FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 20, No 3, 2022, pp. 175 - 185
https://doi.org/10.22190/FUPES220826016L

Research article

INFLUENCE OF BODY COMPOSITION PARAMETERS ON EXPLOSIVE POWER PERFORMANCE IN FEMALE ADOLESCENT FOOTBALL PLAYERS

UDC 796.012.112-053.6
796.332.015.52-055.2

Ana Lilić, Emilija Petković, Mima Stanković, Miljan Hadžović

Faculty of Sport and Physical Education, University of Niš, Niš, Serbia

Abstract. *The primary aim of this study was to quantify the relationship between body composition variables and explosive power performance in female adolescent football players. A secondary aim was mesure the influence of body composition on explosive power in female adolescent football players. A cross-sectional study included sixteen female adolescent football players (age: 14.5 ± 0.97 years; height: 170.06 ± 4.39 cm; weight: 61.35 ± 11.25 kg) competing as part of the Serbia Development League. The body composition parameters were: muscle mass in percentage (MM), body fat mass in kg (BFM), body fat mass in percentage (PBF), while explosive power parameters were: CMJ Jump Height in cm (CMJHeight), CMJ Relative maximal F (CMJF), CMJ Relative maximal P (CMJP), SJ Jump Height in cm (SJHeight), SJ Relative maximal F (SJF), SJ Relative maximal P (SJP). Pearson's correlation coefficient was used to determine the correlation between all tests and a simple linear regression analysis was applied to determine the influence between body composition and explosive power performance. Significant regressions were found between MM and CMJHeight ($r = 0.50$, $p \leq 0.05$, $R2 = 0.25$) and MM and SJHeight ($r = 0.69$, $p \leq 0.003$, $R2 = 0.47$). Also, regression analyses were found between PBF and CMJHeight ($r = 0.58$, $p \leq 0.02$, $R2 = 0.33$) and PBF and SJHeight ($r = 0.72$, $p \leq 0.002$, $R2 = 0.51$). Lower values of body fat mass and body fat mass in percentage and higher values of muscle mass lead to better results in explosive power performance.*

Key words: *strength, force, squat jump, countermovement jump*

Received August 26, 2022 / Revised December 15, 2022 / Accepted December 20, 2022
Corresponding author: Ana Lilić
Faculty of Sport and Physical Education, University of Niš, Čarnojevića 10a, Niš, Serbia
E-mail: analilic93@gmail.com

INTRODUCTION

Women's professional, semi-professional, and community football are some of the fastest growing sports worldwide (Martínez-Lagunas, Niessen, & Hartmann, 2014; Crossley et al., 2020). Identifying and developing young talent in early adolescence are a priority in youth soccer and have grown quickly over recent years (Reilly, Richardson, Stratton, & Williams, 2004). Football clubs are becoming increasingly aware of the importance of identifying talented youth soccer players at early ages or in adolescence and including them in sports club and football youth categories (Dodd, & Newans, 2018). Implementing tests to estimate physical performance plays an important role in the monitoring and development of football players. (Williams, & Reilly, 2000; Reilly, Bangsbo, & Franks, 2000). Over recent years, researchers have tried to identify factors that influence player success in soccer with attention being paid to anthropometric and physical performance (Gil, Ruiz, Irazusta, Gil, & Irazusta, 2007). Body composition and physical performance are an important element in player scouting at young ages (Vaeyens, et al., 2006; Carling, Le Gall, Reilly, & Williams, 2009; Murr, Raabe, & Höner, 2018; Barnes, Archer, Hogg, Bush, & Bradley, 2014; Bradley, Di Mascio, Peart, Olsen, & Sheldon, 2010).

Training is one of the factors which affect the development of physical performance in pre-adolescence and adolescence ages. In football, explosive power has been used to monitor physical performance (Ronnestad, Kvamme, Sunde, & Raastad, 2008), compare training loads (Andersson, et al., 2008; Alves, Rebelo, Abrantes, & Sampaio, 2010), and to prevent injuries (Menzel, et al., 2013), though for young players, it has mostly been used to identify talented athletes (Unnithan, White, Georgiou, Iga, & Drust, 2012). Furthermore, squat jump (SJ) and counter-movement jump (CMJ) height correlate with performance success in this sport (Arnason, et al., 2004; Helgerud, Rodas, Kemi, & Hoff, 2011). Body composition is important because it is among the factors that can determine sports potential and the possibility of success in sport, in combination with technical skills and tactical abilities, physical, functional, and psychosocial factors (Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007). Muscular strength is a very important factor which can influence body composition parameters that support development and maintain the physical performance of players. (Cinita, et al., 2022). Muscular strength correlates with enhanced force-time characteristics, which influences performance. Great muscular strength correlateds with improvement in player performance in jumping, sprinting, and change of direction (Styles, Matthews, & Comfort, 2016; Thomas, Comfort, Chiang, & Jones, 2015). Low fat percentage correlates to sprinting, acceleration, change of direction times, and jumping performance (Dodd, & Newans, 2018). Body fat, lean mass, and muscle mass should be monitored because inappropriate training loads (intensity, frequency...) can lead to undesirable changes in physique, which could influence performance factors such as speed, strength, power, and risk of injury (Collins, & Rollo, 2014; Sutton, Scott, Wallace, & Reilly, 2009). An inappropriate body mass index could be responsible for inconsistent performance over a session (Lesinski, Prieske, Helm, & Granacher, 2017). Nikolaidis (2014) argued that physical fitness and physical performance correlate with the body mass index of female soccer players ($r = 0.27$ to 0.51) (Nikolaidis, 2014). Adolescent sports players, boys and girls, showed a statistically significant correlation between body composition and the standing broad jump ($r = -0.23$ to -0.62) (Agata, & Monyeki, 2018). Pérez-López, Sinovas, Álvarez-Valverde, & Valades (2015) showed similar results in Spanish male adolescent football players, where parameters of body composition were fat mass in percentage, and kilograms were in a negative correlation with height CMJ and SJ (r = -0.21 to -0.34), while correlation values for fat free mass and skeletal muscle mass with height CMJ and SJ were (r = 0.07 to 0.37). However, the results of body composition in young male football players showed a non-significant correlation with CMJ and SJ (Atakan, Unver, Demirci, Bulut, & Turnagol, 2017). In contrast, no equivalent research has ever been conducted in adolescent female football players. Therefore, the precise influence of body composition on explosive power performance remains unclear, with no reference data available for adolescent players or female adolescent football players. Due to that shortage of related studies, normative data for female adolescent football players should be established to help coaches identify and develop young talent in early adolescence.

The primary aim of this study was to quantify the relationship between body composition variables and explosive power performance in female adolescent football players. A secondary aim was to measure the influence of body composition on explosive power in female adolescent football players.

METHODS

Participants

Sixteen female adolescent football players (age: 14.5 ± 0.97 years; height: 170.06 ± 4.39 cm; weight: 61.35 ± 11.25 kg) took part in the study. The players were competing as part of the Serbia Development League. Procedure and testing were at the end of the preseason phase. All female adolescent football players were registered with the same team and had played at least one half-season before testing. Adolescent players who were in the recovery phase from some form of acute or chronic injuries and players in the process of rehabilitation were excluded.

All of the adolescent football players were first informed about the study. The purpose and aim of the study were explained to them, along with any possible consequences. In addition, the players were also informed about the procedure and course of the testing itself.

Procedures

Before testing, all players were familiarized with the testing procedures. Familiarization involved a verbal explanation and demonstration of each test by the same member of the research team. Height was measured using an anthropometer (Seca 220; Seca Corporation, Hamburg, Germany) to the nearest 0,1 cm, while body composition was measured using a digital Inbody 770 (Brewer et al., 2021) scale to the nearest 0.1 kg (InBody 770; Biospace Co. Ltd, Seoul, Korea). Body composition was estimated in the morning hours. One day prior to body composition testing, the players had to adhere to a protocol which included a minimum of eight hours of not consuming food, caffeine, or alcohol until testing the following morning (Brewer et al., 2021). Players completed a battery of explosive power tests indoors. A standardized 10-minute warm-up consisting of jogging and multi-way dynamic stretching, was used for all players before testing. The players completed 3 trials of each test, each separated by 3 minutes of passive standing rest. The best performance was recorded as the outcome measure.

Body composition

The evaluation of body composition was carried out in an indoor facility using multi-frequency bioelectrical impedance (Inbody 770; Biospace Co. Ltd, Seoul, Korea) as per Brewer et al. (2021), at frequencies of 1, 5, 50, 250, 500 and 1000 kHz under controlled temperature conditions of 23-28 °C. The measuring instrument used a tetrapolar system of tactile electrodes with eight points (four are attached to the palm and thumb, and the remaining four to the feet), which independently measure the impedance of the arms, torso, and legs. Body composition measures that were measured are: muscle mass in % (MM), body fat mass in kg (BFM), body fat mass in % (PBF).

Explosive power

The jumps were assessed by using the squat and countermovement jumps. The squat jump (SJ) consisted of a standing position with knees flexed at 90 degrees, hands on the waist. With no help of the upper limbs, the player should jump and extend the legs, falling in the same place. The players waited 3s in the squat position before each jump. The countermovement jump (CMJ) started in a standing position with hands on the waist, realized with flexion of the legs and simultaneously with the jump, legs extended and falling in the same place. The SJ and CMJ were tested with a portable force plate designed for field testing (Quattro Jump, Type 9290 AD, Kistler, Switzerland). This device records only the vertical ground reaction force at a sampling frequency of 500 Hz, and jump height is automatically calculated by the Quattro jump software using double integration of the force signal using Simpson's rule of integration (Buckthorpe, Morris, & Folland, 2012). Explosive power measures that were measured are: CMJ Jump Height from Take Off V in cm (CMJHeight), CMJ Relative maximal F (%BW) (CMJF), CMJ Relative maximal P (W/kg) (CMJP), SJ Jump Height from Take Off V in cm (SJHeight), SJ Relative maximal F (%BW) (SJF), and SJ Relative maximal P (W/kg) (SJP).

Statistical analysis

The data were processed by the Statistical Package for Social Sciences SPSS (v19.0, SPSS Inc., Chicago, IL, USA). The Shapiro-Wilk test confirmed normality in all measures for use of parametric analyses ($p \geq 0.05$). Levene's test was used to assess the equality of variance in all measures. The mean ± standard deviation with 95% confidence intervals was calculated for each outcome measure. Pearson's correlation coefficient was used to determine the correlation between all tests with 95% confidence intervals. The magnitude of the correlations was interpreted using the following criteria: <; 0.1, trivial; 0.1–0.3, small; 0.3–0.5, moderate; 0.5–0.7, large; 0.7–0.9, very large; and > 0.9 almost perfect (Hopkins, 2002). The level of significance for the correlation analysis was set at $p<0.05$ (Hopkins, 2002). Simple linear regression analyses were also conducted to assess the shared variance (R2) between body composition and explosive power performance.

RESULTS

Descriptive statistics, the mean ± standard deviation for each outcome measure is presented in Table 1.

Table 1 Mean ± standard deviation performance times with 95% confidence intervals (CI) for body composition and explosive power

Outcomes	Mean ± SD	95% CI
MM	43.1 ± 3.42	41.28 ± 44.92
BFM	14.32 ± 6.00	11.12 ± 17.52
PBF	21.06 ± 6.50	17.60 ± 24.53
CMJHeight	21.69 ± 3.81	19.66 ± 23.73
CMJF	203.59 ± 13.90	196.19 ± 210.99
CMJP	36.89 ± 3.73	34.91 ± 38.88
SJHeight	18.82 ± 4.35	16.50 ± 21.14
SJF	193.06 ± 7.58	189.03 ± 197.09
SJP	42.89 ± 9.05	38.07 ± 47.71

Pearson correlation coefficients and regression statistics between body composition parameters and all other explosive power outcomes are presented in Table 2.

Table 2 Associations between body composition and explosive power outcomes in female adolescent football players (N=16)

	r (95% CI)	Magnitude	SEE	p
MM				
CMJHeight	0.50 (0.004 to 0.997)	moderate	0.89	**< 0.05**
CMJF	0.61 (0.149 to 1.062)	large	0.82	**0.01**
CMJP	0.24 (-0.317 to 0.796)	small	1.0	0.37
SJHeight	0.69 (0.272 to 1.104)	large	0.75	**0.003**
SJF	0.28 (-0.270 to 0.830)	small	0.99	0.29
SJP	0.61 (0.160 to 1.066)	large	0.81	**0.01**
BFM				
CMJHeight	-0.65 (-1.086 to -0.216)	large	0.79	**0.006**
CMJF	-0.51 (-1.005 to -0.020)	large	0.89	**0.04**
CMJP	-0.52 (-1.011 to -0.034)	large	0.88	**0.03**
SJHeight	-0.62 (-1.072 to -0.177)	large	0.81	**0.01**
SJF	-0.29 (-0.840 to 0.257)	small	0.99	0.27
SJP	-0.66 (-1.092 to -0.232)	large	0.78	**0.005**
PBF				
CMJHeight	-0.58 (-1.045 to -0.107)	large	0.85	**0.02**
CMJF	-0.58 (-1.045 to -0.108)	large	0.84	**0.01**
CMJP	-0.32 (-0.859 to 0.229)	moderate	0.98	0.23
SJHeight	-0.72 (-1.116 to -0.315)	very large	0.72	**0.002**
SJF	-0.32 (-0.861 to 0.277)	moderate	0.98	0.23
SJP	-0.65 (-1.085 to -0.214)	large	0.79	**0.006**

Legend: r - Pearson correlation coefficient with 95% confidence intervals (CI);
SEE - standard error of the estimate; p - statistically significant association

The largest associations ($r = 0.61$, $p \leq 0.01$) were between MM and CMJF and between MM and SJP. The correlation between BFM and SJHeight was ($r = 0.81$, $p \leq 0.01$, large) and between PBF and CMJF was ($r = 0.84$, $p \leq 0.01$, large), as shown in Table 2.

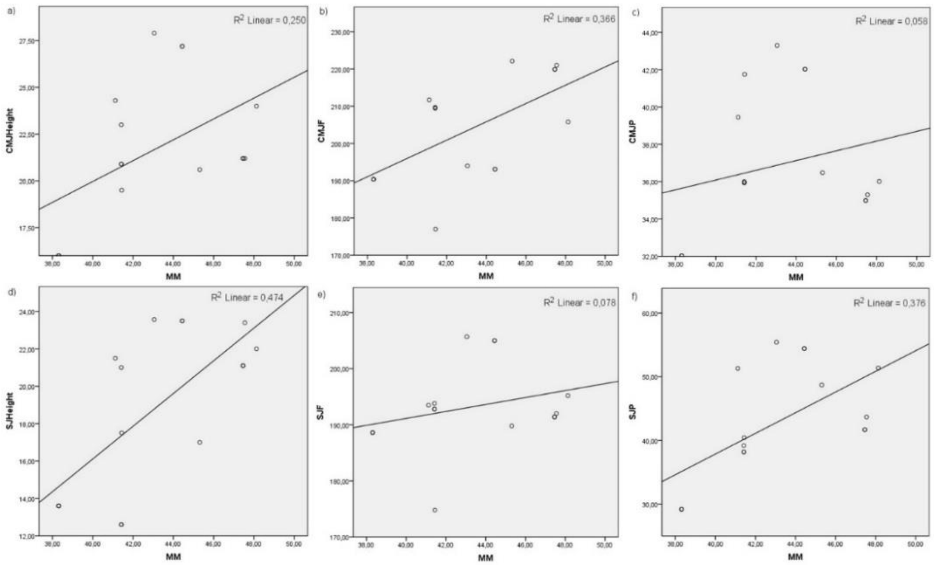

Fig. 1 Scatterplots showing the relationships between MM and a) CMJHeight b) CMJF, c) CMJP, d) SJHeight, e) SJF, f) SJP in female adolescent football players

Significant regressions were found between MM and CMJHeight (r = 0.50, $p \leq 0.05$, moderate, $R^2 = 0.25$) and MM and CMJF (r = 0.61, $p \leq 0.01$, large, $R^2 = 0.36$) and MM and SJHeight (r = 0.69, $p \leq 0.003$, large, $R^2 = 0.47$) and MM and SJP (r = 0.61, $p \leq 0.01$, large, $R^2 = 0.42$)

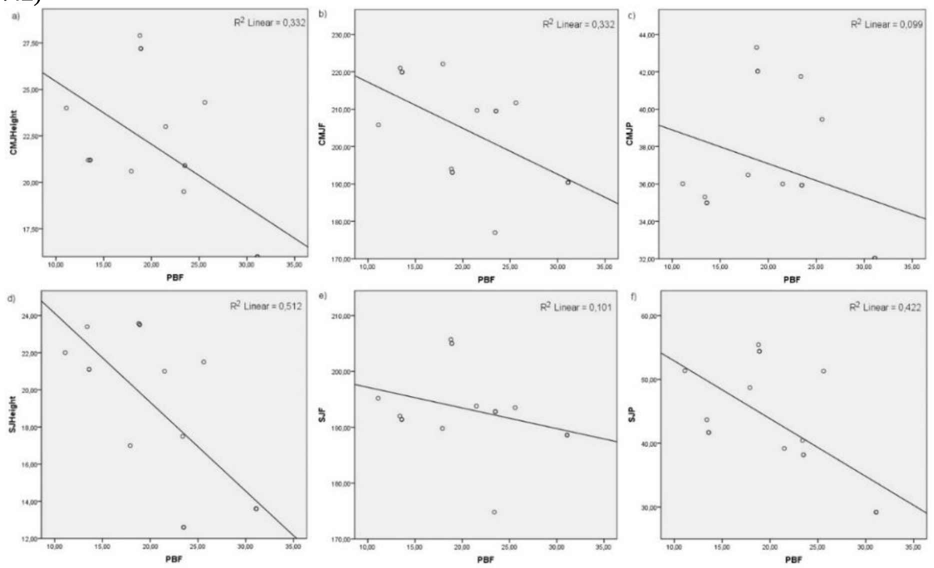

Fig. 2 Scatterplots showing the relationships between PBF and a) CMJHeight b) CMJF, c) CMJP, d) SJHeight, e) SJF, f) SJP in female adolescent football players

Regression analyses in Figure 2 were found between PBF and CMJHeight (r = 0.58, $p \leq 0.02$, large, $R^2 = 0.33$) and PBF and SJHeight (r = 0.72, $p \leq 0.002$, very large, $R^2 = 0.51$), and PBF and SJP (r = 0.65, $p \leq 0.006$, large, $R^2 = 0.42$).

DISCUSSION

The primary aim of the present study was to quantify the relationship between body composition variables such as muscle mass, body fat mass in kilograms and percentage, and explosive power performance parameters in female adolescent football players. A secondary aim was to measure the influence of body composition on explosive power in female adolescent football players. Body composition parameters were correlated with a range of explosive power in female adolescent football players. Specifically, jump height, relative maximal force and relative maximal power depend on body composition parameters. The results of this study suggest that the body composition parameters and explosive power are associated and that muscle mass and body fat mass in percentage can have an on jump height and relative maximal power values in particular.

Estimate of body composition parameters is a significant indicator of vertical jumping performance in adolescent male football players (Cinita, et al., 2022). Cinita et al. (2022) reported a body mass significant correlation with CMJ height (r = 0.25) and SJ height (r = 0.19), while values of PBF were in a negative correlation with CMJ ($p \leq 0.01$, r = -0.47) and SJ ($p \leq 0.01$, r = -0.57). The regression analysis showed a significant influence of body mass and PBF on CMJ height ($p \leq 0.01$, $R^2 = 0.39$) and SJ height ($p \leq 0.01$, $R^2 = 0.45$) in children aged 17, while in children aged 15 it was ($p \leq 0.01$, $R^2 = 0.46$) for CMJ height and ($p \leq 0.01$, $R^2 = 0.52$) for SJ height (Cinita, et al., 2022). Other body composition parameters also showed a significant correlation among Spanish adolescent male football players with CMJ and SJ height such as fat free mass ($p \leq 0.01$, r = 0.36 to 0.37) and skeletal muscle mass ($p \leq 0.05$, r = 0.07 to 0.09), while PBF ($p \leq 0.01$, r = -0.33 to -0.34) and fat mass in kilograms ($p \leq 0.01$, r = -0.21 to -0.23) had a negative correlation (Pérez-López, et al., 2015). Central defenders and forwards players perform better on the vertical jump than midfielders (Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007). This should be related to the fact that defenders and forwards players have more physical contact and jumping in the match (Rebelo, et al., 2013). This was also confirmed by Aurélio et al. (2016) who reported that height has significant influence on CMJ ($R^2 = 0.91$). Atakan et al. (2017) presented different results in adolescent male football players. In seventeen adolescent male football players, no significant correlations for PBF, fat mass, fat mass index, lean mass and lean mas index and parameters of CMJ and SJ (Atakan, et al., 2017) were found. In other sports, for male adolescent handball players 14 years old CMJ height and SJ height showed correlations with the body mass index and PBF ($p \leq 0.05$, r = -0.616 to -0.777), while only lean mass showed a non-statistically significant correlation (Molina-López, Barea Zarzuela, Sáez-Padilla, Tornero-Quiñones, & Planells, 2020). CMJ and SJ power presented a large positive correlation ($p \leq 0.05$, r = 0.703 to 0.904) with the body mass index, lean mass, and PBF (Molina-López, et al., 2020). Older handball players who are 16 years old presented different results for CMJ and SJ height, showing a non-significant correlation with body composition parameters, while CMJ and SJ power showed a positive relationship only with the body mass index and lean mass (Molina-López, et al., 2020). Different results were determined between athlete adolescents and non-sport athlete adolescents. Sport participation in adolescents showed a relationship between the standing broad jump and body mass index and PBF ($p \leq 0.01$, $r = -0.23$ to -0.62), while non-athlete adolescents showed non-significant results with body mass index (Agata, & Monyeki, 2018).

It should be noted the studies which included male adolescent football players (Cinita et al., 2022; Pérez-López et al., 2015; Aurélio et al., 2016) presented results that match those of our study, stressing the multifaceted influence of PBF on CMJ and SJ height (Cinita, et al., 2022). Consequently, parameters of explosive power performance may be more influenced by body composition parameters, specifically PBF and MM. A negative correlation presented that lower PBF values may have a positive influence on CMJ and SJ height, while increasing MM may be also increase CMJ and SJ height. During adolescence in boys, there is an increase in the hormone testosterone, which is responsible for the development of muscle mass (Haff, & Triplett, 2015). Pérez-López et al. (2015) reported increased muscle mass, there is also an improvement in the height of reflection in the CMJ and SJ. In adolescent girls, the hormone estrogen increases the appearance of adipose tissue (Haff, & Triplett, 2015), and accordingly can lead to reduced performance values. However, our results showed that girls who play football also show that increasing MM increases values of CMJ and SJ height ($r = 0.50$ to 0.69) and that PBF and MM have a strong influence on height but also on the power produced during the jump. A study which included fewer male football players aged seventeen did not find a significant correlation with body composition parameters and explosive power parameters (Atakan, et al., 2017). However, the limited contribution of studies involving female adolescent football players should be noted.

The limitations of our study included the recruitment of state-level adolescent female football players. Our findings may not easily transfer to other sports or non-sport populations and explosive power parameters can differ according to sex, sports, playing level, and playing year. We included fewer adolescent female football players which warrants further investigation across a broad range of football player samples. Also, other studies should consider the biological and chronological age of female athletes. In order to expand the knowledge about the influence of body composition on sports performance in adolescent female football players, it is necessary to include other tests for evaluating explosive power, as well as to monitor the changes that occur in female athletes for a certain period of time.

CONCLUSION

Our study provides a comprehensive analysis of the body composition parameters and explosive power parameters and is the first to identify the contribution of their correlation and influence in adolescent female football players. Muscle mass, body fat mass, and body fat mass in percentage were indicators of a correlation with explosive power. Lower values of body fat mass and body fat mass in percentage showed a better performance in CMJ and SJ height, relative maximal force, and relative maximal power. Higher values of muscle mass lead to better results in CMJ and SJ height. Our results suggest the influence of body composition on explosive power parameters in adolescent female football players.

REFERENCES

Agata, K., & Monyeki, M. A. (2018). Association between sport participation, body composition, physical fitness, and social correlates among adolescents: The PAHL study. *International Journal of Environmental Research and Public Health*, *15*(12), 2793. https://doi.org/10.3390/ijerph15122793

Alves, J. M. V. M., Rebelo, A. N., Abrantes, C., & Sampaio, J. (2010). Short-term effects of complex and contrast training in soccer players' vertical jump, sprint, and agility abilities. *The Journal of Strength & Conditioning Research*, *24*(4), 936-941. doi: 10.1519/JSC.0b013e3181c7c5fd

Andersson, H. M., Raastad, T., Nilsson, J., Paulsen, G., Garthe, I. N. A., & Kadi, F. (2008). Neuromuscular fatigue and recovery in elite female soccer: effects of active recovery. *Medicine & Science in Sports & Exercise*, *40*(2), 372-380. doi: 10.1249/mss.0b013e31815b8497

Arnason, A., Sigurdsson, S. B., Gudmundsson, A., Holme, I., Engebretsen, L., & Bahr, R. (2004). Physical fitness, injuries, and team performance in soccer. *Medicine & Science in Sports & Exercise*, *36*(2), 278-285. doi: 10.1249/01.MSS.0000113478.92945.CA

Atakan, M. M., Unver, E., Demirci, N., Bulut, S., & Turnagol, H. H. (2017). Effect of body composition on fitness performance in young male football players. *Turkish Journal of Sport and Exercise*, *19*(1), 54-59. https://dergipark.org.tr/en/pub/tsed/issue/29096/311331

Aurélio, J., Dias, E., Soares, T., Jorge, G., Espada, M., Pereira, A., & Figueiredo, T. (2016). Relationship between body composition, anthropometry and physical fitness in under-12 soccer players of different positions. *International Journal of Sports Science*, *6*, 25-30. http://dx.doi.org/10.5923/s.sports.201601.05

Barnes, C., Archer, D. T., Hogg, B., Bush, M., & Bradley, P. (2014). The evolution of physical and technical performance parameters in the English Premier League. *International Journal of Sports Medicine*, *35*(13), 1095-1100. doi: 10.1055/s-0034-1375695

Bradley, P. S., Di Mascio, M., Peart, D., Olsen, P., & Sheldon, B. (2010). High-intensity activity profiles of elite soccer players at different performance levels. *The Journal of Strength & Conditioning Research*, *24*(9), 2343-2351. doi: 10.1519/JSC.0b013e3181aeb1b3

Brewer, G. J., Blue, M. N., Hirsch, K. R., Saylor, H. E., Gould, L. M., Nelson, A. G., & Smith-Ryan, A. E. (2021). Validation of InBody 770 bioelectrical impedance analysis compared to a four-compartment model criterion in young adults. *Clinical Physiology and Functional Imaging*, 41(4), 317-325. https://doi.org/10.1111/cpf.12700

Buckthorpe, M., Morris, J., & Folland, J. P. (2012). Validity of vertical jump measurement devices. *Journal of Sports Sciences*, *30*(1), 63-69. https://doi.org/10.1080/02640414.2011.624539

Carling, C., Le Gall, F., Reilly, T., & Williams, A. M. (2009). Do anthropometric and fitness characteristics vary according to birth date distribution in elite youth academy soccer players?. *Scandinavian Journal of Medicine & Science in Sports*, *19*(1), 3-9. https://doi.org/10.1111/j.1600-0838.2008.00867.x

Cinita, F., Adilson, M., Andreas, I., Joao, N., Pedro, C., Frederica, G., Joao, M., & Elvio, G., (2022). Associations between muscular strength and vertical jumping performance in adolescent male football players. *Human Movement*, 24(2), 1-7. doi: https://doi.org/10.5114/hm.2023.117778

Collins, J., & Rollo, I. (2014). Practical considerations in elite football. *Sports Science Exchange*, *27*(133), 1-7.

Crossley, K. M., Patterson, B. E., Culvenor, A. G., Bruder, A. M., Mosler, A. B., & Mentiplay, B. F. (2020). Making football safer for women: a systematic review and meta-analysis of injury prevention programmes in 11 773 female football (soccer) players. *British Journal of Sports Medicine*, *54*(18), 1089-1098. http://dx.doi.org/10.1136/bjsports-2019-101587

Dodd, K. D., & Newans, T. J. (2018). Talent identification for soccer: Physiological aspects. *Journal of Science and Medicine in Sport*, *21*(10), 1073-1078. https://doi.org/10.1016/j.jsams.2018.01.009

Gil, S. M., Gil, J., Ruiz, F., Irazusta, A., & Irazusta, J. (2007). Physiological and anthropometric characteristics of young soccer players according to their playing position: relevance for the selection process. *The Journal of Strength & Conditioning Research*, *21*(2), 438-445.

Gil, S., Ruiz, F., Irazusta, A., Gil, J., & Irazusta, J. (2007). Selection of young soccer players in terms of anthropometric and physiological factors. *Journal of Sports Medicine and Physical Fitness, 47*(1), 25.

Haff, G. G., & Triplett, N. T. (2015). Essentials of strength training and conditioning 4th edition. Human kinetics.

Helgerud, J., Rodas, G., Kemi, O. J., & Hoff, J. (2011). Strength and endurance in elite football players. *International Journal of Sports Medicine*, *32*(09), 677-682. doi: 10.1055/s-0031-1275742

Hopkins, W. (2002). A scale of magnitudes for effect statistics. Retrieved from http://sportsci.org/resource/stats/effectmag.html

Lesinski, M., Prieske, O., Helm, N., & Granacher, U. (2017). Effects of soccer training on anthropometry, body composition, and physical fitness during a soccer season in female elite young athletes: A prospective cohort study. *Frontiers in Physiology*, 1093. https://doi.org/10.3389/fphys.2017.01093

Martínez-Lagunas, V., Niessen, M., & Hartmann, U. (2014). Women's football: Player characteristics and demands of the game. *Journal of Sport and Health Science*, *3*(4), 258-272. https://doi.org/10.1016/j.jshs.2014.10.001

Menzel, H. J., Chagas, M. H., Szmuchrowski, L. A., Araujo, S. R., de Andrade, A. G., & de Jesus-Moraleida, F. R. (2013). Analysis of lower limb asymmetries by isokinetic and vertical jump tests in soccer players. *The Journal of Strength & Conditioning Research*, *27*(5), 1370-1377. doi: 10.1519/JSC.0b013e318265a3c8

Molina-López, J., Barea Zarzuela, I., Sáez-Padilla, J., Tornero-Quiñones, I., & Planells, E. (2020). Mediation effect of age category on the relationship between body composition and the physical fitness profile in youth handball players. *International Journal of Environmental Research and Public Health*, *17*(7), 2350. https://doi.org/10.3390/ijerph17072350

Murr, D., Raabe, J., & Höner, O. (2018). The prognostic value of physiological and physical characteristics in youth soccer: A systematic review. *European Journal of Sport Science*, *18*(1), 62-74. https://doi.org/10.1080/17461391.2017.1386719

Nikolaidis, P. T. (2014). Weight status and physical fitness in female soccer players: is there an optimal BMI?. *Sport Sciences for Health*, *10*(1), 41-48. https://doi.org/10.1007/s11332-014-0172-2

Pérez-López, A., Sinovas, M. C., Álvarez-Valverde, I., & Valades, D. (2015). Relationship between body composition and vertical jump performance in young spanish soccer players. *Journal of Sport and Human Performance*, *3*(3), 1-12. doi: 10.12922/jshp.0063.2015

Rampinini, E., Coutts, A. J., Castagna, C., Sassi, R., & Impellizzeri, F. M. (2007). Variation in top level soccer match performance. *International Journal of Sports Medicine*, *28*(12), 1018-1024. doi: 10.1055/s-2007-965158

Rebelo, A., Brito, J., Maia, J., Coelho-e-Silva, M. J., Figueiredo, A. J., Bangsbo, J., Malina, R. M., & Seabra, A. (2013). Anthropometric characteristics, physical fitness and technical performance of under-19 soccer players by competitive level and field position. *International Journal of Sports Medicine*, *34*(04), 312-317. doi: 10.1055/s-0032-1323729

Reilly, T., Bangsbo, J., & Franks, A. (2000). Anthropometric and physiological predispositions for elite soccer. *Journal of Sports Sciences*, *18*(9), 669-683. https://doi.org/10.1080/02640410050120050

Reilly, T., Richardson, D., Stratton, G., & Williams, A. M. (2004). *Youth soccer: From science to performance*. Routledge.

Ronnestad, B. R., Kvamme, N. H., Sunde, A., & Raastad, T. (2008). Short-term effects of strength and plyometric training on sprint and jump performance in professional soccer players. *The Journal of Strength & Conditioning Research*, *22*(3), 773-780. doi: 10.1519/JSC.0b013e31816a5e86

Styles, W. J., Matthews, M. J., & Comfort, P. (2016). Effects of strength training on squat and sprint performance in soccer players. *Journal of Strength and Conditioning Research*, *30*(6), 1534-1539. https://doi.org/10.1519/JSC.0000000000001243

Sutton, L., Scott, M., Wallace, J., & Reilly, T. (2009). Body composition of English Premier League soccer players: Influence of playing position, international status, and ethnicity. *Journal of Sports Sciences*, *27*(10), 1019-1026. https://doi.org/10.1080/02640410903030305

Thomas, C., Comfort, P., Chiang, C. Y., & Jones, P. A. (2015). Relationship between isometric mid-thigh pull variables and sprint and change of direction performance in collegiate athletes. *Journal of Trainology*, *4*(1), 6-10. https://doi.org/10.17338/trainology.4.1_6

Unnithan, V., White, J., Georgiou, A., Iga, J., & Drust, B. (2012). Talent identification in youth soccer. *Journal of Sports Sciences*, *30*(15), 1719-1726. https://doi.org/10.1080/02640414.2012.731515

Vaeyens, R., Malina, R. M., Janssens, M., Van Renterghem, B., Bourgois, J., Vrijens, J., & Philippaerts, R. M. (2006). A multidisciplinary selection model for youth soccer: the Ghent Youth Soccer Project. *British Journal of Sports Medicine*, *40*(11), 928-934. http://dx.doi.org/10.1136/bjsm.2006.029652

Williams, A. M., & Reilly, T. (2000). Talent identification and development in soccer. *Journal of Sports Sciences*, *18*(9), 657-667. https://doi.org/10.1080/02640410050120041

UTICAJ PARAMETRA TELESNE KOMPOZICIJE NA EKSPLOZIVNE SNAGE KOD FUDBALERKI U PERIODU ADOLESCENCIJE

Cilj ove studije bio je da se kvantifikuje odnos između varijabli telesne kompozicije i eksplozivne snage kod fudbalerki u period adolescencije. Sekundarni cilj je bio uticaj telesne kompozicije na eksplozivnu snagu kod kod fudbalerki u period adolescencije. Transverzalna studija obuhvatila je *šesnaest fudbalerki (godine: 14,5 ± 0,97; visina: 170,06 ± 4,39; težina: 61,35 ± 11,25) koje su se takmičile u okviru Razvojne lige Srbije. Parametri telesne kompozicije su bili: mišićna masa u procentima (MM), masa telesne masti u kg (BFM), masa telesne masti u procentima (PBF), dok su parametar eksplozivne snage bili: CMJ Visina skoka u cm (CMJHeight), CMJ Relativni maksimalni sila (CMJF), CMJ Relativni maksimalni snaga (CMJP), SJ Visina skoka u cm (SJHeight), SJ Relativna maksimalna sila (SJF), SJ Relativna maksimalna snaga (SJP). Pirsonov koeficijent korelacije je korišćen za određivanje korelacije između svih testova, a analiza linearne regresije su primenjene da bi se utvrdio uticaj između sastava tela i performansi eksplozivne snage. Pronađene su značajne regresije između MM i CMJHeight ($r = 0,50$, $p \leq 0,05$, $R^2 = 0,25$) i MM i SJHeight ($r = 0,69$, $p \leq 0,003$, $R2 = 0,47$). Takođe, pronađene su regresione analize između PBF i CMJHeight ($r = 0,58$, $p \leq 0,02$, $R^2 = 0,33$) i PBF i SJHeight ($r = 0,72$, $p \leq 0,002$, $R^2 = 0,51$). Manje vrednosti mase telesne masti i mase telesne masti u procentima i veće vrednosti mišićne mase utiču na bolje rezultate u performansama eksplozivne snage.*

Ključne reči: *snaga, sila, skok iz čučnja, skok protiv pokreta*