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

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Abstract

The purpose of this study was to describe anthropometric characteristics and body composition of junior soccer and volleyball players from the Serbian National League as well as to make a comparison between them. Seventy-one male athletes were enrolled in this study, divided into three groups: twenty-five soccer players, fourteen volleyball players and thirty-two healthy sedentary subjects. All subjects were assessed for anthropometric measures required for the calculation of body composition variables, using standardized procedures recommended by previous studies. Data was analysed using SPSS and the descriptive statistics were expressed as a mean (SD) for each variable, while the ANOVA and the LSD Post Hoc tests were carried out to detect effects of each type of sport. The results showed that a significant difference was found in variables height, weight, and body fat, but no significant difference was found in the remaining three variables, body mass index, muscle mass or bone content. Volleyball players were significantly taller and heavier than soccer players or subjects from the control group, while there was no significant difference between height and weight of soccer players and subjects from the control group. Subjects from the control group had significantly higher percentage of body fat than both soccer and volleyball players. Soccer players had the lowest percentage of body fat, while subjects from the control group had the highest values of the same variable. Therefore, these findings may give coaches from the region better working knowledge and suggest to them to follow recent selection process methods and to be more careful during the process of talent identification.

Key words: *sport, junior, soccer, volleyball, male athletes*

Introduction

All competitive sports played at the professional level require that the body performs at the optimal biomechanical and physiological capacity (Zaccagni, 2012). Logically, junior athletes competing in top leagues which have high requirements at certain age levels are expected to have optimal physique, strength, and endurance for the functional requirements of the sport in question. However, a subjective opinion of so-called expert coaches often has influence on which gifted athletes will be selected (Matthys et al., 2011). Nevertheless, it is widely known that there is a growing interest in improving performance of athletes related to characteristics associated with consciousness, awareness and cognitive effort as well as identifying talents, strengths and weaknesses, assigning player positions and helping to design optimal training programs (Popovic, Akpinar, Jaksic, Matic, & Bjelica, 2013) all over the world, including Western Balkan countries. However, in many places a lot of time is spent on increasing the physical fitness

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of athletes without taking into consideration the assessment of their body composition and their nutritional status (Triki et al., 2012). Contemporary sport science is designed to improve performance and to identify talents as precisely as possible and for athletes at all age levels. Many studies have shown that specific anthropometric characteristics are significantly associated with sports results (Masanovic, 2018). Identification is very demanding, as various sporting events require differing body types to achieve maximum performance (Masanovic & Vukasevic, 2009). Therefore, understanding body composition of athletes, and then assigning it with corresponding competitive weights, has been done for decades and is considered an essential part of the overall management process (Popovic, Bjelica, Jaksic, & Hadzic, 2014). On the other hand, although children and adolescents who play sports grow in a manner similar to non-athletes, it is widely addressed in the scientific literature that adequate profiles are primarily important in various sports, mostly due to the reason that absolute size contributes to a significant percentage of the total variance associated with sports results (Rexhepi & Brestovci, 2010). Therefore, scientists all over the world are looking for a standard formula that could improve the performance of players and discover talents as efficiently as possible (Popovic et al., 2013).

Anthropometrical characteristics and body composition of athletes have been the subject of many investigations as many researchers have hypothesized that athletes in training might be expected to exhibit structural and functional characteristics that are specifically favourable to sports they play (S. Singh, K. Singh, & M. Singh, 2010). Since each sport has its own specific demands, every athlete should have specific anthropometrical characteristics and body composition related to sports disciplines involved. Correct body composition assessment is important in sport, since errors may lead to mistakes in training prescription and diet elaboration, and therefore affect athletic performance (De Oliveira-Junior et al., 2016). Some sports, such as wrestling, require further investigation of this topic, because of weight limits as well as favouring the selection of athletes with a limited vertical skeletal development (Popovic et al., 2014). Another example is arm wrestling which requires the selection of athletes with longer forearm bones (Akpinar, Zileli, Senyuzlu, & Tunca, 2012). The need to investigate data obtained from investigation of anthropometrical characteristics and body composition of soccer and volleyball players is as important as adequate body composition and body mass which, among other factors, contribute to optimal exercise routines and performance (Massuça & Fragoso, 2011). According to these two authors, body mass can influence athlete's speed, endurance, and power, whereas body composition can affect strength and agility. In other words, successful participation in both soccer and volleyball games, requires not only a high level of technical and tactical skills, but it also requires from each athlete suitable anthropometrical characteristics and body composition. Most of the descriptive data concerning characteristics of soccer and volleyball players come from America and Western Europe. There is a lack of data from Eastern Europe, especially the Western Balkan region. Hence, this study aims to verify if data collected regarding anthropometrical characteristics and body composition of Western Balkan athletes, where general population had specific measures (Popovic, 2017; Masanovic, 2018a), support previous studies that have evaluated ideal anthropometric profiles of successful soccer players (Saether, 2017; Herdy, Costa, Simao, & Selfe, 2018) and volleyball players (Bayios et al., 2006; Gaurav, M. Singh, & S. Singh, 2010), giving an insight into requirements for competing at the zenith of related sports.

Soccer is a sport game played in the open field, and training is usually based on the movement, expressed through endurance, which consists of a series of moderate activities, followed by alternating periods of high intensity, which leads to a significant metabolic heat production (Gusic, Popovic, Molnar, Masanovic, & Radakovic, 2017). Indeed, soccer requires a high standard of preparation through the development of physical performance skills, as well as tactical and technical expertise, in order to complete 90 minutes of a competitive play. According to Triki et al. (2012), soccer training is mainly based on movement, implementing endurance qualities consisting of moderate activity alternating with periods of intermittent high intensity, leading to a significant production of metabolic heat, mostly due to the fact that the average work intensity, during a soccer match, is usually about 75–90% of maximum heart rate, respectively 70–85% of VO2max (Rexhepi & Brestovci, 2010). On the other hand, volleyball is generally played in an indoor field that is much smaller in respect to a soccer field, in which two teams of six players are separated by a net (without mutual contacts between players). It requires a high standard of preparation in order to complete three sets of competitive play and to achieve high results. In this game, movement patterns significantly differ from those in soccer, as it requires much more effective attack and defense as well as dominance over the net, which is the most decisive factor for a victory (Hurst et al., 2017; Loureiro et al., 2017). Top-level volleyball players do not have VO2max values on a high level as typical endurance trained elite players in other sports do, but they have an optimum level of aerobic capacity that is required for playing this game since it may sometimes continue for a long time (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 (Loureiro et al., 2017).

Hence, the purpose of this study is to describe anthropometric characteristics and body composition profiles of junior soccer and volleyball players from the Serbian National League, and to detect possible differences in relation to the competition levels.

Methods

Seventy-one male athletes were enrolled in this study. They were divided into three groups: twenty-five soccer players (16.64±0.49 yrs.) from the Serbian Junior Premier League, fourteen volleyball players (17.36±0.74 yrs.) from the Serbian Junior Premier League and thirty-one healthy sedentary subjects from the same country (17.34±0.60 yrs.). The measurements were carried out in the winter preparation period.

All subjects were clinically healthy and had no recent history of infectious disease, asthma or cardio-respiratory disorders. All of them gave their written consent and the local ethics committee approved the protocol of the study. All subjects were assessed for anthropometric measures required for the calculation of body composition variables, using the standardized procedure recommended by the 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 the measurement was carried out. Height and weight were measured in the laboratory with

the subject 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 utilizing 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: 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 further analysis. The circumferences of the upper and lower arm and the upper and lower leg were measured in centimeters and the following diameters were measured 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 of the subjects.

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

Results

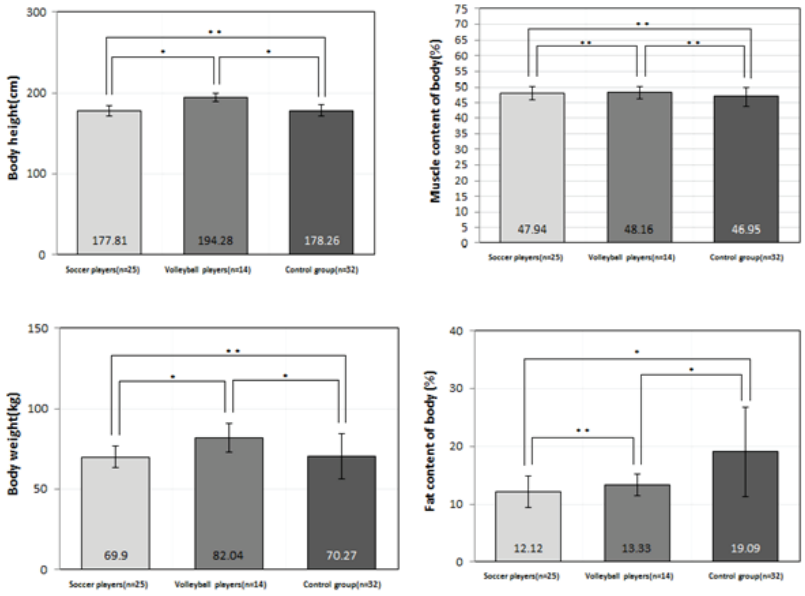
Anthropometric characteristics of subjects are shown in Table 1. There were significant differences in three out of five variables among the groups. Hence, a significant difference was found for height (F=32.90), weight (F=6.58) and body fat (F=12.34). There is no significant difference in the remaining three variables: body mass index (F=0.09), muscle mass (F=1.55) or bone content (F=1.09).

Table 1. Descriptive data and ANOVA of male athletes enrolled in the study (n=71)

Variables	Soccer (n=25)	Volleyball (n=14)	Control (n=32)	ANOVA
	Mean ± Standard Deviation			
Height (cm)	177.81±6.63	194.28±5.30	178.26±7.27	0.000*
Weight (kg)	69.90±6.78	82.04±8.85	70.27±14.09	0.002*
BMI (kg/m2)	22.10±1.74	21.71±1.81	22.11±4.27	0.918^
Muscle mass (%)	47.94±2.12	48.16±2.20	46.95±3.02	0.220^
Bone content (%)	16.76±1.48	16.52±1.20	17.34±2.47	0.343^
Body fat (%)	12.12±2.78	13.33±1.93	19.09±7.77	0.000*

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

Significant differences of anthropometric characteristics among particular sports are shown in Figure 1.



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

Figure 1. The LSD Post Hoc test for different parameters among the subjects

The LSD Post Hoc test indicated that volleyball players were significantly taller and heavier than soccer players or subjects from the control group, while the latter had significantly more percentage of body fat than soccer and volleyball players. Soccer players had the lowest percentage of body fat, while subjects from the control group had the most body fat. No significant difference was found for the other variables. However, it was noticed that volleyball players had the lowest body mass index, while subjects from the control group had the highest values. Lastly, volleyball players had the highest percentage of muscle mass, while subjects from the control group had the lowest values.

Discussion

Results of this study support previous investigations indicating a strong difference regarding body height among volleyball players on one side and soccer players and subjects from the control group that represents general population on the other side (Gaurav et al., 2010; Popovic, Masanovic, Molnar, & Smajic, 2009; Masanovic, Milosevic, & Corluka, 2018). Thus, this confirms the well-known axiom that selection is the main reason that can explain the observed difference, while selection criteria, different type of play and game rules between soccer and volleyball can also explain the observed difference (Popovic et al., 2013). However, a rather more important finding regarding body height is the fact there was no significant difference among soccer players and subjects from the control group representing the general population, mostly due to the reason there has been a tendency to recruit taller and heavier soccer players (S. Gil, J. Gil, Ruiz, A. Irazusta, & J. Irazusta, 2010). The absence of differences between soccer players and subjects from the control group in this study, raises doubts that the selection process has been carried out correctly, especially because soccer players are shorter than subjects from the control group. Nevertheless, it has to be considered that the average body height of all the participants in the FIFA U-17 World Soccer Championship India 2017 was 176.01 centimeters, while the average body height of the national team of Mali, who played the semi-finals of the aforementioned championship, was only 166.81 (the top goal scorer of Mali was Lassana Ndiaye and he was just 170 centimeters tall, while there were nine of his team players who were shorter than 160 centimeters). On the other hand, Philip Foden, the best young player in England and the best one of FIFA U-17 World Soccer Championship in India 2017 was 169 centimeter tall, while the most valuable Brazilian players, Paulinho and Brenner were 174 and 175 centimeters tall; although one more Englishman, Rhian Brewster, top goal scorer of the whole championship was 177 centimeters tall. Mentioned official statistical data proved that soccer players were tall enough removing all doubts about having to be taller than the general population. The tendency to recruit taller soccer players is not unsworn in the scientific literature yet (Popovic, Smajic, Joksimovic, & Masanovic, 2010; Nikolaidis & Vassilios-Karydis, 2011; Herdy et al., 2018). On the other hand, volleyball players tend to be tall because they are players handling a ball above their heads (Gaurav et al., 2010) and their body height helps them to reach high and close to the net as well as to defend the ball against the opponents. Taller players in volleyball have an advantage because they can easily control both defensive and offensive actions over the top of the net (Popovic et al., 2014). Thus, the selection criteria can explain the observed results, as there has been a tendency to recruit the tallest children in volleyball, too. However, extra talented short players, especially those with a high vertical jump, shall also be selected and play a significant role. This conclusion can confirm the fact that professional volleyball players, even the shortest ones, are usually above the average height compared to the general population (Popovic et al., 2014). For example, the average body height of the volleyball teams who played the finishing line CEV U17 Volleyball European Championship 2017 in Turkey were as it follows: Russia (199.1 cm), Belarus (192.44 cm), Greece (187.5 cm), Italy (192.33 cm), Bulgaria (195.84 cm), Netherlands (188 cm), while the average body height of all participants in the championship was 189 cm. This proves that junior volleyball players from the Serbian National League were tall enough and did not lag behind the top European players. However, this is not a surprise, as it is well-known that the density including very tall subjects appears to be characteristic of people from this area (Western Balkan), since a high percentage of people from general population were measured at 190 cm or more (Bjelica et al., 2012; Pineu, Delamarche, & Bozinovic, 2005; Popovic, Bjelica, Molnar, Jaksic, & Akpinar, 2013a). Therefore, this fact may give coaches, especially those from the Dinaric Alps, better working knowledge regarding this particular group of athletes and suggest to them to follow recent talent identification process methods and to be more careful during the recruitment as they have a very tall population on their hands in general (Pineu et al., 2005). Furthermore, it was expected that volleyball players were heavier than subjects from the control group or soccer players, mostly due to the fact they are significantly taller than both groups mentioned. However, the reason we have so heavy volleyball players may also be related to the fact that the average size of volleyball players has increased dramatically in the past 20-30 years. This could be because of a better nutrition, especially in elite volleyball leagues, partly due to the use of nutritional supplements.

The body mass index (BMI) is a parameter that is widely used in adult population as an internationally recognized definition for overweight and obesity (Kovac, Jurak, & Leskosek, 2012). Fortunately, body mass index of subjects from all three groups was within the normal limits according to previous studies (Popovic et al., 2009) and it did not show any significant differences among the groups. Also, we did not find any significant differences among the groups regarding muscle mass as well. While increasing lean body mass is important to improve strength and power, relevant to sport performance (Nikolaidis & Vassilios-Karydis, 2011), it is not a worry factor. Muscle mass of soccer and volleyball players from this study corresponds to the values obtained from the previous studies (Jeukendrup & Gleeson, 2009), however significant differences in muscle mass were observed in later age (Masanovic, 2008). Bone content of subjects from all groups of athletes was proportional to the longitudinal and transversal dimension of the skeleton, and it did not show any significant differences among the groups.

In sports like soccer and volleyball, it is well known that excessive fat mass compromises physical performance (Nikolaidis & Vassilios-Karydis, 2011). Therefore, a low percentage of body fat of soccer and volleyball players from this study, which was significantly lower than the percentage of body fat of subjects from the control group, showed that our players have a high level of physical performance. However, soccer players had significantly lower percentage of body fat, as expected, because many previous studies recognized soccer as a predominantly aerobic sport (Santos-Silva, Fonseca, De Castro, Greve, & Hernandez, 2007; Herdy et al., 2018), while anaerobic energy is essential only to performance in sprints, high-intensity runs, and duel plays, all of which may contribute to the final outcome of a game (Sporis, Ruzic, & Leko, 2008; Gardasevic, Georgijev, & Bjelica, 2012). Volleyball training contains more anaerobic activity than soccer, mostly due to intermittent nature of the game and continuous changes in response to different offensive and defensive situations. This sport demands more high-intensity anaerobic exercises done at short and explosive bursts. Furthermore, it is very important to remember that athletes in elite team sports such as soccer and volleyball need a

certain body fat percentage to perform well enough and achieve their full playing potential. The National Strength and Conditioning Association indicates that body fat percentages vary from less than 7 percent to 17 percent among male athletes, depending on the sports discipline. However, the authors of this study would like to highlight that these are just guidelines and that athletes should work closely with their coaches and their personal physicians to determine the appropriate individual body fat percentage to enhance their physical abilities and their health.

The importance of body composition in sport performance is a primary concern in creating athletes' profiles as well as conditioning programs throughout a season at all levels of competitions (Silvestre et al., 2006), as describing anthropometric characteristics and body composition 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 soccer and volleyball players had a lower percentage of body fat in comparison to the control group. On the other hand, this study also suggests that soccer and volleyball players had slightly increased muscle mass, while differences in bone content are a logical consequence. The part attributed to the body height is the main cause of the selection process, and lastly, the part attributed to body weight could be the main cause consequence 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 soccer 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 is exactly conducted.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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