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Relationship Between Morphological Characteristics and Match Performance in Junior Soccer Players

Relación entre las Características Morfológicas y el Rendimiento en Partido de Jugadores de Fútbol Juvenil

Goran Sporis[*]; Ivan Dujic[*]; Nebojsa Trajkovic[**]; Zoran Milanovic[**] & Dejan Madic[***]

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SUMMARY: Soccer players are usually selected based on their anthropometry characteristics rather than their performances. Therefore, the purpose of this cross-sectional study was to examine the relationship between morphological and match performances among junior soccer players. Thirty seven junior soccer players were randomly selected using as stratification criteria age and playing role. Skinfolds (mm) were measured at six sites: triceps skinfold thickness, subscapular skinfold thickness, thigh skinfold thickness, calf skinfold thickness, supraspinal skinfold thickness and abdominal skinfold thickness. In addition, total distance covered during the match, as well as the distance traveled by walking, jogging, moderate and high intensity running and sprinting was determined. The total distance covered was associated with subscapular and abdominal skinfolds. In addition, the subscapular skinfolds were significantly related to high intensity running and sprinting. No other statistically significant correlations were found among other skinfold and performance parameters. The present study showed no significant relationships between morphological and match performances among junior soccer players. Our study supports the conclusions that beside the anthropometry advantage, psychological and soccer-specific skills should be also considered in the selection of soccer players.

KEY WORDS: Football; Elite; Association; Anthropometric; Match activity.

INTRODUCTION

In order to compete at an elite level, soccer players are expected to possess morphological and physiological characteristics that are important for both, the sport of soccer as well as to their playing position (Hazir, 2010). Therefore, players are always attempting to reduce adiposity levels besides improving their fitness. Although there are no defined optimal values for specific sports, descriptive data for percent body fat is provided from numerous studies (Reilly *et al*., 2009). Morphological characteristics (Reilly *et al*., 2000) successfully discriminate soccer players by competitive level and field position. Moreover, the body composition of a soccer player can have significant impact on his performance (Aurélio *et al*., 2016).

Game of soccer consists of sprints, as well as speed and directions changes as key features in this type of sports (Sheppard & Young, 2006). Recent time– motion analysis has been conducted during competitive match play (Dellal *et al*., 2010a). Previous studies showed that players cover between 10,496 to 11,779 m per official game and that 9.2 % of the activities were considered high intensity (Dellal *et al*., 2010a; Dellal *et al*., 2010b; Dellal *et al*., 2010c; Di Salvo *et al*., 2007; Di Salvo *et al*., 2008 & Di Salvo *et al*., 2009). In addition, there is a decrease in the high intensity activity and the total sprint distance covered as matches progressed (Di Salvo *et al*., 2009).

A few studies have shown high levels of correlation between the body fat percentage and athletic performance (Boileau & Lohman, 1977; Housh *et al*., 1984). Moreover, research in soccer indicate that players' anthropometry is related to performance (Williams & Reilly, 2000). One study which dealt with association between anthropometric and physical performance showed that heavier young soccer players performed better in ball shooting and 30 m sprint, whereas taller players performed better in vertical jump, 10-

[*] Faculty of Kinesiology, University of Zagreb, Zagreb, Croatia.
[**] Faculty of Sport and Physical Education, University of Nis, Nis, Serbia.
[***] Faculty of Sport and Physical Education, University of Novi Sad, Novi Sad, Serbia.

and 30-m sprint, and YYIER and had longer VO2 max running time (Wong *et al*., 2009). Although significant correlations were determined among soccer players' body weight, muscle mass and work-rate profile, the relationship between other anthropometric characteristics and work-rate profile was found to be more complicated (Rienzi *et al*., 2000).

It has been reported that soccer coaches select young players based on their anthropometry characteristics rather than their technical and tactical performances (Helsen *et al*. 1998). The majority of studies have focused largely on players 11–16 years of age – an age interval when individual differences ingrowth and biological maturation are perhaps at their greatest (le Gall *et al*., 2010). In contrast, there is little data for older or late adolescent players aged 17–20 years, which is the last competitive age group before players face challenges associated with the highest competitive levels in the sport. Most of professional soccer players started their careers at this level between 17 and 20 years of age. Moreover, it is generally expected that youth players at this age and stage of development are ready to compete at the highest levels. Therefore, other than just anthropometry advantage, it should also be considered in the selection of young soccer players for developing future high-class players. In order to identify factors that may be relevant in the selection process it is of great importance to investigate the relationship of match activity with other players' characteristics. Therefore, the purpose of this cross-sectional study was to examine the relationship between morphological and match performances among junior soccer players.

MATERIAL AND METHOD

Subjects. Thirty seven soccer players (age 18.4±0.1 years, height 1.67±4.8 cm, body mass 53.6±1.8 kg), all members of six junior National Soccer teams in Croatia (N=50) were randomly selected using as stratification criteria age and playing role. The players were informed about the experimental procedures and possible discomforts associated with the study. Written informed consent was received from all players and parents after verbal and written explanation of the experimental design and potential risks of the study. Informed consent was obtained from each of the participants and their parents or legal guardians only after familiarization with the procedures used in this study. In order to improve internal validity players were blinded about the work hypothesis informing the aims of this observational study. All players agreed to provide their maximum will effort in order to perform at their best during all the field tests and competitions considered in this study. The study was approved by the Ethics Committee of the Faculty of Kinesiology, University of Zagreb according to Helsinki Declaration. The participants were aware that they could withdraw from the study at any time. Selection criteria included: (1) participation at professional (top three division leagues) level of football competition for at least 5 years, (2) all players participated in at least 75 % training sessions per week and played at least 16 matches during season, (3) no consumption of exogenous anabolic-androgenic steroids or other drugs that might have affected their physical performance or hormonal balance during the study (for at least 6 months (4) no recent history of febrile illness, muscle lesions, lower limb trauma, and metabolic diseases. Soccer players were instructed not to change their normal eating habits during the entire period of data collection. Nutritional supplements were not included in their diets. In addition, players were instructed to refrain from drinking beverages containing caffeine or alcohol and from consuming food during the 3 h before testing.

Procedures. Testing procedures were performed during the last stage of the competitive season (April- May 2014). Height and body weight were measured before breakfast and all anthropometric measurements were taken at the same time of day (between 8:00 AM and 10:30 AM), within the last week of the competitive season period. Height was measured to the nearest 0.1 cm using a portable stadiometer (Holtain Ltd, Crymych, U.K.), and body weight to the nearest 0.1 kg using an electronic balance scale (Tanita TBF 401A, Japan), with the players wearing no shoes and only light clothing. Skinfold measurements were taken to the nearest 0.2 mm using a skinfold calliper (Holtain Ltd, Crymych, U.K.). Skinfolds (mm) were measured at six sites: triceps skinfold thickness, subscapular skinfold thickness, thigh skinfold thickness, calf skinfold thickness, supraspinal skinfold thickness and abdominal skinfold thickness.

Match activities were determined according to Castagna *et al*., (7) as follows:

1. Walking (0.4 to 3.0 km/h-1);
2. Jogging (3.0 to 8.0 km/h-1));
3. Medium Intensity Running (MIR; 8.0 to 13.0 km/h-1);
4. High-intensity Running (HIR; 13.0 to 18.0 km7h-1);
5. Sprinting (>18.0 km/h-1).

Data was collected with System 3D tille sport analyzer that measures distance traveled in different intensities running. In this way, it was determined the total distance covered during the match, as well as the distance traveled by walking, jogging, running and sprinting.

Competitive matches (11 vs. 11, n=3) were played at the same time of the day (15.30 pm) on a regular sized synthetic-grass soccer pitch over two halves each lasting 45 min. Match air temperature and relative humidity were 22.8±1.8 °C and 40±9.8 % respectively. In order to avoid dehydration, drinking was allowed to players. A minimum of 6 and a maximum of 9 players were observed during the same competitive match. Each player was observed for a minimum of two and a maximum of three competitive matches (within 10 days) and physical match performance categories were reported as mean of the observed games.

Statistical analyses. The data obtained in the research was processed using the application statistics program SPSS 20.0, adjusted for use on personal computers. The descriptive statistics were expressed as a mean (SD) for each variable. Data sets were checked for normality using the Kolmogorov–Smirnov test of the normality of distribution. Relationships between variables were assessed using Pearson's product moment correlation. Significance was set at 0.05.

RESULTS

During the match players covered 9951.03±1132.63 m (8360.00-11710.00 m) of which 683.51±134.52 m, (500.00-890.00 m) were performed at HIR. Details of match activities are presented in Table I.

Association between morphological characteristics and match activities are reported in Table III. The total distance covered was associated with subscapular and abdominal skinfolds. In addition, the subscapular skinfolds

Table I. Match analysis data (n=37)

Match activity	mean±SD	min	max
Walking (0,4-3,0 km/h) (m)	5535,41±225,78	5120,00	5850,00
Jogging (3,0-8,0 km/h) (m)	1602,70±328,34	1100,00	2200,00
MIR (8,0-13,0 km/h) (m)	1726,43±333,85	1200,00	2300,00
HIR (13,0-18,0 km/h) (m)	683,51±134,52	500,00	890,00
Sprinting (>18,0 km/h) (m)	402,97±170,85	200,00	700,00
Total distance (m)	9951,03±1132,63	8360,00	11710,00

HIR= High Intensity Running; MIR= Medium Intensity Running.

Table II. Morphological characteristics.

Morphological characteristics	Mean±SD	Min	Max
Height (cm)	177.62±27.82	18.50	196.30
Body Mass (kg)	72.83±7.70	56.10	91.20
% PMT	7.23±2.70	3.20	12.6
Triceps skinfold (mm)	10.42±3.79	6.00	18.07
Subscapular skinfold (mm)	9.87±2.96	6.47	16.03
Abdominal skinfold (mm)	6.01±1.62	3.80	8.77
Supraspinal skinfold (mm)	9.87±4.04	4.60	23.10
Thigh skinfold (mm)	12.44±4.04	6.77	21.43
Medial calf skinfold (mm)	7.85±2.73	4.53	12.67

% PMT- body fat percentage.

Table III. Correlation matrix of the relationship between morphological characteristics and match activities.

	HIR	Sprinting	Total distance
Height	-0.28	-0.29	-0,19
Body Mass	-0.22	-0.22	-0,22
% PMT	-0.20	-0.21	-0,20
Triceps skinfold	-0.11	-0.19	-0,13
Subscapular skinfold	-0.39*	-0.49*	-0,37*
Abdominal skinfold	-0.31	-0.23	-0,35*
Supraspinal skinfold	-0.22	-0.26	-0,27
Thigh skinfold	-0.09	0.04	-0,13
Medial calf skinfold	-0.09	-0.13	-0,05

* Significant correlation $p < 0.05$ between variables; % PMT- body fat percentage.

were significantly related to HIR and Sprinting. No other statistically significant correlations were found among other skinfold and performance parameters.

DISCUSSION

This study aimed to investigate the relationship between morphological characteristics and match performance in elite junior soccer players and determine whether skinfolds are associated with high intensity activities in this sport. The results of this study demonstrate a significant relationship between subscapular skinfolds and the distance covered in high-speed running and sprinting during elite soccer league match play. Moreover, subscapular and abdominal skinfolds were associated with total distance covered.

With regard to the skinfold measures, the subscapular score was higher in the players compared to the results found in other study (Gil *et al*., 2010) at the same age group (9.87±2.96 vs. 8.57±1.5). The body composition of a soccer player can also have an impact on his performance (Aurélio *et al*.). Several studies have shown high levels of correlation between the body fat percentage and athletic performance (Boileau & Lohman; Housh *et al*.), elite players have body fat percentage between 7 and 19 % (Rienzi *et al*. & Wittich *et al*., 2001). Moreover, relationship between situational and morphological parameters show that there is negative impact of calf circumference and the number of actions taken with foot (Jovanovic *et al*., 2011). However, although significant (r=-0.311 with p=0.045), aforementioned authors found no practical significant implication that could be interpreted with sufficient scientific evidence.

In competitive sports, as soccer, players with a lower body fat percentage have better performance (Ostojic, 2003), because low body fat is a direct measure of the intensity of training (Reilly, 1996; Ostojic & Zivanic, 2001). Estimated body fat percentage in our study was significantly lower than levels found in elite soccer players (9.6±2.5-11.5±2.1 %) through entire season (Ostojic´, 2003). Several possible reasons could be included concerning these results. One the fact that observations may depend on the methods of measuring or estimating percentage of body fat. Due to the fact that testing was conducted during the last stage of the competitive season, soccer players lost more fat, reaching lowest levels at the end of the season. This was probably because of the intensive training and competition schedules, heavier metabolic loads, and dietary habits (Ostojic´, 2003). Nevertheless, the present study does not show body mass and body fat are a strong predictor of match activity in junior soccer players. In contrast, some studies found a high level of correlation between body mass and body fat percentage and sprint times (Ostojic´, 2003 & Malina *et al*., 2004). Therefore, further observations will be needed to further explain this association.

Soccer coaches usually select young players based on their anthropometry characteristics rather than their performances. Therefore, scientific rationale must be provided in the long-term process of player development. Our study supports the conclusions that beside the anthropometry advantage, psychological and soccer-specific skills should be also considered in the selection of soccer players. The present study showed no significant relationships between morphological and match performances among junior soccer players. However, these results should be of interest to soccer coaches because they may help, directly or indirectly, to improve athletes' performance. Since the measurements were conducted in the end of the season, this study is limited by the fact that changes in body composition may occur from the start to the end of an athlete's training and competitive season. Accordingly, further studies should be very careful in determining the right timelines for measuring anthropometric characteristics and body composition. In summary, soccer players change their morphological content during the conditioning period and during the competitive season. Therefore, periodic measurement should be conducted in order to design the training protocols in right order.

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RESUMEN: Los jugadores de fútbol suelen ser seleccionados sobre la base de sus características antropométricas en lugar de sus actuaciones. Por lo tanto, el propósito de este estudio transversal fue examinar la relación entre la morfología y las coincidencias entre los jugadores de fútbol junior. Treinta y siete jugadores de fútbol junior fueron seleccionados al azar utilizando como criterios de estratificación la edad y el papel de juego. Se midieron pliegues cutáneos (mm) en seis sitios: grosor de pliegue tricipital, grosor de pliegue subescapular, grosor de pliegue de muslo, grosor de pliegue de la pantorrilla, grosor de pliegue supraespinal y grosor de pliegue abdominal. Además, se determinó la distancia total cubierta durante el partido, así como la distancia recorrida por caminar, trotar, corrida de intensidad moderada y alta y sprint. La distancia total cubierta se asoció con los pliegues cutáneos subescapulares y abdominales. Además, los pliegues cutáneos subescapulares se relacionaron significativamente con la corrida de alta intensidad y el sprint. No se encontraron otras correlaciones estadísticamente significativas entre otros pliegues cutáneos y parámetros de rendimiento. El presente estudio no mostró ninguna relación significativa entre la morfología y el rendimiento de partidos entre los jugadores de fútbol menor. Nuestro estudio apoya

las conclusiones de que, además de la ventaja de la antropometría, las habilidades psicológicas y específicas del fútbol también deben considerarse en la selección de jugadores de fútbol.

PALABRAS CLAVE: Fútbol; Élite; Asociación; Antropométrico; Relación de actividades.

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Corresponding Author:
Nebojsa Trajkovic, PhD
Faculty of Sport and Physical Education
C˘arnojeviceva 10a
18000 Nis
SERBIA

Telephone: 00381 63 7 399 366

E-mail: nele_trajce@yahoo.com

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