

ORIGINAL SCIENTIFIC PAPER

Comparative Study of Anthropometric Measurement and Body Composition between Junior Basketball and Volleyball Players from Serbian National League

Bojan Masanovic¹

¹University of Montenegro, Faculty for Sport and Physical Education, Niksic, Montenegro

Abstract

The purpose of this study was to describe anthropometric characteristics and body composition of junior basketball and volleyball players from Serbian national league and to make comparison between them. Fifty-nine males were enrolled in the study divided into three groups: thirteen basketball players, fourteen volleyball players and thirty-two healthy sedentary subjects. All subjects were assessed for the anthropometric measures required for the calculation of body composition variables, using standardized procedure recommended by established literature. Data was analyzed using SPSS and the descriptive statistics were expressed as mean (SD) for each variable, while ANOVA and LSD Post Hoc tests were carried out to detect the effects of each type of sport. The results showed there was no significant difference in body mass index and bone content of body among the groups, while a significant difference was found for body height, body weight, muscle and fat contents of body among the groups. Basketball and volleyball players were significantly taller and heavier than the subjects of the control group, while there was not any significant difference between the body height and body weight of basketball and volleyball players. Muscle content of basketball players was significantly higher than control subjects, while a significant difference was not noticed between volleyball players and subjects of control group. Fat content in the body of basketball and volleyball players are significantly lower than the percent of fat content in the body of control group, while there was not found any other difference in this content. These findings may give coaches from the region better working knowledge and suggest them to follow recent selection process methods and to be more careful during the recruitment.

Key words: *sport, junior, basketball, volleyball, male*

Introduction

Morphological characteristics are of particular importance for orientation and selection in most sports disciplines, since in the equation of the specification of almost every sport and also each specific function in the team, the morphological dimensions occupy one of the most important positions. Identifying talented children, assessing their strength and weaknesses, assigning positions to the team and planning the training programs

in the proper manner are the basis of each work. Therefore, the scientists all over the world are looking for the standard formula that can improve the performance of elite players and discover talents as precisely as possible (Popovic, Akpinar, Jaksic, Matic, & Bjelica, 2013).

Many researchers have hypothesized that practicing athletes might be expected to exhibit structural and functional characteristics that are specifically favorable for their specific sport (S.



Correspondence:

B. Masanovic
University of Montenegro, Faculty for Sport and Physical Education, Narodne omladine bb, 81400 Niksic, Montenegro
E-mail: bojanma@ac.me

Singh, K. Singh, & M. Singh, 2010). Since each sport has its own specific demands, every athlete should have specific anthropometrical characteristics and body composition figures for his or her own sports discipline. Understanding the body composition is considered an essential part of the total management process (Wilmore, 1982). Body composition can affect strength and agility (Massuça & Fragoso, 2011), whereas body mass can influence an athlete's speed, endurance, and power. It is well known that excessive fat mass compromises the physical performance (Nikolaidis & Vassilios-Karydis, 2011), acts as a dead body mass in activities where the body must be repeatedly lifted during locomotion and jumping, decreasing performance and increasing energy demands (Ramos-Campo et al., 2014). On the contrary, muscle-skeletal mass is an indicator of sports performance, because it contributes to the energy production during high-intensity activities and provides absolute strength to athletes (Vila Suárez et al., 2008). From previous mentioned follows that modern athlete it should be fast, explosive and powerful. It should have more muscle mass and less fat tissue.

It is known, on body height cannot be much affected, because it is highly genetically conditioned dimension. On the other hand, body weight, the percentage of fat and muscle it can be changed a lot, and this fact should be used. Sometimes illegal substances are used for these purposes. Although there is little evidence of athletic performance enhancement following diuretic administration, their abuse is widespread among athletes who want to lose weight quickly. For example, diuretics use can allow an athlete to transiently reduce body weight, which is a clear advantage in wrestling, boxing, judo and weight-lifting as well as in general sports where weight categories are involved and among athletes who want to maintain a low body weight, such as female gymnasts and ballet dancers (Cadwallader, de la Torre, Tieri, & Botrè, 2010). Professional athletes commonly use anabolic-androgenic steroids to enhance performance. Anabolic-androgenic steroids include testosterone and its numerous synthetic analogs that have been modified to boost their anabolic, rather than their androgenic effects. Anabolic effects consist in protein synthesis, muscle growth, and erythropoiesis. Therefore, they allow athletes to increase muscle size and reduce body fat. Under the influence of anabolic-androgenic steroids muscles grow, increases muscle strength and density, recovering is faster from workouts and muscle injury, allowing them to train longer and harder (Piacentino et al., 2015). The results of using these unauthorized pharmacology it is augmenting performance but they bring the consequences and followed by an assessment of the health risks. The correct assessment of body composition in sport is important, since errors may lead to mistakes in training prescription and diet elaboration, and therefore affect the athletic performance (De Oliveira-Junior et al., 2016). Some sports, such as boxing, require much more knowledge regarding this topic than others, because of the weight limits. The following example, the sport of arm-wrestling, requires the selection of athletes with longer forearm bones (Popovic et al., 2013). The need to investigate the anthropometrical characteristics and body composition numbers of basketball and volleyball players is equally important, as adequate body composition and body mass figures, among other factors, contribute to optimal exercise routines and performance (Massuça & Fragoso, 2011). According to previous investigations (Hurst et al., 2017; Loureiro et al., 2017; Silva, Marcelino, Lacerda, & Vicente João, 2016; Pojskic, Separovic, Muratovic, & Uzicanin, 2014), successful participation in both basketball and volleyball games, requires not only a high level of

technical and tactical skills, but also requires from each athlete suitable anthropometrical characteristics and body composition. This study aims to verify if data collected regarding the anthropometrical characteristics and body composition of Serbian athletes supports previous studies that have evaluated ideal anthropometric profiles of successful basketball players (Pojskic et al., 2014; Vaquera, Santiago, Gerardo, Rabago, & García-Tormo, 2015) and volleyball players (Lidor & Ziv, 2010; Carvajal et al., 2012).

The previous investigations confirm that players in both mentioned sports are usually taller than the players from other sports (Rahmawati, Budiharjo, & Ashizawa, 2007) as well as the subject from general population (Gaurav, M. Singh, & S. Singh, 2010). Basketball and volleyball require from their players handling a ball above their heads (Gaurav et al., 2010), therefore tallness is great advantage in these sports. Even though these sports have some similar requirements, basketball and volleyball are two sports with different technical skills and different training and playing procedures. Basketball has been described as an intermittent sport, being physically very demanding, requiring players to permanently repeat bouts of intense actions (sprinting, shuffling, jumping) with jogging, walking, or short periods of recovering between (Stojanovic et al., 2016). In this game, movement patterns significantly differ from volleyball, as it requires the fast and explosive application of basketball techniques such as rebounding, driving, lay-ups, jump shooting, shot blocking, fast breaks and high speed play (Pojskic et al., 2014), the average work intensity of a basketball game is above 85% of maximal heart rate and above 80% of VO₂ max (Balciunas, 2006). On the other hand, volleyball is a sport in which there is no contact, in which two teams of six players are separated by a net. It requires a high standard of preparation in order to complete for three sets of competitive play and to achieve success. In this game, movement patterns are significantly different from the soccer, as it requires their attack and defense to be much more effective as well as the dominance over the net becomes the most decisive factor for victory. The top-level volleyball players do not have VO₂ max values on the high level as typical endurance trained elite players in other sports, but they have an optimal level of aerobic capacity that is required for playing this game since it may sometimes continue for longer (Lidor & Ziv, 2010). This game also includes a large number of spiking, jumping, power hitting, blocking, and setting that is mainly based on a high level of strength and power (Lidor & Ziv, 2010). The authors believed it would be reasonable to compare the anthropometrical characteristics and body composition of these athletes to check if there any differences among them (Popović, Bjelica, Jakšić, & Hadžić, 2014). Obtained data can enable switching junior players from one sports discipline to another one during the growing up period. This study also aims to check if this is true for on part of Dinaric Alps countries (Serbia), the place where live the people with the biggest absolute size (Pineau, Delamarche, & Bozinovic, 2005). Many previous studies have accurately determined the ideal anthropometric profile of successful basketball and volleyball player (Marques & Marinho, 2009; Nepocatych, Balilionis, & O'Neal, 2017; Vukasevic, Spaic, & Masanovic, 2018). Based on these results we have insights into the requirements for competing at the top level in particular sports. But, we do not have many studies to compare performance between basketball and volleyball at competition level.

Hence, the purpose of this study was to describe anthropometric characteristics and body composition of junior basketball and volleyball players from Serbian national league and to detect possible differences in relation to competition level.

Method

Fifty-nine males were enrolled in the study. They have been divided into three groups: thirteen basketball players (17.08±0.28 yrs.) and fourteen volleyball players (17.36±0.74 yrs.) from the junior premier league in Serbia as well as thirty-two healthy sedentary subjects (17.34±0.60 yrs.).

All subjects were clinically healthy and had no history of recent infection disease, asthma or cardiorespiratory disorders. Onward, all of them gave their written consent and the local ethics committee approved the study protocol. All subjects were assessed for the anthropometric measures required for the calculation of body composition variables (Matiegka, 1921), using standardized procedure recommended by International Biological Program (IBP) standards respecting the basic rules and principles related to the parameter choice, standard conditions and measurement techniques, as well as the standard measuring instruments adjusted before measurement was carried out. Height and weight were measured in the laboratory with the subjects dressed in light clothing. Height was measured to the nearest 0.1 cm using a fixed stadiometer and weight was measured to the nearest 0.1 kg with a standard scale using a portable balance. Body mass index (BMI) was calculated as body mass in kilograms divided by height in meters squared (kg/m²). Skinfolds

(mm) were measured at six sites using: triceps skinfold thickness, forearm skinfold thickness, thigh skinfold thickness, calf skinfold thickness, chest skinfold thickness and abdominal skinfold thickness, using a skinfold caliper. Each individual measurement and the sum of the six measurements were used for analysis. The circumferences of the upper and lower arm, and upper and lower leg were measured (cm), as well as the following diameters to the nearest 0.1 cm: elbow diameter, wrist diameter, knee diameter, ankle diameter, upper arm diameter, forearm diameter, thigh diameter, and calf diameter. To reduce measurement variation, the same investigator examined all subjects.

The data obtained in the research were processed using the application statistics program SPSS 20.0 adjusted for the use on personal computers. The descriptive statistics were expressed as mean (SD) for each variable. Analysis of variance (ANOVA) and LSD Post Hoc test were carried out to detect the effects for each type of sport (basketball or volleyball) on each variable: body height, body weight, body mass index (BMI), and muscle, bone and fat content of the body, as well as to control it by sedentary subjects. The significance was set at an alpha level of 0.05.

Results

The anthropometric characteristics of subjects are shown

Table 1. Descriptive data and ANOVA

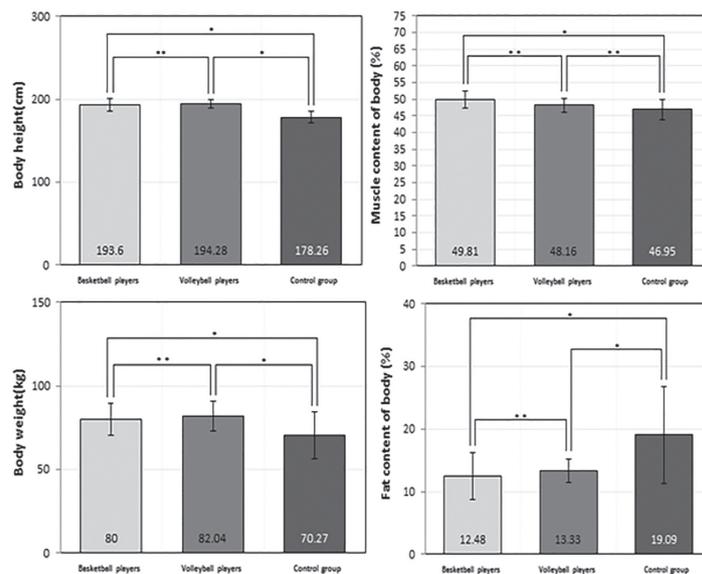
Variables	Basketball (N=13)	Volleyball (N=14)	Control (n=32)	ANOVA
	Mean±Standard Deviation			
Height (cm)	193.60±7.70	194.28±5.30	178.26±7.27	0.000*
Weight (kg)	80.00±9.76	82.04±8.85	70.27±14.09	0.050*
BMI (kg/m ²)	21.32±1.99	21.71±1.81	22.11±4.27	0.771^
Muscle content of body (%)	49.81±2.57	48.16±2.20	46.95±3.02	0.009*
Bone content of body (%)	16.95±1.15	16.52±1.20	17.34±2.47	0.434^
Fat content of body (%)	12.48±3.67	13.33±1.92	19.09±7.77	0.001*

Legend: N-number of subjects; BMI-body mass index; ^-non-significant; *-significant difference between groups

in Table 1. There was no significant difference in body mass index and bone content of body among the groups, while a significant difference was found for body height (F=37.26), body

weight (F=5.84) and other two contents of body among the groups: muscle (F=5.08) and fat (F=7.57).

The significant differences of anthropometric characteris-



Legend: *=significance≤0.01; **=non-significance

Figure 1. Differences among the Subjects

tics among particular sports are shown in Figure 1. The LSD Post Hoc test indicates that basketball and volleyball players were significantly taller and heavier than the subjects of the control group, while there was not any significant difference between the body height and body weight of basketball and volleyball players. Muscle content of basketball players was significantly higher than control subjects, while a significant difference was not between volleyball players and subjects of the control group. Lastly, fat content in the body of basketball and volleyball players was significantly lower than the percent of fat content in the body of control group, while no other differences were found in this content.

Discussion

The results in this study support previous investigations indicating a strong difference regarding the body height among the athletes in these two sports and the subjects from the control group that represents general population (Gaurav et al., 2010). Based on this we can confirm the well-known axiom that selection is the only reason that can explain the observed difference. However, much more important finding regarding the body height is the fact that there was no significant difference among basketball and volleyball players. This finding leads us to conclusions that there are no specific demands regarding the body height between these two sports. The reason for growth tendencies basketball and volleyball players is because their players are handling the ball above their heads (Gaurav et al., 2010) and their height helps them reach toward the basket or the top of the net as well as in the performance of defense elements. Taller basketball players have an advantage because the ball has to pass shorter distance from hand to the basket. Also, it provides them to start out closer to the rebound and their ability to jump higher than their opponents, and give them a chance to block their shoots. Taller volleyball players have an advantage because they can control both, defensive and offensive actions over the top of the net much easier. Thus, there is a tendency for the tallest children to be recruited in both sports, consequently selection criteria is very important. However, extra talented short players, especially those with a high vertical jump, shall also be selected and play a significant role in both sports disciplines (Popović et al., 2014). This conclusion can confirm the fact that male college and professional volleyball players, even the shortest players, are usually above average in height compared to the general population (Popović et al., 2014). For example, the average height of 2016 FIBA U17 World Basketball Championship players who played in Zaragoza in Spain, was 195.56 cm, while the average height of the national basketball teams who played semifinals, according to available data from official website, were following: the USA (198.17 cm), Turkey (195.75 cm), Lithuania (198.17 cm) and Spain (195.92 cm). On the other hand, the average body heights of the volleyball teams who played the finishing line CEV U17 Volleyball European Championship 2017 in Turkey were next: Russia (199.1 cm), Belarus (192.44 cm), Greece (187.5 cm), Italy (192.33 cm), Bulgaria (195.84 cm) and the Netherlands (188 cm). Average height of all participants in the championship was 189 centimeters. This proves that the players from our basketball and volleyball junior premier league are tall enough and they do not lag behind the top European and World players. However, this is not a surprise, as it is well known that the number of very tall subjects appears to be high in Dinaric Alpes area (Popovic, 2017), since 28% of people

from general population were measured 190 centimeters or more in body height (Pineu et al., 2005; Bjelica et al., 2012).

Furthermore, it was expected that basketball and volleyball players were heavier than the subjects of the control group, mostly due to the reason they are significantly taller than they are. However, the reason why basketball and volleyball players are significantly heavier than subjects in control group can be supported with the fact that the average size of the basketball and volleyball players has increased dramatically in the past decades. Therefore, this could be a result of better nutrition, especially in professional basketball leagues, partly due to the use of nutritional supplements. The body mass index (BMI; weight/height^2) is a parameter that is widely used in adult populations such as an internationally recognized definition of overweight and obesity (Kovac, Jurak, & Leskosek, 2012). Fortunately, the body mass index of all three groups is in the area of normal weight according to the established literature (Popovic, Masanovic, Molnar, & Smajic, 2009) and it did not show any significant differences among the groups.

Indeed, the authors found that the basketball players have significantly higher muscle content of body than the subjects of the control group. While there was not significant difference between volleyball players and the subjects of the control group. However, volleyball players have a slightly higher percentage of muscle content than control subjects, which is clearly seen in the table overview. These results may be explained by more demands to grow the muscle contents of the body in sportsmen, while a slightly higher percentage of muscle content of basketball players was found as this game requires intermittent activities when high-intensity activities are followed by low-intensity type of movements. It is well-known that muscle mass is important to improve strength and power which are then relevant to sport performance (Nikolaidis & Vassilios-Karydis, 2011). Our volleyball players have slightly higher values of muscle mass than the participants of the study in the control group but we are not to worry about that because the muscle mass of our volleyball players corresponds to the values in the established literature (Jeukendrup & Gleeson 2009) and higher differences in muscle mass are observed only in older years (Masanovic, 2008). While bone content of body did not show any significant differences among the groups and it corresponds the values in the established literature.

In sports like basketball and volleyball, a gravitational sport (Ackland et al., 2012), it is well known that excessive fat mass compromises the physical performance (Nikolaidis & Vassilios-Karydis, 2011). Therefore, the low percentage of fat content in the body of our basketball and volleyball players, and significantly lower than the percentage of fat content in the body of control subjects, showed that our players have high physical performance. However, it is very important to remember that athletes in elite team sports such as basketball and volleyball need a determined body fat percentage to perform well enough and achieve their full playing potential. The National Strength and Conditioning Association indicates that body fat percentages may vary from less than 7 percent to 17 percent among the male athletes, depending on the sports discipline. However, we would like to stress that these are just guidelines and the athletes would work together with their coaches and their personal physician to determine the appropriate individual body fat percentage to enhance their physical abilities and their health.

The importance of body composition in sport perfor-

mance is a primary concern in creating athletes' profiles as well as conditioning programs throughout a season at all levels of competition (Silvestre et al., 2006), in that describing anthropometric characteristics and body compositions of athletes and detecting possible differences in relation to competition levels may give coaches a better working knowledge of the studied groups of athletes. Moreover, the results of this study suggest that basketball and volleyball have a decreased percent of fat content if we compare it to the control group. This study also suggests that basketball and volleyball players have significantly increased muscle content, while the differences in the bone content are logical consequences. The part attributed to the body height is the main cause of selection process; and lastly, the part attributed to body weight could be the main cause of nutritional habits. Considering that the measurements were conducted in the middle of the season, this study is limited by the fact that changes in body composition and physical performance may occur from the start to the end of an athlete's training and competitive season (Silvestre et al., 2006). Kraemer et al. (2004) reported that players who enter a season with a high catabolic metabolic status could experience reductions in performance during a competitive season accompanied by detrimental changes in body composition. Accordingly, further studies should be very careful in projecting timelines for measuring anthropometric characteristics and body composition, mostly due to the fact that it has to be conducted either at the beginning or at the end of a season. It also has to be explicitly reported when the measurement was conducted.

Acknowledgements

There are no acknowledgements.

Conflict of Interest

The authors declare that there are no conflicts of interest.

Received: 15 June 2018 | **Accepted:** 01 August 2018 | **Published:** 01 October 2018

References

- Ackland, T.R., Lohman, T.G., Sundgot-Borgen, J., Maughan, R.J., Meyer, N.L., Stewart, A.D., & Müller, W. (2012). Current status of body composition assessment in sport: review and position statement on behalf of the ad hoc research working group on body composition health and performance, under the auspices of the I.O.C. Medical Commission. *Sports Medicine*, 42(3), 227-49.
- Balciunas, M., Stonkus, S., Abrantes, C., & Sampaio, J. (2006). Long term effects of different training modalities on power, speed, skill and anaerobic capacity in junior male basketball players. *Journal of Sports Science and Medicine*, 5(2), 163-70.
- Bjelica, D., Popović, S., Kezunović, M., Petković, J., Jurak, G., & Grasgruber, P. (2012). Body Height and Its Estimation Utilizing Arm Span Measurements in Montenegrin Adults. *Anthropological Notebooks*, 18(2), 69-83.
- Cadwallader, A.B., de la Torre, X., Tieri, A., & Botrè, F. (2010). The abuse of diuretics as performance-enhancing drugs and masking agents in sport doping: pharmacology, toxicology and analysis. *British Journal of Pharmacology*, 161(1), 1-16.
- Carvajal, W., Betancourt, H., León, S., Deturnel, Y., Martínez, M., Echevarría, I., Eugenia Castillo, M., & Serviat, N. (2012). Kinanthropometric Profile of Cuban Women Olympic Volleyball Champions. *MEDICC Review*, 14(2), 16-22.
- De Oliveira-Junior, A.V., Casimiro-Lopes, G., Donangelo, C.M., Koury, J.C., Farinatti, P.T.V., Massuça, L., & Fragoso, I.C.J. (2016). Methodological Agreement between Body-Composition Methods in Junior Soccer Players Stratified by Zinc Plasma Levels. *International Journal of Morphology*, 34(1), 49-56.
- Gaurav, V., Singh, M., & Singh, S. (2010). Anthropometric characteristics, somatotyping and body composition of volleyball and basketball players. *Journal of Physical Education and Sports Management*, 1(3), 28-32.
- Hooper, D.M. (1997). Somatotype in high performance female netball players may influence player position and the incidence of lower limb and back injuries. *British Journal of Sports Medicine*, 31(3), 197-9.
- Hurst, M., Loureiro, M., Valongo, B., Laporta, L., Nikolaidis, P., & Afonso, J. (2017). Systemic Mapping of High-Level Women's Volleyball using Social Network Analysis: The Case of Attack Coverage, Freeball, and Downball. *Montenegrin Journal of Sports Science and Medicine*, 6(1), 57-64.
- Jeukendrup, A.E. & Gleeson, M. (2009). *Sport Nutrition: An Introduction to Energy Production and Performance*. Champaign: Human Kinetics.
- Kovac, M., Jurak, G., & Leskosek, B. (2012). The prevalence of excess weight and obesity in Slovenian children and adolescents from 1991 to 2011. *Anthropological Notebook*, 18(1), 91-103.
- Kraemer, W.J., French, D.N., Paxton, N.J., Häkkinen, K., Volek, J.S., Sebastianelli, W.J., Putukian, M., Newton, R.U., Rubin, M.R., Gómez, A.L., Vescovi, J.D., Ratames, N.A., Fleck, S.J., Lynch, J.M., & Knuttgen, H.G. (2004). Changes in exercise performance and hormonal concentrations over a Big Ten soccer season in starters and nonstarters. *The Journal of Strength & Conditioning Research*, 18(1), 121-8.
- Lidor, R. & Ziv, G. (2010). Physical characteristics and physiological attributes of adolescent volleyball players-a review. *Pediatric Exercise Science*, 22(1), 114-34.
- Loureiro, M., Hurst, M., Valongo, B., Nikolaidis, P., Laporta, L., & Afonso, J. (2017). A comprehensive mapping of high-level men's volleyball game-play through social network analysis: Analysing serve, side-out, side-out transition and transition. *Montenegrin Journal of Sports Science and Medicine*, 6(2), 35-41.
- Marques, M.C. & Marinho, D.A. (2009). Physical parameters and performance values in starters and non-starters volleyball players: A brief research note. *Motricidade*, 5(3), 7-11.
- Masanovic, B. (2008). *Determination of body composition of athletes*. Unpublished Master Thesis. Novi Sad: Faculty of Sport and Physical Education.
- Massuça, L. & Fragoso, I. (2011). Study of Portuguese handball players of different playing status. A morphological and biosocial perspective. *Biology of Sport*, 28(1), 37-44.
- Matiiegka, J. (1921). The testing of physical efficiency. *American Journal of Physical Anthropology*, 4, 223-30.
- Nepocatyč, S., Balilionis, G., & O'Neal, E.K. (2017). Analysis of dietary intake and body composition of female athletes over a competitive season. *Montenegrin Journal of Sports Science and Medicine*, 6(2), 57-65.
- Nikolaidis, P.T. & Vassilios Karydis, N. (2011). Physique and body composition in soccer players across adolescence. *Asian Journal of Sports Medicine*, 2(2), 75-82.
- Piacentino, D., Kotzalis, G.D., del Casale, A., Aromatario, M.R., Pomara, C., Girardi, P., & Sani, G. (2015). Anabolic-androgenic Steroid use and Psychopathology in Athletes. A Systematic Review. *Current Neuropharmacology*, 13(1), 101-21.
- Pineau, J., Delamarche P., & Bozinovic, S. (2005). Average height of adolescents in the Dinaric Alps (in French). *Comptes Rendus Biologies*, 328(9), 841-6.
- Pojškić, H., Separović, V., Muratović, M., & Uzicanin, E. (2014). Morphological Differences of Elite Bosnian Basketball Players According to Team Position. *Intional Journal of Morphology*, 32(2), 690-4.
- Popovic, S. (2017). Local Geographical Differences in Adult Body Height in Montenegro. *Montenegrin Journal of Sports Science and Medicine*, 6(1), 81-7.
- Popovic, S., Akpınar, S., Jaksic, D., Matic, R., & Bjelica, D. (2013). Comparative Study of Anthropometric Measurement and Body Composition between Elite Soccer and Basketball Players. *International Journal of Morphology*, 31(2), 461-7.
- Popović, S., Bjelica, D., Jakšić, D., & Hadžić, R. (2014). Comparative Study of Anthropometric Measurement and Body Composition between Elite Soccer and Volleyball Players. *International Journal of Morphology*, 32(1), 267-74.
- Popovic, S., Masanovic, B., Molnar, S., & Smajic, M. (2009). Determining Body Composition of Top Level Athletes. *Teme*, 33(4), 1534-49.
- Rahmawati, N.T., Budiharjo, S., & Ashizawa, K. (2007). Somatotypes of junior male athletes and non-athlete students in Yogyakarta, Indonesia. *Anthropological Science*, 115(1), 1-7.
- Ramos-Campo, D.J., Martínez-Sánchez, F., Esteban-García, P., Rubio-Arias, J.A., Boreas, C.A., Clemente-Suarez, V.J., & Jiménez-Díaz, J.F. (2014). Body Composition Features in Different Playing Position of Professional Team Indoor Players: Basketball, Handball and Futsal. *International Journal of Morphology*, 32(4), 1316-24.
- Silva, M., Marcelino, R., Lacerda, D., & Vicente João, P. (2016). Match Analysis in Volleyball: a systematic review. *Montenegrin Journal of Sports Science and Medicine*, 5(1), 35-46.

- Silvestre, R., Kraemer, W.J., West, C., Judelson, D.A., Spiering, B.A., Vingren, J.L., Hatfield, D.L., Anderson, J.M., & Maresh, C.M. (2006). Body Composition and Physical Performance during a National Collegiate Athletic Association Division I Men's Soccer Season. *The Journal of Strength & Conditioning Research*, 20(4), 962-70.
- Singh, S., Singh, K., & Singh, M. (2010). Anthropometric measurements, body composition and somatotyping of high jumpers. *Brazilian Journal of Biomechanics*, 4(4), 266-71.
- Stojanovic, M., Calleja-Gonzalez, J., Mikic, M., Madic, D., Drid, P., Vučković, I., & Ostojić, S. (2016). Accuracy and Criterion-Related Validity of the 20-M Shuttle Run Test in Well-Trained Young Basketball Players. *Montenegrin Journal of Sports Science and Medicine*, 5(2), 5-10.
- Vaquera, A., Santiago, S., Gerardo, V.J., Rabago, J.C.M., & García-Tormo, V.J. (2015). Anthropometric Characteristics of Spanish Professional Basketball Players. *Journal of Human Kinetics* 462015(46), 99-106.
- Vila Suárez, M.H., Ferragut, C., Alcaraz, P.E., Rodríguez Suárez, N., & Cruz Martínez, M. (2008). Anthropometric and strength characteristics in junior handball players by playing positions. *Archivos de Medicina del Deporte*, 125(3), 167-77.
- Vukasevic, V., Spaic, S., & Masanovic, B. (2018). Comparative study of anthropometric measurement and body composition between the basketball player first and second league in Montenegro. *Journal of Anthropology of Sport and Physical Education*, 2(3), 61-65.
- Wilmore, J.H. (1982). *Body composition and athletic performance*. In: Haskell, W.; Scala, J. & Whittam, J. (Eds.). *Nutrition and Athletic Performance*. California, Bull Publishing, 158-75.