABOLIC-ENERGY POTENTIAL IN U16 FOOTBALL PLAYERS (CADET AGE) IN RELATION TO COMPETITION LEVEL

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**Apstrakt:** Sa ciljem da se utvrdi razlika metaboličko-energetskih potencijala fudbalera kadetskog uzrasta različitih stepena takmičenja, sprovedeno je istraživanje na uzorku od šezdeset fudbalera starosti 14 do 16 godina. Uzorak ispitanika je podeljen na sledeće subuzorke: igrači fudbalske reprezentacije Srbije (n=20), igrači kvalitetne lige Vojvodine (n=21) i igrači područnog ranga takmičenja (n=19). Određivanje koncentracije laktata u krvi vršeno je uzimanjem kapilarne krvi iz prsta u tri faze Kuperovog testa: koncentracija laktata u miru merena je pre početka opterećenja-testa, koncentracija laktata u opterećenju merena je jedan minut po završetku testa i koncentracija laktata u oporavku merena je u desetoj minuti oporavka. Rezultati istraživanja ukazuju na postojanje statistički značajnih razlika navedenih grupa u odnosu na analizirane metaboličko-energetske vrednosti fudbalera.

**Ključne reči:** fudbaleri, laktati, kadeti, metaboličko-energetski procesi

**Abstract:** In order to determine the difference in metabolic-energy potential in U16 football players (cadet age) at different levels of competition, a survey was conducted on a sample of sixty players aged 14 to 16. The sample of respondents is divided into the following subsamples: players of Serbian national football team (n=20), players from high-quality league of Vojvodina (n=21) and the players from the regional competition levels (n=19). The lactate blood level was determined by testing capillary blood from the finger during three stages of Cooper test: the concentration of lactate in the standstill stage was measured before the start of the test – before the load; the concentration of lactate during the load stage was measured one minute after completion of the test; and the concentration of lactate in the recovery stage was measured in the tenth minute of recovery. The survey results indicate a statistically significant difference between the said groups of players in relation to the analyzed metabolic-energy parameters of the players.

**Keywords:** football players, lactates, cadets (U16 age), metabolic-energy processes

### Uvod

Fudbal karakteriše kombinacija kratkotrajnih aktivnosti visokog intenziteta i dugotrajnih aktivnosti srednjeg i niskog intenziteta. Tokom utakmice, posmatrajući bioenergetske procese stvaranja energije, organizam fudbalera uključuje sve izvore energije. Od izuzetnog značaja je da organizam fudbalera ne zapadne u energetske krizu. Samo pravilan trenažni rad baziran na formiranim individualnim zonama rada omogućuje maksimalno iskorišćenje energetskih potencijala fudbalera (Higgins i sar. 2009).

Profesionalni fudbaler mora posedovati visok aerobni kapacitet i istovremeno, za fudbal specifičan ana-

### INTRODUCTION

The football is characterized by a combination of short-term high-intensity activities and long-term medium and low intensity activities. During the game, regarding the bioenergetic processes of generation of energy, the body of a football player activates all energy sources. It is of utmost importance that the body of the player does not fall into an energy crisis. Only proper training process based on defined individual work zones allows maximum utilization of energy resources of the player (Higgins et al. 2009).

A professional football player must have a high aerobic capacity and at the same time, the football-specific anaerobic capacity (Ekblom, 1986). During the game the

erobni kapacitet (Ekblom, 1986). Tokom utakmice igrač često pređe u različitom tempu trčanja distancu od devet do dvanaest kilometara (Jeffreys, 2008; Burgess i sar., 2006; Mohr i sar., 2003; Bangsbo, 2003; Ohashi i sar., 1988). Snaga, izdržljivost i brzina kao spoljašnje manifestacije energetske-metaboličkih procesa su presudne motoričke sposobnosti u uspešnosti fudbalske igre, ali se ni jedna od njih ne ispoljava samostalno, već u međusobnoj kombinaciji. Ovakav vid sportskog opterećenja je produkt specifične međuzavisnosti koja postoji između metaboličkih i kardiorespiratornih parametara.

Promena nivoa metabolita u krvi, odnosno proces stvaranja i eliminacije iz organizma, u direktnoj je zavisnosti od trajanja rada, intenziteta, i stanja treniranosti fudbalera. Sistematskim praćenjem promena laktata u krvi tokom različitih opterećenja mogu se precizno formirati zone rada i dobiti pouzdani podaci o stanju treniranosti sportiste.

Glavni cilj ovog istraživanja je utvrđivanje razlika između fudbalera različitih nivoa takmičenja u odnosu na stepen adaptacije na laktate, kao i na brzinu eliminacije istih iz organizma, odnosno određivanje vremena oporavka sportiste.

## METOD RADA

### *Uzorak ispitanika*

Uzorak ispitanika u istraživanju obuhvata dečake starosti od 14 do 16 godina. Po fudbalskoj kategorizaciji ovaj uzrast spada u kadete. Prvi subuzorak čini dvadeset selektovanih igrača fudbalske reprezentacije Srbije. Drugi subuzorak čini dvadeset i jedan igrač F.K. „Spartak“ iz Subotice koji se takmiče u okviru kvalitetne lige Vojvodine. Treći subuzorak čini devetnaest fudbalera F.K. „Bačka“ iz Subotice i F.K. „Radnički“ iz Bajmoka koji se takmiče u područnom rangu. Kriterijum za izbor ispitanika pored hronološke starosti je: da je ispitanik osoba muškog pola; da je zdravstveno sposobna za bavljenje sportom-fudbalom i da je bez ikakvih morfoloških i motoričkih aberacija.

### *Postupci istraživanja*

Za potrebe istraživanja primenjen je Kuperov test, koji predstavlja najpoznatiji terenski test za indirektno određivanje  $VO_{2max}$ . Test je odrađen na atletskoj stazi dugoj 400 m, i obeleženoj na svakih 50 i 10 metara, radi lakšeg očitavanja rezultata. Zadatak fudbalera je bio da pređe što dužu deonicu trčanjem za 12 minuta. Pre početka testa sprovedeno je zagrevanje u trajanju od 15 minuta. Jednu grupu činilo je osam ispitanika,

player often goes a running distance of nine to twelve kilometers with a different running pace (Jeffreys, 2008; Burgess et al., 2006; Mohr et al., 2003; Bangsbo, 2003; Ohashi et al., 1988). Strength, endurance and speed as the external manifestation of the energy-metabolic processes represent essential motor skills for the success during the football game, but none of them manifests itself individually, but in combination with each other. This kind of sport load is the product of the specific interdependence that exists between the metabolic and cardiorespiratory parameters.

Changes in levels of metabolites in the blood, i.e. the process of their creation and elimination from the body, is directly depending on the duration of training, intensity and fitness status of a player. Systematic monitoring of changes in lactate levels at different loads can be used for precise definition of zones of work and obtaining reliable data on the state of fitness of the athlete.

The main objective of this research is to determine the differences between the players from different levels of competition in relation to the degree of adaptation to lactates, as well as to the rate of elimination of the same from the body, i.e. to determine the time needed by athlete to recover.

## METHOD

### *The sample of respondents*

The sample in the study includes boys aged 14 to 16. According to the football classification this age group is categorized as cadets (U16 age). The first sub-sample is made of twenty selected players of the national football team of Serbia. The second subsample comprises twenty-one players of the FC “Spartak” from Subotica who compete within the high-quality league of Vojvodina. The third subsample included nineteen players of FC “Bačka” from Subotica and FC “Radnički” from Bajmok who compete in the regional level of competition. In addition to chronological age, criteria for the selection of respondents were: the respondents were males; the respondents were medically fit for engaging in sports-football and the respondents had no morphological and motor abnormalities.

### *Research methods*

For the purpose of this research Cooper test was applied, which is the most known field test for the indirect determination of  $VO_{2max}$ . The test was conducted on the 400 m long track, marked at every 50 and 10 meters, for easy reading of the results. The players were asked to cross as long as possible distance by running 12 minutes. Before starting the test a 15 minutes warm-up was conducted. One group consisted of eight respondents, the start was individual, and the time difference

start je bio pojedinačan, a razlika između starta dva ispitanika iznosila je 1 min. Nakon testa ispitanik je nastavljao hodom do zapisničkog stola da bi se izvršilo merenje laktata. Za određivanje laktata u krvi korišćen je elektronski laktat analizator marke "Accusport" firme Boehringer Mannheim. Aparat registruje vrednosti laktata u opsegu od 0,7 mmol/l do 27 mmol/l, a vreme potrebno za merenje iznosi oko 60 sekundi. Metabolička merenja obavljana su u prepodnevni časovima, u terenskim uslovima i svi fudbaleri su bili upoznati sa procedurom merenja. Određivanje koncentracije laktata u krvi vršeno je uzimanjem uzoraka kapilarne krvi sportista iz prsta. Ispitanik je prilikom merenja bio u sedećem položaju sa podignutom rukom iznad nivoa srca, a sa ciljem smanjenja venske primese koja je u jagodici prsta i inače jače izražena. Pre početka merenja na jagodicu prsta utrljana je mala količina finalgon masti da bi se osigurala hiperemija i sprečila koagulacija krvi. Za uzorak se uzimala krupna kap krvi koja se nanosila na reagentnu traku u tri faze testiranja.

#### ***Uzorak varijabli***

Za procenu metaboličko-energetskih potencijala fudbalera u ovom istraživanju primenjene su sledeće varijable: koncentracija laktata u miru (mmol/l) - merena je pre početka opterećenja, odnosno Cooper-ovog testa, koncentracija laktata u opterećenju - merena je 1 minut po završetku opterećenja i koncentracija laktata u oporavku - merena je u desetoj minuti oporavka. Celu proceduru merenja vršio je isti merilac, istim instrumentom i istom tehnikom merenja.

#### ***Statistička analiza***

Za analizu osnovnih statističkih podataka i distribucije rezultata u ovom radu su prikazani: srednja vrednost, standardna devijacija, minimum i maksimum svih vrednosti, koeficijent varijacije, interval poverenja, mere asimetrije Skjunis, mere spoljoštenosti Kurtozis i vrednost testa Kolmogorov-Smirnov. Za utvrđivanje razlika između grupa primenjeni su multivarijantni postupci MANOVA i diskriminativna analiza. Od univarijantnih postupaka primenjeni su ANOVA i t-test za male nezavisne uzorke. Izračunavanjem koeficijenta diskriminacije izdvajaju se obeležja koja određuju specifičnost subuzoraka i obeležja koje je potrebno isključiti iz dalje obrade, odnosno vrši se redukcija posmatranog prostora.

#### **REZULTATI I RASPRAVA**

Procena metaboličko-energetskih potencijala urađena je na osnovu merenja nivoa laktata u tri faze testiranja

between the start of two successive respondents was 1 min. After the test, respondents were asked to keep walking to the scorer's table for measurement of lactate blood level. Electronic lactate analyzer of brand "Accusport" produced by the company Boehringer Mannheim was used to determine the lactate blood level. The apparatus registers lactate values in the range from 0.7 mmol/l to 27 mmol/l, and the time required for measurement is around 60 seconds. Metabolic measurements were performed in the morning, on field and all the players were familiar with the measurement procedure. Determination of the lactate blood level was carried out by sampling capillary blood from the finger of these athletes. Respondents were seated during measurement with their arms raised above heart level, in order to reduce venous admixture which is normally more pronounced at the tips of the fingers. Before the measurement a small amount of finalgon ointment was rubbed on player's finger to ensure hyperemia and prevent blood coagulation. A large drop of blood was taken for a sample, and then applied on reagent-grade strip in three phases of testing.

#### ***The sample of variables***

To assess metabolic-energy potential in football players in this study, the following variables were used: the concentration of lactate in standstill position (mmol/l) - measured before the physical load, i.e. Cooper test, the concentration of lactate during the physical load - measured 1 minute after the end of the test and the concentration of lactate during the recovery - measured in the tenth minute of recovery. The entire measurement procedure was performed by the same measurer, with the same instrument and the same technique of measurement.

#### ***Statistical analysis***

For the analysis of basic statistics and distribution of results in this paper the following parameters are shown: the mean, standard deviation, minimum and maximum of all values, the coefficient of variation, confidence intervals, skewness as measure of asymmetry, kurtosis as measure of tailedness and the value of Kolmogorov-Smirnov test. To determine differences between groups, multivariate methods MANOVA and discriminant analysis were applied. Regarding univariate methods, ANOVA and t-test for small independent samples were applied. By calculating the coefficient of discrimination we were able to determine the characteristics that describe the specificity of the subsamples and characteristics that need to be excluded from further processing, that is performed by reduction of the observed area.

#### **RESULTS AND DISCUSSION**

Assessment of the metabolic-energy potential was performed on the basis of measuring the level of lactate in

nja. Pre početka Kuperovog testa mereni su laktati u miru (LAKTMI), neposredno po završetku testa, odnosno u prvom minutu oporavka mereni su laktati u opterećenju (LAKOPT) i na kraju u desetom minutu mereni su laktati u oporavku (LAKOPO).

three stages of testing. Lactates levels were measured before the start of the Cooper test, in standstill position (LAKTMI), under load immediately after the completion of the test, i.e. in the first minute of the recovery (LAKOPT) and finally in the tenth minute of the recovery (LAKOPO).

**Tabela 1.** Osnovni statistički parametri metaboličko-energetskih potencijala fudbalera u odnosu na stepen takmičenja

**Table 1.** Basic statistical parameters of metabolic-energy potential in football players in relation to the level of competition

**igrači reprezentacije / National team players**

	Mean	St. dev	Min	Max.	C. Var.	Interval	Sk	Ku	K-S	
LAKTMI	2.56	.69	1.4	4.3	27.07	2.23	2.88	.60	.09	.787
LAKOPT	12.33	1.59	10.0	15.5	12.87	11.59	13.07	.49	-.67	.873
LAKOPO	8.47	2.25	4.8	12.6	26.58	7.41	9.52	.24	-1.07	.892

**igrači kvalitetne lige Vojvodine / players from high-quality league of Vojvodina**

LAKTMI	2.11	.79	1.2	3.9	37.67	1.74	2.47	.74	-.44	.586
LAKOPT	12.29	2.71	5.7	16.6	22.05	11.05	13.52	-.53	-.00	1.000
LAKOPO	9.64	2.83	6.0	16.1	29.34	8.35	10.93	.70	-.58	.330

**igrači područnog ranga / players from regional competition level**

LAKTMI	2.34	.51	1.4	3.1	21.88	2.10	2.59	-.19	-1.08	.651
LAKOPT	10.81	3.27	3.0	16.2	30.26	9.23	12.39	-.54	.14	1.000
LAKOPO	8.32	2.73	3.1	11.8	32.81	7.00	9.63	-.66	-.89	.983

**Legenda:** Mean- aritmetička sredina; St.dev.-standardna devijacija; Min.-minimalni rezultat; Max.-maksimalni rezultat; C.Var.-koeficijent varijacije; Interval- interval poverenja; Sk.-simetričnost krive raspodele rezultata; Ku.-spljoštenost krive raspodele rezultata; K-S –Kolmogorov-Smirnov test normalnosti krivulje distribucije.

**Legend:** Mean- arithmetic mean; St.dev.-standard deviation; Min.-minimum result; Max.-maximum result; C.Var.-coefficient of variation; Interval- confidence interval; Sk.-symmetry of the results distribution curve; Ku.-flatness (tailedness) of the results distribution curve; K-S –Kolmogorov-Smirnov test of distribution curve normality.

Pregledom varijacione širine u svim posmatranim varijablama (tabela 1) može se konstatovati da se rezultati tj. vrednosti nalaze u očekivanom rasponu, kao i da se distribucija vrednosti kreće u okviru normalne raspodele (K-S). Međutim, izrazito odstupanje od srednjih vrednosti, na šta ukazuje koeficijent varijacije, postoji kod svih varijabli, izuzev laktata u opterećenju (12,87 mmol/l) kod igrača reprezentacije. Ove vrednosti navode na činjenicu da su grupe prilično heterogene u odnosu na analizirane metaboličko-energetske vrednosti fudbalera. Vrednosti skjunisa (sk) ukazuju na to da nema izražene asimetrije, pa se može konstatovati da se nalaze u granicama dozvoljenih odstupanja. Negativne vrednosti kurtozisa (ku) ukazuju na to da je kriva spljoštena i da je prisutna veća rasplinutost rezultata kod igrača reprezentacije, za vrednost laktata u oporavku (LAKOPO) i kod igrača područnog ranga, za vrednost laktata u miru (LAKTMI). Srednje vrednosti laktata merenih u miru se kreću u opsegu od 2,11 do 2,56 mmol/l, laktata u

By examining the variation width in all observed variables (Table 1) it can be concluded that the results, i.e. values, fall within the expected range, and that the distribution of values is within the normal distribution ranges (K-S). However, a marked deviation from the mean values, as indicated by the coefficient of variation, is observed in all variables, except for lactates level under load (12.87 mmol/l) in the national team players. These values indicate the fact that the groups were quite heterogeneous with respect to the analyzed metabolic-energy values in football players. Skewness values (sk) indicate that there is no marked asymmetry, so it can be concluded that they are within the permissible tolerances. Negative values of kurtosis (ku) indicate that the curve is flattened and that there is a greater lengthiness of results in national team players regarding the level of lactates in the recovery stage (LAKOPO), and regional competition level players regarding the level of lactates in standstill position (LAKTMI). Mean values of lactates



opterećenju od 10,81 do 12,33 mmol/l i laktata u oporavku od 8,32 do 9,64 mmol/l. Navedene srednje vrednosti ukazuju na to da je razlika najmanja kod laktata merenih u miru i da je verovatno statistički neznčajna, dok se u druge dve vrednosti mogu očekivati značajne razlike. Takođe, razlika između vrednosti laktata izmerene neposredno posle opterećenja i u desetom minutu oporavka je najveća kod igrača reprezentacije i iznosi 3,86 mmol/l.

Smatra se (Sudarov i sar., 2000.) da su vrednosti rane faze oporavka dobre ako u desetom minutu nakon opterećenja dobijene vrednosti laktata budu za 1,5 do 2,0 mmol/l manje od vrednosti izmerenih neposredno posle testa (maksimalna vrednost). Takođe, visoka koncentracija laktata uz brzu ranu fazu oporavka, ukazuje na to da fudbaler dobro podnosi opterećenje visokog intenziteta.

Rezultati multivarijantne analize varijanse ( $p = .066$ ) i diskriminativne analize ( $p = .075$ ), prikazane u tabeli 2, ukazuju na postojanje statistički značajne razlike grupa podeljenih prema stepenu takmičenja u odnosu na analizirane metaboličko-energetske vrednosti fudbalera.

**Tabela 2.** Značajnost razlike metaboličko-energetskih potencijala fudbalera u odnosu na stepen takmičenja

	n	F	P
MANOVA	3	2.046	.066
Discr. Analysis	3	1.977	.075

**Legenda:** n-broj varijabli, F- vrednost F-testa za testiranje značajnosti razlika aritmetičkih sredina; p- koeficijent značajnosti razlika aritmetičkih sredina; Discr. Analysis -diskriminativna analiza.

Analiza koeficijenta diskriminacije (tabela 3), ukazuje na to da su najveći uticaj diskriminaciji između različitih stepena takmičenja fudbalera u odnosu na procenu metaboličko-energetskih potencijala imali laktati u opterećenju (LAKOPT .096), dok je razlika manja kod laktata u oporavku (LAKOPO .067) i laktata u miru (LAKTMI .055). Univarijantnom metodom ( $p > .1$ ) nije uočena značajna razlika grupa u posmatranim vrednostima.

measured in standstill position range from 2.11 to 2.56 mmol/l, under the load from 10.81 to 12.33 mmol/l, and during the recovery from 8.32 to 9.64 mmol/l. Mentioned mean values indicate that the difference is smallest for lactates measured in standstill position and they are probably statistically insignificant, while for other two values significant differences are expected. Also, the difference between the lactate levels measured immediately after the load, and in the tenth minute of recovery is greatest in the national team players and amounts 3.86 mmol/l.

It is believed (Sudarov et al., 2000) that the values in the early stage of recovery are good if in the tenth minute after the load lactate values are 1.5 to 2.0 mmol/l less than the values measured directly after the test (maximum value). Also, high concentrations of lactate, followed by fast early phase of recovery, indicate that the player tolerates high intensity load very well.

The results of multivariate analysis of variance ( $p = .066$ ) and discriminant analysis ( $p = .075$ ), shown in Table 2, indicate the existence of statistically significant differences between the groups divided according to the level of competition in relation to the analyzed metabolic-energy values in football players.

**Table 2.** Significance of differences between metabolic-energy potential in football players in relation to the level of competition

**Legend:** n-number of variables, F- values of F-test used for testing the significance of differences between arithmetic means; p- coefficient of significance of differences between arithmetic means; Discriminative analysis - discriminant analysis.

The analysis of the coefficient of discrimination (Table 3) indicates that the greatest impact on discrimination between different levels of competition of football players in relation to the assessment of metabolic-energy potential, was exerted by lactates under load (LAKOPT .096), while the difference is smaller for lactates during the recovery (LAKOPO .067) and lactates in standstill position (LAKTMI .055). Univariate method ( $p > .1$ ) did not reveal any significant differences between the groups for observed values.

**Tabela 3.** Značajnost razlike i koeficijent diskriminacije po pojedinim obeležjima metaboličko-energetskih potencijala fudbalera u odnosu na stepen takmičenja

ANOVA	F	P
LAKTMI	2.247	.115
LAKOPT	2.143	.127
LAKOPO	1.575	.216

**Legenda:** F- vrednost F-testa za testiranje značajnosti razlika aritmetičkih sredina; p- koeficijent značajnosti razlika aritmetičkih sredina; K.dis.- koeficijent diskriminacije.

Na osnovu dosadašnjih razmatranja, analizom homogenosti, mogu se izvesti karakteristike svake grupe i broj unutar grupe. Doprinos karakteristikama fudbalera unutar grupa određen je stepenom diskriminacije, počev od najveće razlike: laktati u opterećenju, laktati u oporavku i laktati u miru.

**Tabela 4.** Homogenost fudbalera različitog stepena takmičenja u odnosu na procenu metaboličko-energetskih potencijala

	m/n	%
igrači reprezentacije / national team players	13/20	65.00
igrači kvalitetne lige Vojvodine / players from high-quality league of Vojvodina	14/21	66.67
igrači područnog ranga / players from regional competition level	10/19	52.63

**Legenda:** m-broj igrača koji poseduje karakteristike grupe; n- broj igrača u grupi; %- procenat igrača koji poseduje karakteristike grupe.

Definisane karakteristike igrača reprezentacije ima 13 od 20 fudbalera, homogenost je 65.0% (veća), što znači da 7 fudbalera ima druge karakteristike, a ne karakteristike svoje grupe. Definisane karakteristike igrača kvalitetne lige Vojvodine ima 14 od 21 fudbalera, homogenost je 66.7% (veća) jer 7 fudbalera ima druge karakteristike. Definisane karakteristike igrača područnog ranga ima 10 od 19 fudbalera, homogenost je 52.6% (manja) jer 9 fudbalera ima druge karakteristike (tabela 4).

Veća homogenost prve dve grupe verovatno je posledica bolje selekcije, za razliku od najnižeg stepena igrača gde selekcija ne postoji i gde za ekipu igraju sva deca koja treniraju u klubu. Na kraju potrebno je napomenuti da su veće vrednosti koncentracije laktata dobijene u ovom istraživanju posledica maksimalnog opterećenja na testu. Tokom utakmice, igrači gotovo nikada ne dolaze u stanje totalne iscrpljenosti što rezultira nižim vrednostima laktata. Potvrdu ovim vrednostima daje istraživanje na devet danskih fudbalera (Krustrup i sar.,

**Table 3.** Significance of differences and the coefficient of discrimination by individual features of metabolic-energy potential in football players in relation to the level of competition

	K. dis.
LAKOPT	.096
LAKOPO	.067
LAKTMI	.055

**Legend:** F- values of F-test used for testing the significance of differences between arithmetic means; p- coefficient of significance of differences between arithmetic means; K.dis.- coefficient of discrimination.

Based on the previous considerations, by using the analysis of homogeneity, characteristics of each group and the number within the group can be derived. Contribution to the characteristics of football players within the groups is determined by the level of discrimination, starting with the biggest difference: lactates under load, lactates during recovery and lactates in standstill position.

**Table 4.** Homogeneity of football players from different levels of competition in relation to the assessment of metabolic-energy potential

	m/n	%
igrači reprezentacije / national team players	13/20	65.00
igrači kvalitetne lige Vojvodine / players from high-quality league of Vojvodina	14/21	66.67
igrači područnog ranga / players from regional competition level	10/19	52.63

**Legend:** m- number of players who possess the characteristics of the group; n- number of players in the group; %- percentage of players who possess the characteristics of the group.

Defined characteristics of a national team player were observed in 13 out of 20 players, homogeneity is 65.0% (higher), which means that seven players have other characteristics, and not characteristics of their group. Defined characteristics of players from high-quality league of Vojvodina were observed in 14 out of 21 players, homogeneity is 66.7% (higher) as 7 players have other characteristics. Defined characteristics of players from the regional competition level were observed in 10 out of 19 players, homogeneity is 52.6% (lower) because 9 players have other characteristics (Table 4).

Greater homogeneity of the first two groups is probably due to better selection, as opposed to the lowest level of competition where there is no player selection and where all children who train at the club also play for the club. Finally, it should be noted that the higher values of blood lactate concentration obtained in this study are the result of the maximum load during the test. During the game, the players almost never come into a state of total exhaustion

2006) kojima je uzorak krvi uziman tokom odigravanja prijateljskog meča: pre utakmice, posle 5, 15 i 45 min. svakog poluvremena, 15 min. posle utakmice i u mirovanju. Tokom mirovanja vrednosti laktata su bile  $0,9 \pm 0,2$  mmol, posle 5 min. igre  $6,7 \pm 0,9$  mmol, posle 15 min. prvog perioda  $7,9 \pm 0,7$  i nakon prvog i drugog poluvremena  $6,0 \pm 0,4$  i  $5,0 \pm 0,4$  mmol. Reilly (1997) u svojim istraživanjima dobija širi raspon vrednosti, i tvrdi da vrhunski fudbaleri tokom igre imaju od 150 do 200 kratkih intenzivnih akcija, tokom kojih se vrednosti laktata kreću u opsegu od 2 do 14 mmol/l, što ukazuje na to da je u velikom procentu utakmice prisutno obnavljanje energije u anaerobnim uslovima.

### ZAKLJUČAK

Vrednosti laktata selektovanih igrača reprezentacije merene neposredno posle opterećenja ukazuju na to da oni imaju najveću vrednost koja iznosi 12,33 mmol/l. Naveden rezultat upućuje na konstataciju da igrači reprezentacije imaju veću toleranciju na laktate i da mogu da podnesu veće koncentracije istih u organizmu. Igrači područnog ranga imaju najmanju vrednost laktata merenih u oporavku (8,32 mmol/l), za razliku od igrača kvalitetne lige (9,64 mmol/l) i igrača reprezentacije (8,47 mmol/l). Međutim, iako igrači reprezentacije nemaju najmanju vrednost laktata u oporavku, imaju najveću razliku između laktata merenih neposredno po završetku testa i u desetom minutu oporavka (rana faza oporavka). Navedena razlika kod igrača reprezentacije iznosi 3,86 mmol/l, kod igrača kvalitetne lige 2,65 mmol/l i kod igrača područnog ranga 2,49 mmol/l.

Vrednosti laktata igrača reprezentacije ukazuju na njihovu sposobnost za opterećenje u formi brzinsko sprinterske i brzinsko distancione izdržljivosti koja je u najvećoj meri prisutna u fudbalskoj igri.

Rezultati ovog istraživanja ukazuju na značaj anaerobnog laktatnog procesa stvaranja energije u uspešnosti fudbalske igre posmatran kroz različit takmičarski nivo. Igrač tokom utakmice veliki deo igre provodi u režimu preko 4 mmol/l, odnosno u anaerobnim uslovima obezbeđuje energiju potrebnu za rad.

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*Mi izjavljujemo da nemamo konflikt interesa.*

resulting in lower values of lactates. Confirmation of these values gives the research on nine Danish players (Krustrup et al., 2006) where a blood sample was taken during the friendly match: before the game, after 5, 15 and 45 min. during each half, 15 min. after the game and in standstill position. During the standstill position the values of lactate levels were  $0.9 \pm 0.2$  mmol, after 5 min. of the game  $6.7 \pm 0.9$  mmol, after 15 min. of the first period  $7.9 \pm 0.7$  and after the first and second half of  $6.0 \pm 0.4$  and  $5.0 \pm 0.4$  mmol. Reilly (1997) in his research gains a wider range of values, and claims that top players during the game have from 150 to 200 short intensive actions, during which the lactate values range from 2 to 14 mmol/l, which indicates that during the great part of the game there is a process of energy recovery in anaerobic conditions.

### CONCLUSION

The values of lactates in selected national team players measured immediately after the load point to the fact that they have the highest value, which amounts to 12.33 mmol/l. This result indicates the conclusion that national team players have a higher tolerance to lactate, and can tolerate a higher concentration of the same in the body. Players from the regional competition level have the lowest level of lactate measured during the recovery (8.32 mmol/l), unlike high-quality league players (9.64 mmol/l) and the national team players (8.47 mmol/l). However, although the national team players have the least amount of lactates during the recovery, they also exert the greatest difference between the lactates level measured immediately after the test and in the tenth minute of recovery (early recovery phase). The said difference in national team players amounts to 3.86 mmol/l, in high-quality league players 2.65 mmol/l, and in regional competition level players 2.49 mmol/l.

The values of lactate in national team players indicate that they are able to engage in high-load activities in the form of speed-sprint and speed-distance endurance which are largely present in a football game.

The results of this study indicate the importance of anaerobic lactate process of creating energy in the performance of the football game at different competitive levels. During the game the player spends a big part of it with lactate levels higher than 4 mmol/l, which means that the player generates energy in anaerobic conditions.

### *Authorship statement*

*The authors have contributed equally.*

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