

## 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 primijenjene su četiri multiple regresione analize. Rezultati regresionih analiza pokazuju da su morfološke karakteristike praćene u ovom istraživanju, relativno slabo povezane sa rezultatima u primijenjenim 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 arise 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 domenija (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 definiše kao kompleksno ispoljavanje motoričkih sposobnosti od kojih zavisi brzo i efikasno povezivanje promjena smjera i ponovnog ubrzanja i usporenja 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 preduslove neophodne za efikasnije ispoljavanje agilnosti.

Nogomet je kompleksna promjenjiva polistrukturalna 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. Biacromial 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 fudbalera zahtijeva visok intenzitet različitih aktivnosti. Međutim, očigledan je nedostatak istraživanja koja su se bavila utvrđivanjem uticaja morfoloških karakteristika na rezultate u testovima agilnosti kod nogometaša. 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 mogućeg intenziteta sa promjenom pravca i smjera, morfološke karakteristike ponašaju kao inercioni faktor, 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 zgloba.....(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 90° and 180° ..... 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 mjerenja 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 mjerenje 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 ponavljani dva puta. Mjerenje morfoloških karakteristika bilo je organizovano posebno, nezavisno od testiranja agilnosti i realizovano je u ranim prijepodnevnim časovima. Mjerenje predviđenih morfoloških karakteristika i testova agilnosti organizovano je i sprovedeno u sportskoj sali ŠŠC "Gemit" u Banja Luci.

Za sve primijenjene varijable izračunati su osnovni deskriptivni parametri. Za utvrđivanje veličine i značaja uticaja odabranih morfoloških karakteristika na rezultate u testovima agilnosti primijenjene 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 standardne 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
NABLED	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 (RO), 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 kompletan 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 (RO) 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	.980
ADUŽNO	-3.000E-5	.002	-.003	-.012	.990
ADUŽRU	-.005	.004	-.341	-1.109	.274
ABIARA	.000	.003	-.030	-.159	.874
ADIJKO	-.023	.024	-.192	-.927	.359
ADIJSZ	-.008	.019	-.087	-.399	.692
ATEŽTJ	.060	.033	1.025	1.812	.078
AOPNAT	-.005	.004	-.407	-1.132	.265
ASROGK	-.003	.003	-.302	-.953	.346
NABTRB	-.013	.027	-.111	-.490	.627
NABLEĐ	.042	.063	.145	.664	.510
NABPOT	-.032	.053	-.119	-.596	.555

**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 Regression	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 (ADIJKO, 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 900 and 1800 (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 (ADIJKO , 0739).

**Regresiona naliza 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

ANOVA

Model	Sum of Squares	df	Mean Square	f	Sig.
1 Regression	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, ADIJKO, 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
ADIJKO	-.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 – dijаметar 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 Regression	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 (ANATR, 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 (ADIJKO). 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 naliza 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 odabranih morfoloških varijabli ne pokazuje statistički značajnu povezanost odabranih 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 (ANATR, 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 odabranih 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 odabranih 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 mjera dijametar koljena (ADIJKO). 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 nivou 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 mjenog svojstva dobijena u različitim testovima za procjenu agilnosti nije ista.

Povezanost izabranih pokazatelja za procjenu morfoloških karakteristika i primijenjenih 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 usporenja, 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 mladim uzrasnim kategorijama fudbalera sa aspekta kvalitetnijeg i svrsishodnijeg programiranja sadržaja trenaznog 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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