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CORRELATION BETWEEN MORPHOLOGICAL CHARACTERISTICS AND MOTOR ABILITIES IN YOUNG CROATIAN SOCCER PLAYERS

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(Original scientific paper)

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Abstract

A set of 10 morphological and 7 motor tests was applied on a group of seventy two Croatian soccer players, with the aim of determining the relation between morphological characteristics and motor abilities. The predictor group of variables consisted of 10 measures of morphological characteristics evaluation: 5 body mass and volume evaluation tests, 1 longitudinal skeleton dimensionality evaluation test and 4 subcutaneous fat tissue evaluation tests. After the preliminary processing procedures, the relations between the predictor and the criterion set of variables were determined, with the help of series of regression correlation analysis. Significant and positive relations between some morphological characteristics and motor abilities were determined, with the $p<0.05$ level of significance. The obtained result confirmed the findings of previous studies about the negative influence of body mass and volume on motor abilities of soccer players. Also, the conclusion was that the morphological structure slightly influenced the motor success in the analysed sample of young Croatian soccer players of young cadet age.

Key Words: *soccer, kinanthropological status, regression analysis*

Introduction

Soccer is one of the most popular games of contemporary world. According to the structural complexity of the sport classification, soccer belongs to the group of complex sport activities, implying different technical performances in the conditions of mutual cooperation of all team members within the agreed tactics, i.e., strategy of confronting the rival team (Erceg, Laštre & Lisica, 2006; Erceg, Grgantov, Rađa & Milić, 2013a).

The efficiency of the game is influenced by different factors, such as morphological characteristics, motor abilities, functional abilities, technical-tactic knowledge, psychological (conative and cognitive), but also a factor of sports luck. The most important factors are the situational-motor abilities, represented by a combination of motor and functional abilities with technical-tactic knowledge. They are the prerequisite for solving the game situations. A soccer player today has to have extraordinary motor abilities, especially speed, explosive power and speed endurance. Modern soccer requires specific soccer intelligence from the soccer player, meaning that they have to think fast, cope with different situations and have the ability of fast decision making (Erceg, Milić & Živković, 2013b; Rađa, Erceg & Grgantov, 2013).

Morphological characteristics are very important in realization of motor structures in which they are the real biomechanical basis, either as the facilitating factors, or the ones that make the performance harder. Besides this, morphological characteristics are very important for the realization of all the motor tasks in which one's own body, or part of the body, is moved, or the determined body position is maintained, whether the task is strength, speed, flexibility, coordination or balance. However, the need of knowing the laws of relation between morphological characteristics and motor abilities is extremely important because motor abilities can be manifested only through something that characterizes the morphological entity's (examinee) structure. Therefore, the efficiency of motor manifestation directly depends on anthropometric dimensions, as the previous research showed (Reilly, Bangsbo, & Franks, 2000; Erceg, Zagorac, &Katić, 2008).

Following from the cited, the aim of this study was to determine the relation between certain morphological characteristics and motor abilities in young Croatian soccer players of young cadet age.

Material and methods

The subject sample included 72 Croatian soccer players whose average chronological age was 14.18±0.60 years (young cadet age group) and whose average training experience was 3.1±0.7 years.

Average body height of all the examinees was 168.59±9.07 cm and average body mass was 52.98±8.97 kg.

The variable sample was represented by a group of 10 morphological measures and 7 motor abilities tests.

The used morphological measures were: Body height (cm), Body mass (kg), Upper arm circumference extended (cm), Forearm circumference (cm), Thorax circumference (cm), Calf circumference (cm), Triceps skinfold (cm), Back skinfold (cm), Abdomen skinfold (cm) and Calf skinfold (cm). Seven tests were used to check the motor abilities: 5 m run (s), 20 m run (s), Sargent test (cm), 60-second sit-ups (freq), Push-ups until exhaustion (freq), Running *9-3-6-3-9* (s) and *Bip* test (level).

Methods of data processing included the calculation of basic descriptive indicators: arithmetic mean (M), standard deviation (SD), minimum (Min) and maximum (Max) result, with the aim of describing the motor-functional and morphological status of the examinee. Normality distribution was tested by the K-S test.

The stability of the partial relation between the morphological characteristics and motor abilities of young Croatian athletes was determined by linear correlation analysis. In determining the global relation between the morphological characteristics and motor abilities the series of regression analysis was used. The data was processed by *Statistica Ver. 12.00.* computer program.

Results

Table 1 shows descriptive statistics parameters of the variables applied on the total sample of Croatian soccer players of younger cadet age group, N=72. Regarding the fact that the central and dispersive parameters were not the aim of this work, they are shown because the sample of examinees was relevant – young athletes, because they can serve in further result comparisons. It is obvious that all the used variables do not exceed the critical value of the K-S test, i.e., they do not significantly deviate from normal distribution and further parametric result analysis is allowed.

Table 1 Descriptive statistics parameters of the applied variables in Croatian soccer players of young cadet age, N=72.

Variables	M	Min	Max	SD	KS
Body height (cm)	168.59	150.00	181.00	9.07	0.09
Body mass (kg)	52.98	37.60	73.60	8.97	0.11
Upper arm circumference (cm)	24.01	21.20	28.40	1.89	0.11
Forearm circumference (cm)	23.15	20.10	27.80	1.87	0.12
Thorax circumference (cm)	75.28	66.30	84.30	5.36	0.13
Calf circumference (cm)	34.55	31.00	38.50	2.12	0.10
Triceps skinfold (cm)	8.92	7.10	15.40	2.04	0.16
Back skinfold (cm)	6.18	4.80	9.80	1.17	0.16
Abdomen skinfold (cm)	7.61	4.60	18.00	3.02	0.15
Calf skinfold (cm)	10.17	7.00	18.00	2.71	0.15
5 m run (s)	1.21	1.11	1.49	0.10	0.12
20 m run(s)	3.35	3.09	3.63	0.15	0.11
Sargent test (cm)	39.20	30.00	49.00	4.79	0.12
60-sec sit-ups (freq)	53.00	47.00	64.00	4.61	0.11
Push-ups until exhaustion (freq)	24.90	8.00	49.00	11.38	0.13
Running 9-3-6-3-9 (sec)	9.91	8.72	11.77	0.81	0.14
BIP test (level)	11.87	8.40	13.20	1.24	0.14
Border value of KS test for N=72 is 0.16					

Legend: M – arithmetic mean; Min – minimum result; Max – maximum result; SD – standard deviation; KS – Kolmogorov-Smirnov normality distribution test

Table 2 shows the results of linear correlation analysis, which determined the relationship between the motor and functional abilities evaluation variables on one side and morphological characteristics on the other side. Out of the 70 correlations coefficients, 21 were significant, which indicates the relatively good connection of these sets of variables.

It is interesting to sort out 7 significant correlation coefficients (out of the 10 possible) which connect the *20 m run* variable and 6 significant correlation coefficients that connect the *Sargent test* variable with the morphological variables. This relation is firstly determined by significant positive influence of all voluminosity and longitudinality variables on these motor manifestations.

The *Body height* and *Body mass* predictor variables were significantly correlated with *Running 9-3-6-3-9* and *Bip test* variables as well. Also, all the *Circumference* variables (*upper arm, forearm, thorax and calf*) had significant correlation with *BIP test variable*.

The sign in front of the correlation coefficient indicates the inversely scaled variable.

Table 2 Correlation matrix of morphological and motor set of variables of Croatian soccer players of young cadet age, N=72

Variables	5 m run(s)	20 m run(s)	Sargent Test(cm)	Sit-ups (freq)	Push-ups exh. (freq)	Running 93639(s)	BIP Test(level)
Body height (cm)	0.27	-0.55*	0.45*	-0.16	-0.31	-0.54*	0.65*
Body mass (kg)	0.15	-0.49*	0.55*	0.02	-0.14	-0.45*	0.57*
Upper arm circumference (cm)	0.11	-0.45*	0.64*	0.09	-0.04	-0.17	0.51*
Forearm circumference (cm)	-0.03	-0.49*	0.66*	0.03	-0.03	-0.21	0.47*
Thorax circumference (cm)	0.18	-0.46*	0.39	-0.06	0.06	-0.18	0.49*
Calf circumference (cm)	-0.12	-0.45*	0.49*	0.12	-0.10	-0.15	0.45*
Triceps skinfold (cm)	0.12	0.60*	-0.40	0.00	-0.30	0.39	-0.06
Back skinfold (cm)	0.01	0.12	-0.20	-0.23	-0.33	0.31	0.13
Abdomen skinfold (cm)	0.00	0.20	-0.28	-0.09	-0.38	0.25	0.18
Calf skinfold (cm)	-0.03	0.21	-0.48*	-0.10	-0.23	0.35	0.07

*- correlation coefficients significant at the p<0.05 level; # - inversely scaled variable

Table 3 Multiple regression analysis – significant criteria regression with the set of predictor variables in Croatian soccer players of young cadet age, N=72

Criteria	20 m run (s)#		Sargent test (cm)		Push-ups until exhaustion (freq)	
	Beta	p-level	Beta	p-level	Beta	p-level
Body height (cm)	-0.38	0.48	-0.17	0.73	-1.29	0.07
Body mass (kg)	-0.48	0.60	-0.09	0.92	0.70	0.53
Upper arm circumference (cm)	-0.55	0.46	1.34*	0.05	-0.18	0.84
Forearm circumference (cm)	0.04	0.95	0.06	0.93	0.40	0.62
Thorax circumference (cm)	-0.18	0.67	-0.02	0.95	1.18*	0.04
Calf circumference (cm)	0.05	0.90	0.40	0.32	-0.68	0.20
Triceps skinfold (cm)	1.05*	0.05	0.10	0.83	-0.01	0.98
Back skinfold (cm)	-0.07	0.86	-0.70	0.09	-0.53	0.29
Abdomen skinfold (cm)	-0.02	0.96	-0.30	0.54	-0.24	0.70
Calf skinfold (cm)	0.60	0.09	-0.41	0.20	0.22	0.59
R	0.87		0.89		0.81	
R^2	0.76		0.79		0.65	
p	0.05		0.04		0.05	

Legend: R – multiple correlation coefficient; R^2 - determination coefficient; p – level of significance; BETA – beta ponder of predictor variable; * - correlation coefficients significant on p< 0.05 level; # - inversely scaled variable

The multiple regression analysis of 7 variables of the criterion set, with the predictor set of morphological variables, was significant in 3 variables, and the obtained values are shown in Table 3 (R – multiple correlation coefficient, R^2 - determination coefficient, p – significance level and BETA – beta ponder of predictor variable).

The speed variable, *20 m run*, is explained by the predictor set on the satisfactory level of significance with 76% of the explained variance. This is related to general connection between voluminosity and test results. Taller and heavier examinees with lesser amount of subcutaneous body fat achieved better result in this test.

In prediction of *Sargent test* variable, the highest global relation was noticed for the set of variables that described the voluminosity and subcutaneous fat tissue, explaining in total 79% of criterion variance. The examinees with higher volume values and lower subcutaneous fat tissue achieved better results in this test.

The *Push-ups until exhaustion* variable was explained by the predictor set on the satisfactory level of significant, with 65% of explained variance. The highest global relation was again noticeable in the set of variables that describe the voluminosity and subcutaneous fat tissue. This is related to negative influence of adipose voluminosity (subcutaneous fat tissue), while the influence of non-adipose voluminosity was positive. The examinees with higher volume values and lower subcutaneous fat tissue values achieved better results in this test. Also, *Body height* had a negative, and *Body mass* a positive influence on the results of this test. The remaining criterion was not significantly connected to morphological predictors.

Discussion

The highest global relation was noticed in the set of variables which describe the voluminosity and subcutaneous fat tissue, caused by the negative influence of adipose voluminosity (subcutaneous fat tissue), while the influence of non-adipose voluminosity was positive.

The descriptive parameters of analysed values of total sample were similar to previous research on young Croatian soccer players (Erceg et al., 2006; Erceg et al., 2008; Erceg et al., 2013a; Erceg et al., 2013b; Grgantov, Rađa, Erceg, Kujundžić & Milić, 2013; Marov, Grgantov, Milić, Erceg & Sivrić, 2013; Rađa et al., 2013).

The criterion variables *20 m run, Sargent test* and *Push-ups until exhaustion* explained the predictor set with a satisfactory level of significance, while the explained variance was from 65% to 79% of the criteria. It is interesting that multiple regression analysis "recognised" the suppression influence of body height and body mass on the motor manifestation of *20 m run* variable, which almost surely indicates the fact that voluminosity variables represent real predictors of *20 m run*. Meaning, taller and heavier examinees with less subcutaneous fat tissue achieved better results in this test.

Similar discussion was confirmed in prediction of *Sargent test* variable, the highest global value was observed in the set of variables which describe voluminosity and subcutaneous fat tissue, completely explaining the highest value of 79% of the criterion variable. This means that the examinees with higher volume values and lower subcutaneous fat tissue values achieved better results in this test (it can be assumed that the examinees with greater volume had more muscle mass).

Significant correlation of the criterion variable *Push-ups until exhaustion* with the predictor set can be explained by the assumption that the examines with greater volume values and lower subcutaneous fat tissue values achieved better results in this test. It is interesting to notice that *Body height* had a negative, and *Body mass* a positive influence on the results of this test. Shorter examines with greater thorax volume had shorter extremities (shorter hands-shorter lever), what facilitates the performance of the test. The remaining criterion was not significantly related to the morphological predictors, what can be probably explained by the mentioned influence of the specific motor knowledge.

Conclusions

The aim of this paper was to determine the relation between morphological characteristics and motor abilities in young Croatian soccer players of young cadet age group. The conducted analysis determined that morphological stature slightly determines motor success in the analysed set of examinees. The reason was probably the fact that the examinees (in early puberty) did not reach the period of rapid growth and development, and therefore the differences in their morphological stature could not represent a significant factor in motor view, or any other. Besides this, is it very possible that the specific motor knowledge

significantly influenced the performance of certain tests, and since they tested specific motor abilities, it is probable that the mentioned influence overcame the significance of morphological characteristics factor.

Further research should determine the relation between these anthropological dimensions for older age categories of examinees, where a greater influence of morphological characteristics on motor success should be expected.

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