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Original Article

Morphological characteristics, body composition and explosive power in female football professional players

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Abstract
Morphological characteristics of athletes determine their success in certain sports in different ways. Knowledge of these characteristics is required to determine their significance for success in competitive sports. The aim of this study was to determine whether there are differences in the morphological characteristics, body composition and explosive strength of the lower extremities in relation to the playing position in a team of top football players. The sample of respondents consisted of football players who compete in the highest rank of competition, the Serbian Super League. The total number of respondents in the study included 20 female football players (aged 19.73 ± 4.81, body height of 167.37 ± 6.35 cm, and body weight 59.68 ± 6.76 kg). The results of this study indicated that there are statistically significant differences in relation to the position in the team among professional football players regarding assessment of the explosive power of the lower extremities but, only in the squat jump (SJ) test. Differences were noticeable between midfielders and attacking players. The countermovement jump (CMJ) and CMJ free arms tests showed no statistical significances. Values for assessing body composition, such as body fat, lean body mass, and muscle mass in absolute and relative values did not show differences between players in different playing positions. Regarding the morphological values of football players in different playing positions, differences were also not noticeable. In further research, to obtain the most relevant results, it is necessary to include an even larger number of respondents and to, include other ranks of competition as the respondent sample.
Key words:Somatotype, strength, football game, vertical jumps

Introduction

Interest in women's football is on the rise in all aspects. A total of 200,000 players have been registered in Sweden since 1997, of which 40,000 or 20% have been women (Krustrup et al., 2005). Statistics from 2011 indicated that there were 29 million registered players worldwide, which represented a 34% increase in the number of female players compared to that in 2000. (Fahmy, 2011) Physiological and morphological parameters are important components of performance in many sports. Different sports disciplines require different body parameters and body structure for maximum performance. The morphological and body composition (body fat, body mass, muscle mass) of athletes, physical characteristics and technical-tactics capacity significantly affect success and performance (Cıplak et al., 2020). Knowledge of these characteristics is necessary to determine their significance for success in competitive sports. Research on the influence of morphological characteristics on sports games (football) is particularly complex, because success in the game, among other things, depends on how the individual characteristics of each player fit into the whole, thus creating a coherent team.The position of the team is extremely important in the interpretation of morphological data because there are different requirements for a particular sport. Over the last few decades, there has been a growing interest in analysis of morphological status and physique for success in a particular sport (Matković et al., 2003). Therefore, body composition is an important indicator of physical condition and the general health of athletes, and this topic is often discussed in the scientific literature. The shape of the body and its morphology, in addition to physical abilities, psychological characteristics and energy capacities of the system, is one of the main factors that determine sports performance. Therefore, diagnosis of somatotype and morphological characteristics is often the subject of research based on realistic insight into the current state of a defined population and possible negative or positive trends of growth and development over a period of time (Joksimović et al., 2019). Analysis of the physique, shape and composition of athletes in different sports and their relationship to athletic success has long

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been an area of great scientific interest. Somatotyping is one of the most commonly used techniques for body composition analysis. Because of its uniqueness, the somatotype has been used to study many aspects of exercise, sports science, and human biology, which may be important for identifying talented young athletes for specific sports (Carter et al., 2005). The morphological characteristics of female football players and the level of their ability are not clearly defined in the scientific literature. The requirements of the football game increasingly require selection of those female football players who are characterized by strength, speed, agility and dexterity. These are women who are characterized a higher body height, broad shoulders, strong legs, thus such footballers can be classified as an athletic constitutional type (Mladenović, 2006), and this was confirmed by a study conducted by (Can et al., 2004), which states that professional football players belong to the mesomorphic and less to the ectomorphic constitutional type.

Some authors have assessed factors that greatly contribute to the successful realization of a football game (Svensson& Durst, 2005;), and football research, has shown a strong link between anthropometric and physical parameters with the success of a football game. It has been confirmed that there is a correlation between the body composition of athletes and their functional characteristics, and that body composition and variables that define a certain somatotype affect the achievement of good motor parameters (Joksimović et al., 2019). Assessing the ability of explosive power has been accepted as a functional measure of strength in football (Stolen et al., 2005). The association of mean jump values for the assessment of lower extremity explosive strength and team success has been determined, and showed the importance of this component for the assessment of physical performance in football (Arnason et al., 2004). For the assessment of explosiveness, a special group of muscle strength tests includes tests of individual or serial vertical jumps, and this measurement and interpretation is widespread in modern sports science and practical work (Ostojić, Stojanović, &Ahmetović, 2010). The vertical jump is a component of most sports activities, which is used as a measure of leg muscle strength in football (Nikolaidis, 2014). Jumps are phylogenetic movements that take on an ontogenic form in a given activity and require complex motor coordination between the cranial and caudal segments of an athlete's body. The propulsive action of the caudal extremities during vertical jumps is considered suitable for assessing the explosive characteristics of top athletes (Marković et al., 2004). Explosive power in the form of a vertical jump is considered highly functional for optimal performance in football and is taken into account when testing abilities (Castagna&Castellini, 2013) and identifying bilateral differences (Menzel, 2013). The aim of this research was to determine whether there are differences in the morphological characteristics, body composition and explosive strength of the lower extremities in relation to the playing position in the team among top female football players.

Material &methods

Participants

The sample of respondents consisted of female football players who compete in the highest rank of competition, the Serbian Super League. The total number of respondents 20 female football players (aged 19.73 ± 4.81, body height of 167.37 ± 6.35 cm, and body weight of 59.68 ± 6.76 kg). The study was transversal in nature and testing was done in the pre-competition period. The criteria for inclusion were: players who joined the first team for at least six months, players who played at least one half-season before testing, and that all football players went through the preparation period with the team, without injuries in the last six months.Exclusion criteria were: players in the recovery phase from some form of acute or chronic injuriy, players in the process of rehabilitation and football players who did not complete the entire preparation period.The total number of respondents was divided into sub-samples as shown in Table 1. All respondents were first informed about the study, and the purpose and goal of the research were explained to them. Additionally, the procedure and the course of the testing itself were explained to the respondents. Prior to the survey, each respondent signed a consent form to participate. For this study, consent and approval of the head coach and the president of the club were obtained, and afterwards, testing began. The research was approved by the Ethics Commission of the Faculty of Sports and Physical Education, University of Nis in accordance with the Declaration of Helsinki (World Medical Association, 2013).

Procedure

The items determined using the measuring instruments in this studyincluded body composition, explosive power of the lower extremities and assessment of the morphological characteristics of the players. Assessment of body composition, explosive power of the lower extremities and morphology was, performed done in the morning (09:30 h). Testing was done after a day of break that the female players had. The day before the examination of the body composition, the examinees had to follow a protocol, which included the requirements not to consume food or drink after 10 pm. Additionally, on the morning, before the test, the respondents did not consume food and drink.

Measurement of body composition

Body composition assessment was performed indoors using a multifrequency bioelectric impedance (Inbody 770; Biospace Co. Ltd, Seoul, Korea), (Aandstad et al., 2014) at frequencies of 1, 5, 50, 250, 500 and 1000 kHz at acontrolled at a temperature of 23-28 ° C. This instrument uses a tetrapolar system of tactile electrodes with eightpoints (four in contact with the palm and thumb, and the other four in contact with the feet) which separately measure the impedance of the arms, torso and legs. Participants (wearing minimal clothing) stood barefoot on metal scales and grabbed hand electrodes as instructed. The Inbody 770 automatically measures total body weight, fatmass, muscle mass and lean (muscle and bone) mass in absolute amounts up to the nearest 0.05 kg.

The values of lean body mass in% were obtained using the formula of LBM% $=\frac{LBM\ kg}{Body\ weight\ kg}$. Values of muscle mass in% were obtained using the formula MM% $=\frac{MM\ kg}{Body\ weight\ kg}$.

Measurement of morphological characteristics

The following anthropometric measurements were conducted: height, body mass, four skinfolds (triceps, subscapular, supraspinale and calf), breadths (humerus and femur diameters) and girths (arm and calf). Body height was determined using a Martin anthropometer (GPM, Switzerland); skinfolds were measured using a John Bullcaliper (British Indicator Ltd, UK) that is, accurate to 0.2 mm; girth measurements were acquired with a steel measuringtape and wrist girth and bicondylar diameters of the femurandhumerus were measured using a small spreading caliper (SiberHegner, Switzerland). All variables were measured on the right side of the body following standardized procedures (Riebe et al., 2018).Two measurements were taken from each site and the value recorded was the mean, if there was a difference of no greater than 5% between the two measurements;however if that was not the case, a third measurement was taken and the median value was used. All skinfold measurements were taken indoors at approximately the same time of the day by the same investigators.

Measurement of explosive power

The tests used to assess the explosive power of the lower extremities included: the countermovement jump (CMJ), countermovement jump free arms (CMJA) and squat jumps (SJ).

The countermovement jump (**CMJ**) test was measured using Optojump (Glatthorn et al., 2011). Jump values were obtained by placing the subject in a confined space encompassed by Optojump sensors. From the upright position on the meter's signal, with his hands on his hips, the examinee goes into a half-squat and from that position he reflects as much as possible in height. It was necessary for the respondent to perform three technically correct jumps. The best result was taken for the analysis.

The countermovement jump free arms (**CMJ free arms**) test also assesses the explosive power of the lower extremities, and the only difference is that the hands are free next to the body. It was necessary for the respondent to perform three technically correct jumps. The best result was used for analysis. It was also measured using the Optojump sensor (Glatthorn et al., 2011).

The squat jumps (**SJ**) test was performed by the subject taking the starting position in a half squat with his hands on his hips. At the sign of the measurer, the examinee is reflected from the starting position in a vertical jump. Each test was repeated three times, and the best achieved values were used for analysis. Jump values were displayed on the screen using Optojump sensors (Glatthorn et al., 2011).

Statistical analysis

Data were processed using the Statistical Package for Social Sciences SPSS (v17.0, SPSS Inc., Chicago, IL, USA). In the first step, the basic descriptive parameters and distribution of variables were determined. Central and dispersive parameters were calculated for all tests: arithmetic mean (Mean), standard deviation (Std. Deviation). The normality of the distribution of the variables was derived through two procedures: the asymmetries of the Skew results and the homogeneity of the Kurtz results. To determine the differences between the groups of investigated variables, the One - Way ANOVA test was performed, whereas the LSD Post Hoc test was used to determine which groups exactly differed. The statistical significance of the differences was determined at the level of $p < 0.05$.

Results

Table 1 shows the basic central and dispersion data and the differences between the groups of investigated variables on body composition, explosive power of the lower extremities and anthropometric values. The results of skewness and kurtosis showed that there was a symmetry in the results and that there was homogeneity in the results, and thedistribution of the results was normal.

Table 1. Basic central and dispersion parameters and One-Way ANOVA for difference testing

	Defender (n=7)		Midfielder (n=6)		Forward (n=7)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Body height	171.17	6.05	167.07	7.46	163.83	3.67
Body weight	61.71	6.77	61.25	7.35	56.30	5.78
Body fatkg	12.93	3.82	14.13	4.28	11.90	3.23
Body fat %	20.81	4.97	22.83	4.63	20.94	4.23
Lean body masskg	48.79	5.26	47.13	4.60	44.06	4.37
Lean body mass%	79.14	5.00	77.20	4.63	78.39	5.19
Muscle mass kg	27.03	3.05	26.10	2.62	24.60	2.35
Muscle mass %	44.67	3.00	42.73	2.54	43.76	2.47

CMJ	26.54	4.50	24.85	2.48	27.24	2.10
CMJ free arms	30.01	4.67	28.32	3.72	30.79	2.66
SJ	25.37	3.63	23.13*°	2.78	28.06*°	1.74
Triceps SF	11.53	2.03	12.75	2.82	10.30	2.00
Subscapular SF	7.94	1.09	8.88	2.10	6.94	1.24
Supraspinale SF	8.94	1.80	10.15	3.35	9.89	3.71
Calf SF	12.39	1.19	12.87	2.01	12.07	1.87
Arm Girth	26.24	1.77	27.28	1.65	25.99	1.42
Calf Girth	36.74	2.14	36.20	1.6	35.66	1.23
Humerus B	6.07	0.24	6.03	0.41	6.00	0.45
Femur B	8.59	0.33	8.55	0.53	6.00	0.45

Legend: kg-kilograms; %- percentages; SF – skinfold; G – girth; B – breadth; SD – standard deviation; CMJ - countermovement jump; CMJ free arms - countermovement jump free arms; SJ - squat jumps; * $p<0.05$; °- differences between attackers and midfielders.

The One - Way ANOVA test to determine differences between groups indicated that there was a statistically significant difference of $p<0.05$ only in the squat jumps test values. The LSD Post Hoc test determined that these differences were present between midfielders and attackers.

Table2. Mean values of players somatotypes and their classification

	Mean somatotype			
	Endo	***Meso***	***Ecto***	***Classification***
Defender (n=7)	2.89	2.87	3.19	endomorph-ectomorph
Midfielder (n=6)	3.32	3.43	2.53	balanced endomorph
Forward (n=7)	2.71	3.46	2.74	mesomorphic endomorph
p		0.326		

Table 2 shows the mean values of the somatotypes of the players according to their positions in the team. Mean values of the somatotypes of defensive players were classified as endo-ectomorph, which implies that ectomorphia is dominant and endomorphism is greater than mesomorphism. Midfield players were a balanced endomorph where endomorphism is the dominant component and mesomorphism and ectomorphism are equal. The classification of players playing in the attacking line was mesomorph-endomorph, which indicates that endomorphism and mesomorphism are equal, and ectomorphism is of low value.Values of statistical significance showed that there were no differences in the somatotypes of the players at different positions (p = 0.326). For the best overview of the somatotype classification, the results are presented using a somatochart (Figure 1) in which rhombus-shaped figures represent female athletes while the circle refers to the location of the mean values in the examined group.

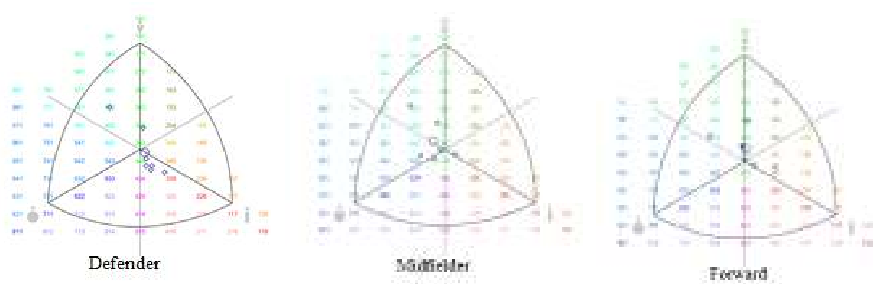

Figure 1. Somatotypes between different playing positions

Discussion

Some sports, such as football, are still new and uncommon for women, although a large number of athletes have begun to train and compete more intensely than in the past (Can et al., 2004). Anthropometric research on football players has shown that body height and weight are important factors. Therefore, football differs from other individual sports in that there are no definite characteristics of each player, whereas anthropometric characteristics of height and weight are necessary for good performance their relationship is equally important due to the fact that top football involves dueling, hitting the ball with the head, and alternating attack and defense, and all this is related to the efficient implementation during the match (Joksimović et al., 2019). In our study, no statistically significant differences were recorded in relation to team positions. However, the highest body height and weight recorded for defense players were 171.17 ± 6.05 cm and 61.71 ± 6.77 kg compared to those of midfield and attack players. Body height is an advantage for defensive players who use head play the most during the game, whereas midfielders and defenders tend for lower height (Ostojić&Stojanović, 2015). It is precisely these morphological characteristics in midfielders zhatallow them to move more efficiently and cover greater distances on the field (Hazir, 2010), additionally, a lower body height allows them to handle the ball well, to outplay defensive players (AI-Hazza et al., 2001) because low body height keeps the center of gravity closer to the ground, and their dynamic balance is facilitated during dribbling. For defensive players, body height is suitable when the ball is to be hit with the head from a jump or from the ground (Matković et al., 2003) and they are the tallest and heaviest players due to the frequent jumps they have to perform during tactical tasks (Sporiš et al., 2011). Upon comparing the values of body height with female players competing in the first Norwegian league from Ingebrigtsen et al., (2011), it was noticeable that female football players from Serbia have a higher body height in defensive and midfield positions while having similar values in body weight in all playing positions. Higher values forfootball players from Serbia were noticeable in relation to football players from Denmark (Jensen & Larsson, 1993), and England (Davids& Brewer, 1992). Research indicates that geographical area as a determinant of growth has an impact on the selection of football players (Lilic, 2007), and this was confirmed by research conducted by Popovic et al., (2013) which found that people from Serbia are very tall with an average of 181.96 cm and one of the tallest nationalitiess in Europe. Given that defensive players are taller and heavier than players in other positions, this study is consistent with previous research (Idrizović, 2014; Tomić, 2013).

It has long been known that a greater amount of muscle mass produces the greater strength that athletes need to compete successfully in sports. Unlike muscle mass, too much ballast mass has the opposite effect (reduces running speed, reduces explosive power, and aerobic and anaerobic endurance). For this reason, methods for determining the composition of the body are necessary, for athletes to achieve an ideal state for achieving maximum achievements (Mišigoj-Duraković, 2008). The results of body composition shown in Table 1, indicate that there are no statistically significant differences in relation to the playing position.The results of the body composition parameters agree with the values (Bajramović et al., 2018) in which body mass index and body mass (Idrizovic, 2014) do not show statistically significant differences ($p>0.05$) between female players of the midfield, offensive line and defensive line. Additionally, Milanović et al., (2012) found no statistically significant difference in the body mass index ($p = 0.207$) and percentage of body fat ($p = 0.061$) in female football players in the senior category. Research conducted by Gonçalves et al., (2018) indicated that the percentage of body fat was slightly higher in goalkeepers, but not statistically significant, whereas body weight was lowest in players who play in side positions (defenders and wingers).In our study, the highest percentage of body fat was recorded for midfield players, whereas the highest muscle mass was recorded for defensive players. Sedano et al., (2009) concluded that defensive line players (central defenders) have the highest percentage of body fat by which they differ from players in other positions ($p <0.05$), whereas the highestpercentage of muscle mass by shown by defensive line players in back positions. A good body mass percentage is absolutely necessary for the overall abilities of football players, because if there is an increase in body weight, there is a proportional loss of muscle mass.The final product is a deficit in the development of explosive power, which is necessary for a large number of changes in terms of the direction of movement, jumps, and sprinting abilities. There is a large negative correlation between body fat percentage and performance in those activities where body mass must move through space, either vertically as in jumping or horizontally as in running (Milanović et al., 2012).

CMJ and SJ have constructive validity for male and female footballers competing at a professional level. It has been noted that the abilities of vertical jumps covariate with the maximum strength of the lower extremities and the sprint performance in professional football players (Castagna&Castellini, 2013). The results of explosive power of the lower extremities shown in Table 1 indicate that statistically significant differences were shown in the SJ test between attack players and midfield at $p <0.05$, whereas no statistically significant differences were recorded in the CMJ and CMJ free arms tests. Research has indicated that there are no significant differences in the CMJ test between professional soccer players (Booysen et al., 2019).In contrast, although there were no statistically significant differences, the highest values in the CMJ test were achieved by backline players, whereas in the SJ test the best results were achieved by midfielders and midfielders (Gonçalves et al., 2018), which is in line with our results. Some studies have shown that the strength of female football players, as measured by the vertical jump, is on average between 38 and 45 cm (Gil et al., 2007). Our players were below the set norms. Reilly et al., (2000) stated that differentiating performance in a vertical jump can be explained by many factors, the most important of which isstrength, thus it is interesting to analyze the relationship between muscle force and its circumference, which is of great importance for jumping.The force that a muscle can exhibit during a vertical jump depends more on the cross-section of the muscle than on the volume of the muscle (Haff& Triplett, 2016). This can be explained by the fact that the rate of force generation within a muscle group depends on the number of sacromeres, where muscles with long sarcomeres exert greater force per unit cross-section (Zatsiorsky& Kraemer, 2009).In many muscles, the units that generate the force are oriented at an angle to the direction of the muscle tendon, where the length of the fibers is shorter than the length of the muscles due to the fact that the fibers do not work to the end, i.e. from one end to the other, where the pinning angle varies from 0-0.4 rad (Ilić&Mrdaković, 2009). Explosive activities play a major role during a football match and they depend on maximum strength (Chelly et al., 2009). Muscle strength increases with age, but not explosively, which may be associated with changes in muscle structure, size, and metabolism (Vescovi et al., 2011).

Conclusion

The results of this study indicated that there is a statistically significant difference in a playersposition in the team among professional football players whenthe explosive power of the lower extremities, was assessed but only in the SJ test. Differences were noticeable between midfielders and attacking players. The CMJ and CMJ free arms tests showed no statistical significance. Values for assessing body composition, such as body fat, lean body mass, and muscle mass in absolute and relative values did not show differences between players in different playing positions. Regarding the morphological values of football players in different playing positions, differenceswere also not noticeable. By determining the somatization of different positions in the team, we found that they are more of a mesomorphic and ectomorphic type of material. Thus, in future research, it is necessary to include an even larger number of respondents and to include other ranks of competition in the respondents samples.

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Conflicts of interest

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