

Seasonal Changes in Anthropometric Characteristics and Body Composition of Elite Montenegrin Football Players

Cambios Estacionales en las Características Antropométricas y la Composición Corporal de los Futbolistas de Élite de Montenegro

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CUG, M.; STANKOVIC, M.; KATANIC, B.; DJORDJEVIC, S. & MASANOVIC, B. Seasonal changes in anthropometric characteristics and body composition of elite Montenegrin football players. *Int. J. Morphol.*, 42(5):1306-1311, 2024.

SUMMARY: Anthropometric characteristics and body composition are significant factors for success in elite football, and there has been a growing body of research on this subject recently. This study aimed to investigate changes in the anthropometric characteristics and body composition of football players during both preparatory and competitive periods. The research involved 10 professional football players (24.4±4.84 yrs.) competing in the First Montenegrin Telecom League. Measurements were taken in January before the preparatory phase, then again 30 days prior to the start of the season in February, and after the season in May. Anthropometric characteristics and body composition were evaluated using a set of 15 variables, including body height, body weight, triceps skinfold, biceps skinfold, back skinfold, abdominal skinfold, lower leg skinfold, upper leg skinfold, body mass index, fat kg, fat percentage, muscle mass kg, muscle mass percentage, lean body mass kg, lean body mass percentage. There were no differences in anthropometric characteristics across the three measurement periods for the football players. However, differences were observed in all six parameters of body composition across the three measurement periods. Fat mass and fat percentage significantly decreased after the competitive phase compared to measurements before and after the preparatory period. Furthermore, muscle mass, muscle mass percentage, lean muscle mass, and lean muscle mass percentage significantly increased in football players after the competitive season compared to measurements before and after the preparatory period. This indicates that the competitive season has a positive effect on changes in body composition, leading to a reduction in fat mass while simultaneously increasing muscle and lean mass components in football players, while anthropometric parameters remain unchanged.

KEY WORDS: Professional soccer players; Seasonal variations; Morphological characteristics.

INTRODUCTION

Football is among the most widely enjoyed sports globally, engaging millions of individuals across countries, each participating at different skill levels (Stankovic *et al.*, 2022). The player movements during one football game (90 minutes) are characterized by high intensity, fast activities, and breaks of varied duration (Drust *et al.*, 2007; Radakovic *et al.*, 2024). Football players have to achieve physical demands and maintain a high level of physical fitness during the entire season (Stasiewicz *et al.*, 2022).

Professional football clubs frequently assess body composition as part of their standard monitoring processes (Stankovic *et al.*, 2023). The significance given to these

evaluations may stem from the knowledge that low levels of fat content combined with high proportions of lean mass provide an appropriate platform for the locomotor activities and specialized technical abilities needed for the sport (Iga *et al.*, 2014). Achievement in sports is closely linked with the individual anthropometric characteristics, body composition and body fat percentages. As a result, regular evaluation of players' physical condition is crucial to any team's performance (Staskiewicz *et al.*, 2022). Additionally, current research suggests that body composition is a crucial additional fitness factor defining a player's ability for competition in professional football (Mukherjee & Chia, 2010).

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Maintaining optimum physical fitness is a difficult challenge in sports with long competitive seasons, and few studies have dealt with changes in the physical and performance characteristics of football players within the season (Carling & Orhant, 2010; Mukherjee & Chia, 2010; Michailidis *et al.*, 2013; Devlin *et al.*, 2017; Parpa *et al.*, 2024). Increasing aerobic and anaerobic fitness, along with the redistribution of body composition involving the maintenance of fat-free mass (FFM) while reducing body mass and fat mass (FM), have been observed in previous studies on seasonal changes in football players (Peart *et al.*, 2018). Understanding that low levels of fat mass combined with high proportions of lean mass provide an appropriate structure for the locomotor movements and specialized technical skills required by the football may explain the significance defined to assessments of body composition (Iga *et al.*, 2014). Additionally, understanding nutrition has an impact on how stable the body composition is throughout all examined periods, such as preparatory, competitive, and transitional periods (Staskiewicz *et al.*, 2022).

Although anthropometric characteristics and body composition are significant factors for success in elite football, and recently, there has been increasing research on this issue, there is still not enough knowledge about their seasonal changes (Morgan, Weston, & Nevill 2005; Bjelica *et al.*, 2020). This indicates the need to examine morphological changes in football players throughout the season using a broader system of anthropometric and body composition parameters. Therefore, the aim of this research was to investigate changes in anthropometric characteristics and body composition of football players during both preparatory and competitive periods.

MATERIAL AND METHOD

Participants. In this longitudinal study, a group of 10 male football players (aged 24.4 ± 4.84 years, with a body height of 181.62 ± 6.77 cm, and a body weight of 76.82 ± 7.97 kg) from the First Montenegrin Telecom League were included. The inclusion criteria for participants in the study included the following: players aged ≥ 17 to ≤ 35 years, with a training experience of ≥ 6 years, without severe injuries (>12 months), and who were not ill at the time of the assessment. Measurements were taken at three points: initially in January before the preparatory period, then again after a 30-day interval just before the start of the season in February, and finally after the season concluded in May. Participants were informed about the research objectives and voluntarily agreed to participate by providing written consent. The study was conducted in accordance with ethical standards for biomedical research involving human

subjects, as outlined in the Helsinki Declaration (World Medical Association, 2013).

Anthropometric and Body Composition Parameters.

Anthropometric parameters were assessed in accordance with the guidelines of the International Biological Program (Eston & Reilly, 2009). Anthropometric characteristics and body composition were evaluated using a set of 15 variables, including body height, body weight, triceps skinfold, biceps skinfold, back skinfold, abdominal skinfold, lower leg skinfold, upper leg skinfold, body mass index, fat kg, fat percentage, muscle mass kg, muscle mass percentage, lean body mass kg, lean body mass percentage. The body height of players was measured using a portable stadiometer (Seca Ltd., Bonn, Germany) with an accuracy of 0.1 cm. The Harpenden "John Bull" caliper was used for assessing skinfold thickness (CMS Instruments, London, United Kingdom). To assess body composition, a Tanita body fat scale (Tanita ® model BC-418MA, Tokyo, Japan) was utilized.

Statistics. The statistical analyses in this study involved descriptive statistics, as well as the parametric procedure of Repeated-measures ANOVA (analysis of variance) with Post-hoc testing. Descriptive data included calculating the mean and standard deviation for each variable. While repeated measures ANOVA was used to determine differences in anthropometric and body composition parameters of football players measured at three different measurement points. The data obtained in the research were processed using the SPSS software, version - 26.0 (SPSS Inc., Chicago, IL, USA). The alpha error level was accepted as 0.05.

RESULTS

The results in Table I show that there was no significant difference in measurements during the season in anthropometric parameters. Fat mass and fat percentage significantly decreased after the competitive phase compared to measurements before and after the preparatory period (0.042; 0,041 respectively). Furthermore, muscle mass, muscle mass percentage, lean muscle mass, and lean muscle mass percentage significantly increased (0.007, 0.092, 0.011, 0.042, respectively) in football players after the competitive season compared to measurements before and after the preparatory period.

Figure 1 depicts changes in body composition parameters throughout the season. It is noticeable that body fat percentages at the end of the competitive season is lower compared to the beginning of the season, while muscle mass percentages values increased from the start of preparations to the end of the competitive season.

Table I. Descriptive data and ANOVA with Post-hoc test of 10 football players over a season.

	I test Mean±SD	II test Mean±SD	III test Mean±SD	Sig	Post-hoc
Body height	181.62±6.77	181.62±6.77	181.62±6.77	1	/
Body weight	76.82±7.97	77.15±7.52	77.31±7.62	.557	/
Triceps skinfold	5.77±1.43	5.49±1.24	5.06±1.62	.117	/
Biceps skinfold	4.28±.77	4.30±.72	4.31±1.23	.977	/
Back skinfold	9.32±1.17	9.26±1.65	9.20±1.25	.809	/
Abdominal skinfold	10.81±4.07	10.36±3.80	10.74±4.40	.454	/
Lower leg skinfold	5.23±1.44	5.48±1.73	5.00±1.20	.565	/
Upper leg skinfold	10.43±2.67	9.92±1.90	9.48±2.81	.458	/
Body mass index	23.64±1.56	23.36±1.40	23.40±1.40	.753	/
Fat kg	9.07±3.52	8.98±2.98	7.76±3.66	.042*	I>III, II>III
Fat %	11.53±3.43	11.46±2.89	9.78±3.9	.042*	I>III, II>III
Muscle mass kg	38.20±2.63	38.54±2.55	39.24±2.52	.007*	III>I, III>II
Muscle mass %	49.90±1.98	50.10±1.86	50.94±3.50	.092	III>I, III>II
Lean body mass kg	67.76±5.01	68.17±5.28	69.55±4.99	.011*	III>I, III>II
Lean body mass %	88.47±3.43	88.54±2.89	90.22±3.90	.042*	III>I, III>II

Mean - Arithmetic mean; SD - Standard deviation; ^ - non-significant; * - significant difference between groups.

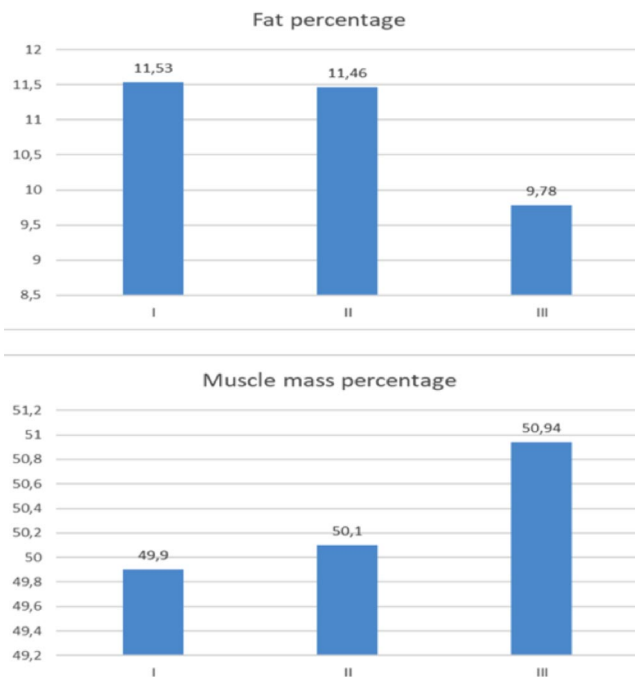


Fig. 1. The differences in body fat and muscle mass percentages of football players during a season.

DISCUSSION

The importance of body composition is very high in sports such as football, where body weight often shifts in the opposite direction of gravitational force during the expression of specific motor abilities in training, especially in situational circumstances during competitive matches (Owen *et al.*, 2018). Accordingly, this study aimed to examine the anthropometric characteristics and body composition of football players during

both the preparatory and competitive periods. The main findings of this study are: i) there is no difference in the anthropometric characteristics of football players during the season; ii) the body composition of football players changes during the season, with body fat showing lower values at the end of the competitive season compared to the preparatory period, while muscle mass of football players shows higher values at the end of the season compared to the beginning of preparations and the start of the season. Additionally, lean muscle mass is higher at the end of the season compared to the beginning of the season.

The information obtained from this study can be compared with previous research that followed the same parameters among elite senior football players, both before the start of the first part of the season, during the season, and at the end of the season (Bunc *et al.*, 2015; Owen *et al.*, 2018). Additionally, the results have shown that during the season and at its end, the percentage of fat decreases while muscle mass and lean body mass increase (Bunc *et al.*, 2015). However, the analysis of the time intervals during which measurements were taken did not adequately track the initial and final stages of the training process; therefore, the results obtained from this study provide a more precise curve of transformation for fat, muscle, and lean body mass parameters compared to earlier research (Bunc *et al.*, 2015; Owen *et al.*, 2018). Supporting this observation are the findings of a study (Suarez-Arrones *et al.*, 2019) indicating that during the transitional period of the season, after the first half of the season and with only two to five weeks without training, the body undergoes significant changes in its composition. The most significant changes occur in the absolute and relative values of fat, muscle, and lean tissue (Bunc *et al.*, 2015; Owen *et al.*, 2018; Suarez-Arrones *et al.*, 2019). The explanation for

such changes in body composition at the beginning of the preparatory period, after the preparatory period, and after the competitive period is that the type of activity during the competitive season significantly changes, with higher intensity during the competitive part of the season. During this phase of the season, emphasis is primarily placed on strength, explosiveness, and speed as the foundations of basic motor abilities, which are then transferred to situational circumstances and competitive matches. Additionally, besides the higher intensity present in training and competitive activities, during the matches, there is an increase in the number of body systems involved in the execution of tasks on the football field, which consequently requires additional energy expenditure (Bunc & Skalská, 2014; Bunc *et al.*, 2015).

Analysis of the results from previous studies (Iga *et al.*, 2014; Bunc *et al.*, 2015; Milanese *et al.*, 2015), which focused on tracking body fat among football players and their performance, clearly indicates that players with lower body fat percentages demonstrate better results. These findings further suggest in the cited research, that this is a direct result of training intensity. Therefore, when there is an increase in body weight and body fat during the competitive season, it can be considered detrimental to competitive performance (Kraemer *et al.*, 2004; Bunc *et al.*, 2015; Sermaxhaj *et al.*, 2024). Moreover, by analyzing additional information obtained from the research, it is also evident that segmental analysis of body composition transformation during the competitive season reveals an increase in muscle mass primarily in specific regions, such as the trunk and lower limbs, while fat is predominantly lost in the trunk area (Bunc *et al.*, 2015; Owen *et al.*, 2018; Suarez-Arrones *et al.*, 2019).

In line with the aforementioned, the main advantage of this study lies in the application of sophisticated technology for assessing body composition parameters, specifically newer generation bioelectrical impedance, which eliminates the possibility of subjective assessment by the measurer. Furthermore, the greatest strength of this study is the analysis of elite football players over a period of five months, covering three key points during one half of the season, enabling various benefits through monitored parameters. By tracking a large number of parameters, the moment of greatest transformation in body composition and analyzed anthropometric parameters was identified, although no statistically significant difference was observed among them. The peak transformation moment during one half of the season could be noted, indicating the training and competitive load during the analyzed time periods.

These findings regarding body composition, namely that the percentage of fat is higher at the beginning of preparation compared to the season, suggest that footballers disrupt their physical status during the transitional period,

which can have a negative impact on other aspects of their performance. In this regard, these results underscore the need to propose an individualized supervised off-season training plan, which would help footballers maintain their physical status at the desired level and enter the next preparatory cycle with the same level of ability. This is supported by numerous studies that have shown that footballers who trained according to a prescribed training plan during the transitional period were able to maintain their level of performance (Miller *et al.*, 2007; Boullosa *et al.*, 2013). By emphasizing the off-season training plan, negative impacts on physical status and performance fluctuations would be reduced, which would be of great importance for footballers and enable further performance development.

Despite some limitations, this study is significant because it thoroughly examined the levels of anthropometric and body composition parameters among elite footballers in Montenegro and tracked their changes in these parameters throughout the season. This provided a deeper insight into the state of these characteristics. These data can be useful for further research in the field of morphological characteristics of footballers and, on the other hand, can also serve coaches by providing guidance in creating an annual training plan for their players.

However, the limitation of this study may be reflected in the number of tracked parameters used to analyze the body composition of elite footballers. It would be advisable for future studies to also include tracking of body fluids. Additionally, it would be desirable to conduct a segmental analysis of body composition parameters to determine regions where fat accumulation and muscle mass reduction occur, thus enabling a more adequate planning of the training process and nutrition during the pre-preparatory period. In addition to the mentioned limitations, it should also be noted that it would be significantly beneficial to cover the entire season and analyze players based on their positions on the field. This would create a comprehensive picture of the transformations in body composition and anthropometric parameters among senior category elite footballers. Moreover, it would enable a more suitable planning of the training process based on players' positions on the field and, consequently, a more appropriate nutrition plan to minimize variations in body composition before, during, and between half-seasons and seasons.

CONCLUSION

This study aimed to examine the anthropometric characteristics and body composition of football players during both the preparatory and competitive periods. The main findings indicate that there is no difference in anthropometric characteristics during the season. However,

significant changes in body composition were observed, with body fat showing lower values at the end of the competitive season compared to the preparatory period, while muscle mass and lean mass of football players showed higher values at the end of the season compared to the beginning of preparations and the start of the season.

Our results have indicated that football training and competition during the season positively affected the physical status of footballers, indirectly suggesting that players started the season with a disrupted physical status after the transitional period. In that regard, our findings may assist fitness trainers engaged in football clubs in designing and implementing an organized training regimen for elite footballers throughout the year. This approach aims to maintain the body composition and physical performance of footballers throughout the year.

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RESUMEN: Las características antropométricas y la composición corporal son factores importantes para el éxito en el fútbol de élite, y recientemente ha habido un creciente número de investigaciones sobre este tema. Este estudio tuvo como objetivo investigar los cambios en las características antropométricas y la composición corporal de los futbolistas durante los períodos preparatorios y competitivos. La investigación involucró a 10 futbolistas profesionales ($24,4 \pm 4,84$ años) que competían en la Primera Liga de Telecomunicación de Montenegro. Las mediciones se tomaron en enero antes de la fase preparatoria, luego nuevamente 30 días antes del inicio de la temporada en febrero y después de la temporada en mayo. Las características antropométricas y la composición corporal se evaluaron utilizando un conjunto de 15 variables, incluyendo altura corporal, peso corporal, pliegue cutáneo tricótipal, pliegue cutáneo bicipital, pliegue cutáneo dorsal, pliegue cutáneo abdominal, pliegue cutáneo de la parte inferior de la pierna, pliegue cutáneo de la parte superior de la pierna, índice de masa corporal, kg de grasa, porcentaje de grasa, kg de masa muscular, porcentaje de masa muscular, kg de masa corporal magra, porcentaje de masa corporal magra. No hubo diferencias en las características antropométricas en los tres períodos de medición para los jugadores de fútbol. Sin embargo, se observaron diferencias en los seis parámetros de la composición corporal en los tres períodos de medición. La masa grasa y el porcentaje de grasa disminuyeron significativamente después de la fase competitiva en comparación con las mediciones antes y después del período preparatorio. Además, la masa muscular, el porcentaje de masa muscular, la masa muscular magra y el porcentaje de masa muscular magra aumentaron significativamente en los jugadores de fútbol después de la temporada competitiva en comparación con las mediciones antes y después del período preparatorio. Esto indica que la temporada competitiva tiene un efecto positivo en los cambios en la composición corporal, lo que lleva a una reducción

de la masa grasa al mismo tiempo que aumenta los componentes de masa muscular y masa magra en los jugadores de fútbol, mientras que los parámetros antropométricos permanecen sin cambios.

PALABRAS CLAVE: Futbolistas profesionales; Variaciones estacionales; Características morfológicas.

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