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COMPARATIVE STUDY OF ANTHROPOMETRIC MEASUREMENT AND BODY COMPOSITION OF JUNIOR SOCCER AND HANDBALL PLAYERS FROM THE SERBIAN NATIONAL LEAGUE

PRIMERJALNA ŠTUDIJA ANTROPOMETRIČNIH MERITEV IN TELESNE ZGRADBE NOGOMETAŠEV IN ROKOMETAŠEV MLADINCEV IZ SRBSKE DRŽAVNE LIGE

ABSTRACT

The purpose of this study was to describe anthropometric characteristics and body composition of junior soccer and handball players from the Serbian National League and to make a comparison between them. Seventy-two male athletes engaged in this study were divided into three groups: twenty-five soccer players, fifteen handball players and thirty-two healthy sedentary subjects. All subjects were assessed for anthropometric measures required for the calculation of body composition variables, using standardized procedure recommended by previous studies. Data was analysed using SPSS and the descriptive statistics were expressed as a mean (SD) for each variable, while ANOVA and LSD Post Hoc test were carried out to detect the effects of each type of sport. The results showed that a significant difference was only found in body fat among the groups, while there was no significant difference in height, weight, body mass index, muscle mass or in bone content among the groups. Handball players showed significantly higher percentage of muscle mass than subjects from the control group, while no other differences were found regarding this variable. Soccer players showed significantly lower percentage of body fat than subjects from the control group, while no other differences were found regarding this variable. 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 recruitment.

Key words: sport, junior, soccer, handball, male athletes

IZVLEČEK

Namen raziskave je opisati antropometrične značilnosti in telesno zgradbo nogometašev in rokometašev mladincev iz srbske državne lige ter jih primerjati med seboj. V raziskavi je sodelovalo 72 športnikov, ki so bili razdeljeni v tri skupine: 25 nogometašev, 15 rokometašev in 32 zdravih merjencev, ki veliko časa preživijo sede. Vsi merjenci so opravili antropometrične meritve, na podlagi katerih smo izračunali spremenljivke telesne zgradbe, pri čemer smo uporabili standardiziran postopek, ki so ga priporočala predhodne raziskave. Podatke smo analizirali s statističnim paketom SPSS, deskriptivni statistični podatki pa so bili prikazani kot srednja vrednost (SD) za vsako spremenljivko. Izvedli smo tudi analizo ANOVA in test LSD Post Hoc, da smo lahko ugotovili učinke za vsako vrsto športa posebej. Rezultati so pokazali, da je bila statistično značilna razlika med skupinami ugotovljena samo v telesni maščobi, medtem ko v višini, telesni teži, indeksu telesne mase, mišični masi ali kostni masi statistično značilnih razlik ni bilo. Rokometaši so pokazali značilno višji odstotek mišične mase kot merjenci iz kontrolne skupine, medtem ko drugih razlik pri tej spremenljivki ni bilo. Pri nogometaših je bil odstotek telesne maščobe značilno nižji kot pri merjencih iz kontrolne skupine, drugih razlik pa pri tej spremenljivki ni bilo. S temi ugotovitvami se lahko nadgradi delovno znanje trenerjev iz omenjene regije, poleg tega pa nakazujejo, naj izberejo najnovejše metode selekcije in naj sestavljanju ekip posvetijo več pozornosti.

Ključne besede: šport, mladinci, nogomet, rokomet, športniki

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INTRODUCTION

It is often the case that a lot of time is spent on increasing physical fitness of athletes without taking into consideration the assessment of their body composition or their nutritional status (Triki et al. 2011). The essential part of the overall management process is considered to be the understanding of body composition of athletes, and then assigning corresponding competitive weights accordingly (Popovic et al, 2013). On the other hand, although child and adolescent athletes grow in a manner similar to the non-athlete one (Rexhepi & Brestovci, 2010), it is widely addressed in the scientific literature that adequate profiling is primarily important in various sports, mostly due to the reason that absolute size contributes to a significant percentage of total variance associated with sport results (Carvajal et al., 2012). Therefore, as various sports events require different body types to achieve maximum performance (Masanovic & Vukasevic, 2009), contemporary sports researchers all over the world are looking for a standard formula that can improve the performance of elite athletes and discover talents as efficiently and as precisely as possible.

The anthropometrical characteristics and body composition of athletes have been the subject of many studies. This is due to the fact that many researchers hypothesized that the human body, through a long-term process of systematic training, in morphological and functional sense, adapts to the influences it is exposed to (Masanovic 2015). Active athletes might be expected to demonstrate characteristics that are specifically favorable for a certain sport (Singh et al., 2010). The body is required to perform at optimum capacity in terms of biomechanics and physiology in all athletes involved in professional competitive sports (Zaccagni, 2012). Adequate body composition and body mass, among other factors, contribute to optimal exercise routines and performance (Massuça & Fragoso 2011). In gravitational sports such as soccer or handball, (Ackland et al., 2012), it is well known that excessive fat mass compromises the physical performance, while increased muscle mass is important to improve strength and power which are relevant for athletics performance (Nikolaidis & Vassilios-Karydis, 2011). An excess of fat mass acts as dead body mass in activities where the body must be repeatedly lifted during locomotion and jumping, which means that it decreases performance and increases energy requirements (Ramos-Campo et al., 2014). However, musculoskeletal mass is an indicator of sports performance, since it contributes to the energy production during high-intensity activities and provides absolute strength to athletes (Vila Suárez et al., 2008). It all leads to a conclusion that a modern athlete should develop speed, explosive strength and overall power. They should have more muscle mass and less fat tissue. Accordingly, a successful participation in both soccer and handball, beside a high level of technical and tactical skills, also requires adequate anthropometrical characteristics and body composition of each athlete. Most of the data regarding characteristics of soccer and handball players we have, came from the USA and Western Europe, as well as from Eastern Europe. The task of this study aimed to verify that data regarding the anthropometrical characteristics and body composition of athletes from the region of Western Balkan, where the general population has specific measurements, (Popovic, 2017) supports previous studies that had evaluated ideal anthropometric profiles of successful soccer players (Jorquera, 2013; Veale, 2010; Barraza et al., 2015) as well as handball players (Popovic et al., 2010; Massuça & Fragoso 2011; Chaouach et al., 2009; Fieseler et al., 2017).

Soccer is a sports game played in the open field and training is usually based on the movement which is expressed through endurance, consisting of a series of moderate activities followed by alternating periods of high intensity, which leads to significant metabolic heat production

(Masanovic, 2015). 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 competitive play. The average intensity during a soccer match is usually about 75–90% of maximum heart rate, respectively 70–85% of VO2 max (Rexhepi & Brestovci, 2010). On the other hand, handball is a team sport that is generally played in an indoor field and it requires a high standard of aerobic and anaerobic fitness in order to complete 60 minutes of competitive play, and to achieve success through an intermittent high intensity body-contact and well-coordinated activities (Buchheit et al., 2009). Handball is one of the fastest and the most endurance requiring team sports and it is epitomized by special maneuvers such as jumping, shooting under the pressure, faking against hard defense players and attempting fast breaks despite all the fatigue (Bilge, 2013). In this game, movement patterns differ from those in soccer as they are intermittent and they continuously change in response to different offensive and defensive situations.

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

MATERIALS AND METHODS

Subjects

Seventy-two male were enrolled in the study. They have been divided into three groups: twenty-five soccer players (16.64±0.49 yrs) from the junior premier league in Serbia, fifteen handball players (16.93±0.59 yrs) from the junior premier league in Serbia and thirty-two healthy sedentary subjects from the same country (17.34±0.60 yrs). The measurements were carried out in the winter preparation period.

Variables

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 twenty 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 a laboratory with 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. Skinfold (mm) was measured from 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). The circumferences (cm) were measured at eight sites: minimum and maximum circumference of the upper arm, minimum and maximum circumference of the forearm, minimum and maximum circumference of the upper leg, minimum and maximum circumference of the lower leg (using an anthropometric tape). And finally the following diameters were measured to the nearest 0.1 cm: elbow diameter, wrist diameter, diameter of the knee, diameter of the ankle (using a small siding caliper). To reduce measurement variation, the same investigator examined all of the subjects.

Body mass index (BMI) was calculated as body mass in kilograms divided by height in meters squared (kg/m2). The values of bone content, muscle mass and body fat were acquired by distributing all the measured variables in formulae originally formulated by Mateigka (Masanovic, 2015).

Statistical Analysis

Data obtained from this research was processed using software SPSS Statistics 20.0, adapted to be used on a personal computer. Descriptive statistics was used to compute the mean (SD) for each variable. Analysis of variance (ANOVA) and the LSD Post Hoc test were carried out to detect the effects of every type of sport (soccer or handball) on each variable: body height, body weight, body mass index (BMI), muscle mass, bone content and body fat, as well as to monitor them in subjects representing general population. The significance was set at an alpha level of 0.05.

RESULTS

Anthropometric characteristics of subjects are shown in Table 1. A significant difference was found in body fat (F=10.67) among the groups, while a significant difference was not found in variables height (1.61), weight (1.02), body mass index (0.17), muscle mass (2.19), as well as in bone content (0.50) among the groups.

Table 1: Descriptive data and ANOVA

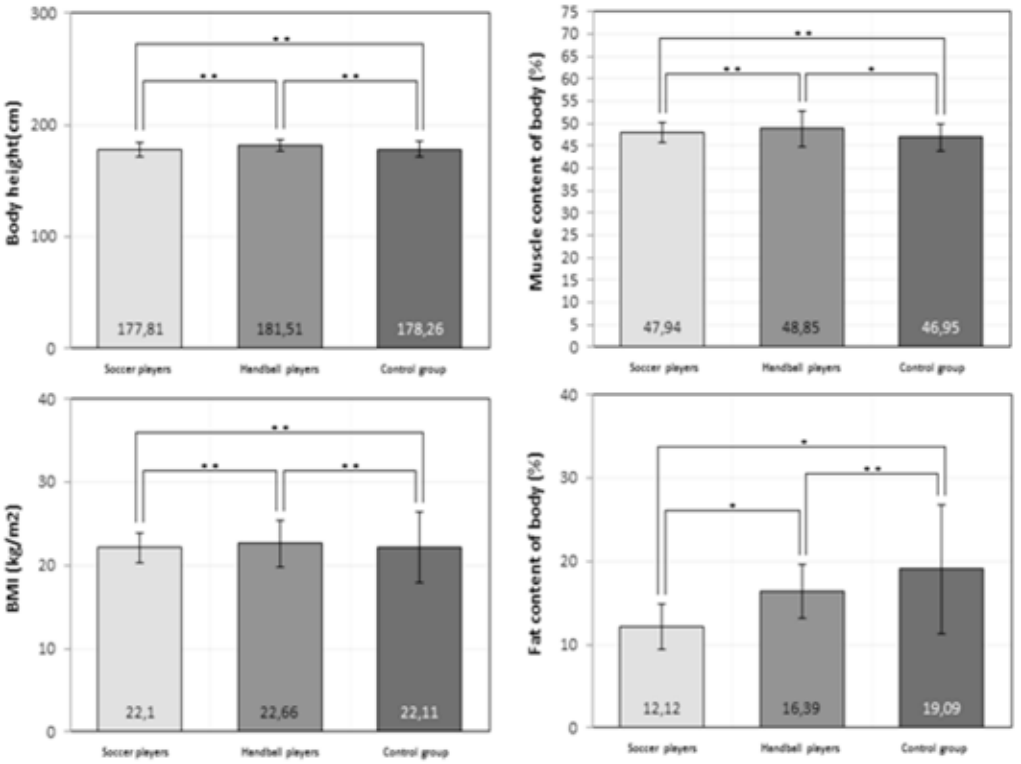
Variables	Soccer (N=25)	Handball (N=15)	Control (N=32)	ANOVA
	Mean ± Standard Deviation			
Height (cm)	177.81±6.63	181.51±5.33	178.26±7.27	0.207^
Weight (kg)	69.90±6.78	74.73±10.17	70.27±14.09	0.368^
BMI (kg/m2)	22.10±1.74	22.66±2.83	22.11±4.27	0.845^
Muscle mass (%)	47.94±2.12	48.85±4.03	46.95±3.02	0.120^
Bone content of body (%)	16.76±1.48	17.03±2.49	17.34±2.47	0.609^
Body fat (%)	12.12±2.78	16.39±3.28	19.09±7.77	0.000*

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

Significant differences of anthropometric characteristics among particular sports are shown in Figure 1. The LSD Post Hoc test indicates that a significant difference was found only for body fat among the groups, while there was no significant difference in height, weight, body mass index, muscle mass or in bone content among the groups. Handball players showed significantly higher percentage of muscle mass than the subjects from the control group, while soccer players had insignificantly higher percentage of muscle mass than the subjects from the control group. Soccer players showed significantly lower percentage of body fat than subjects from the control group, while handball players had insignificantly lower percentage of fat content than the subjects from the control group.

DISCUSSION AND CONCLUSIONS

Results of this study support previous research indicating a strong difference regarding body height among handball players on one side, and soccer players and subjects from the control group that represent general population on the other side (Gaurav et al., 2010; Popovic et al., 2010).



Legend: * - significance; **- non-significance

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

Thus, this confirms a well-known axiom that selection is the main reason for the observed difference. Selection criteria, different types of play, and game rules between soccer and handball game also explain the observed difference (Popovic et al., 2013). However, a rather more important finding regarding the body height is the fact that there was no significant difference among soccer players and subjects from the control group representing the general population. The mentioned is mostly due to a tendency of recruiting taller and heavier soccer players (Gil et al., 2010). The absence of the difference between soccer players and subjects from the control group in this study raises doubts whether the selection process has been carried out correctly, especially because soccer players are shorter than subjects from the control group representing the general population. Nevertheless, it has to be considered that the average body height of all 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 that played the semifinals of the aforementioned championship, was only 166.81 (the top goal scorer of Mali was a 170 centimeters tall Lassana Ndiaye, while there were nine of his teammates shorter than 160 centimeters). Likewise, Philip Foden, the best young player in England and the best one of FIFA U-17 World Soccer Championship India 2017, was 169 centimeters tall, while the most valuable Brazilian players, Paulinho and Brenner were 174 and 175 centimeters tall. Finally, another Englishman, Rhian Brewster, the top goal scorer of the whole championship was 177 centimeters tall. Acquired official statistical data confirms that

Serbian soccer players were tall enough, and that the doubt about the correctness of the selection process had been unfounded. The tendency to recruit taller soccer players is still not scientifically proved (Popovic et al., 2012; Chuman et al., 2013; Nikolaidis & Vassilios-Karydis, 2011). Height of handball players obtained in this study also raises doubt that the selection process had been carried out correctly, especially because official statistical data proved that players from the Serbian National League are shorter than the most successful team players from the IHF Men's Youth World Championship, played in Russia in 2015. For example, average height of the France national handball team players, who won the championship, was 191.8 centimeters, while Korea, that ranked 13th had an average of 183.4 centimeters, Poland that ranked 19th had an average of 190.1 centimeters and Japan that ranked 20th had an average of 181.7 centimeters. African and Asian teams are comparably shorter than the majority of the European teams (Taborsky, 2007) and players from the Serbian National League are of similar height, but all these teams lack of achieving good results. Serbian players have not been on a winning streak for years, which thus deepens the suspicion in the correctness of the selection process. This insight may suggest coaches from Serbia to follow recent selection process methods and to be more careful when identifying talents, as they have a very tall population in general to choose from (Popovic et al., 2013). It is well known that a great number of very tall subjects appears to be characteristic of this area (Western Balkan), since high percentage of people from the general population were at least190 centimeters tall (Bjelica et al., 2012).

Furthermore, it was expected for handball players to be heavier than soccer players and subjects from the control group, mostly due to the reason that they were taller than subjects from both mentioned groups. They were heavier but there was no significant difference found. The difference in weight was in proportion to the difference in height. Body mass index (BMI; weight/height2) is widely used in adult population to determine overweight or obesity. Fortunately, body mass index of subjects from all three groups reported their normal weight according to previous research and there was no significant differences among the groups.

Indeed, it was found that muscle mass in handball players was significantly higher than muscle mass in subjects from the control group. As opposed to that, muscle mass in soccer players was insignificantly higher than in subjects from the control group. These results may be explained with growing demands to increase muscle mass in handball players, as this game requires intermittent activities when high-intensity activities are followed by low-intensity type of movements. It is also interesting to mention that handball players have to use both upper and lower extremities, while soccer players only use lower extremities, possibly an additional reason why the authors have reached these results. Muscle mass in soccer players from the Serbian National League correspond to the values found in previous studies (Jeukendrup & Gleeson 2009), and higher differences in muscle mass were noticed in the following years. The bone content in subjects from all groups was proportional to the longitudinal and transversal dimension of the skeleton, and showed no significant differences among the groups.

It was expected for soccer players to have significantly lower percentage of fat than subjects from the control group, because many previous studies recognized soccer as a predominantly aerobic sport (Sæther, 2017; Amani et al., 2018). It is interesting that the percentage of body fat in handball players was insignificantly lower than the percentage of body fat in subjects from the control group. These results may be explained with the fact that handball training sessions include much more anaerobic activities than soccer as this game requires higher intensity body-contact and well-coordinated activities (Buchheit et al., 2009). Also, this game is intermittent

and it changes continuously in response to different offensive and defensive situations, and it requires more anaerobic exercises that are high in intensity and executed in short and explosive bursts. Although handball matches have duration of 60 minutes divided in two halves, each lasting 30 minutes, handball players cover a total distance ranging approximately from 2,000 to 6,000 meters (Popovic et al, 2012). This is a shorter distance than a range between10,500 and 12,000 meters covered by soccer players (Krespi et al., 2019), although soccer matches have a duration of 90 minutes divided into two halves, each lasting 45 minutes. These distances are based on different circumstances in each sport. First, it depends on the position, and then on tactical defensive or offensive characteristics, or characteristics of the game. Significantly lower percentage of body fat in soccer players from the Serbian National League shows that they have high physical performance. As opposed to that, body fat in handball players from the Serbian National League is insignificantly lower than in subjects from the control group. Regardless, this also corresponds to body fat values found previous studies (Jeukendrup & Gleeson 2009).

It is very important to note that athletes from elite sports teams such as soccer or handball need a certain body fat percentage to perform well enough to achieve their full playing potential. People who have too little fat tissue are exposed to certain risks. Excessive lowering of body fat levels can lead to complications and contraindications. The best example to see this is in the cutting phase during a competition period of a bodybuilder. Many of the physiological changes observed, including an elevation in cortisol, reduction in testosterone, reduction in immune function, alterations in mood status, and decrease in physical performance and maximal heart rate that occurred during the preparation period, were consistent with the markers of overtraining (Rossow et al 2013). Today we all know that adipose tissue is a complex, essential, and highly active metabolic and endocrine organ (Kershaw and Flie, 2004) which communicates with the central nervous system (Costa et al., 2011). In addition to energy storage, it also regulates energy metabolism via secreting the adipokines into the circulation (Verdes 2017). Those bioactive peptides play a role in the regulation of energy consumption, in proliferation of many normal and neoplastic tissues, in hematopoiesis, reproduction, angiogenesis, bone development, immune function, glucose metabolism and lipid homeostasis, and they have anti-diabetic, as well as anti-inflammatory and anti-atherogenic properties (Milosevic et al., 2015; Silva et al., 2016). Through this interactive network, adipose tissue is integrally involved in coordinating a variety of biological processes including energy metabolism and immune function (Fusaru et al., 2012). Also, it is thought to act as a hormone that mobilizes extracellular substances and changes the delivery of the substrate during physical activity. Thus, both excess and deficiency of adipose tissue have harmful metabolic consequences and represent significant medical and socioeconomic burdens in the world today. The National Strength 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, we would like to highlight that these are just guidelines and athletes would work together closely with their coaches and personal physicians to determine an adequate individual body fat percentage without making mistakes in training prescription and diet elaboration, which can affect athletic performance (De Oliveira-Junior et al., 2016).

Moreover, results of this study suggest that playing soccer (significantly) and playing handball (slightly) resulted in decreased percentage of fat content if we compare it to control group. Moreover, this study also suggests that playing soccer (slightly) and playing handball (significantly) has an effect on increased muscle mass content, while differences in bone content are logical

consequences. The part attributed to body height is the main cause of selection process and lastly, the part attributed to body weight could be the main consequence of nutritional habits.

If we take into consideration that the measurements were done in the middle of a season, this study is limited by the fact that body composition and physical performance change during a competitive season (Nepocatych et al., 2017). It is reported that soccer players who enter a season with a high catabolic status could experience reductions in performance during a competitive season accompanied by detrimental changes in body composition (Kraemer et al., 2004). Accordingly, further studies should be very careful in projecting timelines for measuring anthropometric characteristics and body composition, mostly as it has to be conducted either at the beginning or at the end of a season. It also has to be explicitly reported when measurements are taken.

Results of this research demonstrate a temporary gap between Serbian soccer and handball players and the world top teams as well as the methods that coaches should consider in order reach results of the world leading teams. They also indicate mistakes that are being made during the talent identification process by Serbian handball coaches. It is also worth mentioning that players who want to have a successful performance at top quality competitions, are required to possess characteristics established by the standards for each sport, and also that anthropometric measurements and body composition play a crucial role here. New information generated by this study will help in defining a more precise profile foe a soccer or handball player, which would be of value for coaches' evaluation, which represents a considerable contribution of this research to a broader knowledge base.

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