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Differences between functional movement screen and somatotype to young handball and volleyball players

Diferencias entre pantalla de movimiento funcional y somatotipo en jóvenes jugadores de balonmano y voleibol

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Abstract

Introduction. Handball and volleyball are among the world's popular sports, which are played practically in every country at different levels of competition. The aim of this study was to determine the differences in somatotype and morphological characteristics between young handball players and volleyball players as well as the differences in the results of functional body mobility tests between the tested groups. **Material and Methods.** The research included a sample of 23 female athletes who were divided into two subsamples, as follows. A total of 12 athletes were from the Handball team and a total of 11 athletes were from the Volleyball team. The following anthropometric measurements were conducted: Height and body mass, four skinfolds (triceps, subscapular, supraspinal and calf), breadths (humerus and femur diameters) and girths (arm and calf). Body mass (kg) and body fat (%) of the subjects were measured by the method of bioelectrical impedance (TANITA 545N) with an accuracy of 0.1 kg. Functional Movement Score is a scanning system which includes seven steps (i.e., deep squat, hurdle step, in-line lunge, shoulder mobility, active leg raise, trunk stability push-up, and rotary stability). **Results.** The results of the study in female handball players recorded a higher percentage of body fat and body mass index compared to female volleyball players ($p < .05$), while no statistically significant difference was recorded in body weight and height. Analyzing the somatotype of players, it is noticeable that handball players have higher values of endomorphism and mesomorphism, while volleyball players have higher values of ectomorphism. Statistically significant differences were observed in mesomorph and ectomorph ($p < .001$). In the Functional Movement Screen test, it was noticeable that statistically significant differences were recorded in the two variables (Shoulder mobility and trunk stability push up) in favor of the volleyball players, as well as in the overall standings, while in the other variables no statistically significant difference was recorded. **Conclusions.** Determining somatotype must occupy the attention of coaches who work with young athletes. Movement-based assessment serves to pinpoint functional deficits (or bio-markers) related to proprioceptive, mobility and stability weaknesses.

Key words: Biological age, Talent identification, Functional mobility, Rotator cuff

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Resumen

Introducción. El balonmano y el voleibol se encuentran entre los deportes populares del mundo, que se juegan prácticamente en todos los países en diferentes niveles de competencia. El objetivo de este estudio fue determinar las diferencias en el somatotipo y las características morfológicas entre los jóvenes jugadores de balonmano y voleibol, así como las diferencias en los resultados de las pruebas de movilidad corporal funcional entre los grupos evaluados. **Material y métodos.** La investigación contó con una muestra de 23 mujeres atletas que fueron divididas en dos submuestras, de la siguiente manera. Un total de 12 atletas eran del equipo de Balonmano y un total de 11 atletas eran del equipo de Voleibol. Se realizaron las siguientes medidas antropométricas: altura y masa corporal, cuatro pliegues cutáneos (tríceps, subescapular, supraespinal y pantorrilla), anchos (diámetros de húmero y fémur) y perímetros (brazo y pantorrilla). El peso corporal (kg) y la grasa corporal (%) de los sujetos se midieron mediante el método de impedancia bioeléctrica (TANITA 545N) con una precisión de 0,1 kg. La puntuación de movimiento funcional es un sistema de escaneo que incluye siete pasos (es decir, sentadilla profunda, paso de obstáculos, estocada en línea, movilidad del hombro, elevación activa de la pierna, flexión de estabilidad del tronco y estabilidad rotatoria). **Resultados.** Los resultados del estudio en jugadoras de balonmano registraron un mayor porcentaje de grasa corporal e índice de masa corporal en comparación con las jugadoras de voleibol ($p < 0,05$), mientras que no se registró diferencia estadísticamente significativa en peso corporal y talla. Analizando el somatotipo de los jugadores, se destaca que los jugadores de balonmano tienen valores más altos de endomorfismo y mesomorfismo, mientras que los jugadores de voleibol tienen valores más altos de ectomorfismo. Se observaron diferencias estadísticamente significativas en mesomorfo y ectomorfo ($p <.001$). En el test *Functional Movement Screen*, se notó que se registraron diferencias estadísticamente significativas en las dos variables (Movilidad de hombros y estabilidad del tronco) a favor de las jugadoras de voleibol, así como en la clasificación general, mientras que en las demás variables no se registró una diferencia estadísticamente significativa. **Conclusiones.** La determinación del somatotipo debe ocupar la atención de los entrenadores que trabajan con atletas jóvenes. La evaluación basada en el movimiento sirve para identificar los déficits funcionales (o biomarcadores) relacionados con las debilidades propioceptivas, de movilidad y de estabilidad.

Palabras claves: Edad biológica, Identificación de talentos, Movilidad funcional, Manguito rotador

INTRODUCTION

Handball and volleyball are among the world's popular sports, which are played practically in every country at different levels of competition. The successful practice of these sports requires from each player a high level of technical and tactical skills and appropriate anthropometric characteristics. Among them, the physical abilities of players are more important than others, because they have pronounced effects on player skill and team tactics, for this reason handball and volleyball require repeated maximum effort such as running and jumping (Tsunawake et al., 2013).

Such physical abilities are important for both volleyball and handball players in order to achieve a higher level of performance. Anthropometric characteristics of athletes determine success in certain sports in different ways (Mocanu, 2016). Knowledge of these characteristics is necessary to determine their significance for success in competitive sports. Research on the influence of anthropometric characteristics on sports games (handball and

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volleyball) is particularly complex, because success in the game, among other things, depends on how the individual characteristics of some players fit into the whole, thus creating a coherent team. The position of the team is extremely important in the interpretation of morphological data because there are different requirements for every particular sport. Over the last few decades, there has been a growing interest in the analysis of morphological status and physique for success in a particular sport (Matković et al., 2003). Therefore, body composition is an important indicator of the physical condition and general health of athletes, and nowadays this topic is often discussed in the scientific literature. The shape of the body and its morphology, in addition to the physical abilities, psychological characteristics and energy capacities of the system, is one of the main factors that determine sports performance. High body weight and musculoskeletal problems can cause dysfunction in the main joints of the body (Iordan et al., 2021; Nastase et al., 2022). Therefore, the diagnosis of somatotype and anthropometric characteristics is often the subject of research based on when a realistic insight into the current state of a defined population and possible negative or positive trends of growth and development over a period of time (Joksimović et al., 2019). Analysis of the physique, shape and composition of athletes in different sports and their relationship to athletic success has long been an area of great scientific interest. Somatotyping is one of the most commonly used techniques for body composition analysis. Because of its uniqueness, the somatotype has been used to study many aspects of exercise, sports science, and human biology, which may be important for identifying talented young athletes for specific sports (Carter et al., 2005).

Functional Movement Screen (FMS) is a comprehensive display for assessing quality movement patterns, identifying physical limitations, and asymmetry of individuals (O'Connor et al., 2011). It is designed to assess the various functional movements necessary to compete in a particular sport (Letafatkar et al., 2014). Cook et al., (2006a) state that functional movement is the ability to perform locomotor, manipulative and stabilizing actions while maintaining control along the kinetic chain. Also FMS test includes assessment of all major motor requirements in athletes such as muscle strength, flexibility, range of motion, coordination, balance and proprioception. Screening exercises should place the individual in positions where certain muscle or joint limitations can be identified if adequate stability or mobility is not present. To assess these capacities, FMS (Lockie et al., 2015) was developed and consists of: deep squat; hurdle step; in-line lunge; shoulder mobility; active straight-leg raise; trunk stability push-up; and rotary stability and is used to identify deficiencies that may lead to an increased risk of injury (Cook et al., 2006a; Cook et al., 2006b; Chorba et al., 2010). Each test is scored from 0 to 3 points, with a maximum total score of 21 points. Research indicates that low scores (≤14) are associated with serious injuries (Letafatkar et al., 2014). Also, muscle flexibility and imbalance in strength development have been recognized as significant risk factors for injury (Mocanu & Dobrescu, 2021a; Mocanu & Dobrescu, 2021b) and can be identified using FMS (Kiesel et al., 2007). Structures based on active and passive stretching are used in recovery programs, as an option to improve the range of motion in athletes.

The aim of this study was to determine the differences in somatotype and morphological characteristics between young handball players and volleyball players as well as the differences in the results of functional body mobility tests between the tested groups.

MATERIAL AND METHODS

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Participants

The research included a sample of 23 female athletes that was divided into two subsamples, as follows. A total of 12 athletes were from the Handball team with the average values for body height (BH) of 163.91±8.08 cm, body mass (BM) of 62.58±13.62 kg, body mass index (BMI) of 23.05±3.72 kg/m2, and chronological age of 14.5±2.02 years. A total of 11 athletes were from the Volleyball team with the average values for BH of 169.67±7.65 cm, BM of 58.96±9.36 kg, BMI of 20.42±2.01kg/m2, and chronological age of 14.64±1.12 years. Both teams compete in national leagues.

Procedure

Functional movement analysis

The second station (FMS), is a scanning system which include seven steps (i.e., deep squat (DS), hurdle step (HS), in-line lunge (IL), shoulder mobility (SM), active leg raise (ASTR), trunk stability push-up (TSPU), and rotary stability (RS) [10, 12]. The FMS test kit is used to perform the test. This kit consists of the main test piece, two auxiliary fixed measuring sticks, an elastic rope, and a moving measuring stick. About 15 m2 of space is sufficient to perform the test. The test is carried out by the practitioner watching the tests during a maximum of three repetitions and giving a score of 0–3 according to this observation (Cook et al., 2006a). If the participant feels pain during test, 0 point is given although he/she manages to perform the test. Scoring was done by a physiotherapist who had received an FMS course certificate. In our study, the same FMS protocol was used.

Anthropometrical measurements

The following anthropometric measurements were conducted: Height and body mass, four skinfolds (triceps, subscapular, supraspinal and calf), breadths (humerus and femur diameters) and girths (arm and calf). Body weight (kg) and body fat (%) of the subjects were measured by the method of bioelectrical impedance (TANITA 545N) with an accuracy of 0.1 kg. Body height was determined using a Martin anthropometer (GPM, Switzerland); skinfolds were measured using a John Bull caliper (British Indicator Ltd, UK), accurate to 0.2 mm; girth measurements were acquired with a steel measuring tape and wrist girth and bicondylar diameters of the femur and humerus were measured using a small spreading caliper (Siber Hegner, Switzerland). All variables were measured on the right side of the body following standardized procedures (Riebe, et al., 2018). Two measurements were taken from each site and the value recorded was the mean, provided that there was a difference of no greater than 5% between the two measurements; if that was the case, a third measurement was taken and the median value was used. All skinfold measurements were taken indoors at approximately the same time of the day by the same investigators.

Statistical analysis

All data collected by this research were processed by descriptive and comparative statistics. Using descriptive statistics, the arithmetic mean and standard deviation were calculated for each variable. The normality of the distribution of the variables was derived through two procedures: the asymmetries of the Skewness results and the homogeneity of the Kurtosis results. ANOVA was used to identify differences. The statistical program for personal computers SPSS (Murariu, 2018) for Windows-version 20.6 was used for data processing.

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RESULTS

Demographic and anthropometric characteristics of handball and volleyball players are listed in Table 1. The results of skewness and kurtosis showed that there is a symmetry of the results and that there is homogeneity of the results the distribution of the results was normal. In handball players, a higher percentage of body fat and body mass index was recorded compared to volleyball players, while no statistically significant difference was recorded in body mass and height.

Table 1. Anthropometric and demographic characteristics of the players

Variables	Sport	M±SD	p
Age	Handball	14.5 ± 2.02	p=.05
	Volleyball	14.64 ± 1.12	
Body Height (cm)	Handball	163.91 ± 8.08	p=.05
	Volleyball	169.67 ± 7.65	
Body mass (kg)	Handball	62.58 ± 13.62	p=.05
	Volleyball	58.96 ± 9.36	
Body Mass Index (kg/m^2)	Handball	23.05 ± 3.72	p<.05
	Volleyball	20.42 ± 2.01	
Body Fat (%)	Handball	31.63 ± 8.17	p<.05
	Volleyball	24.09 ± 4.45	

Figure 1 as well as Table 2 show the results of descriptive statistics as well as statistically significant differences in somatotype between handball players and volleyball players. Analyzing the somatotype of players, it is noticeable that handball players have higher values of endomorphism and mesomorphism, while volleyball players have higher values of ectomorphism. Statistically significant differences were recorded in mesomorph and ectomorph ($p \leq .001$).

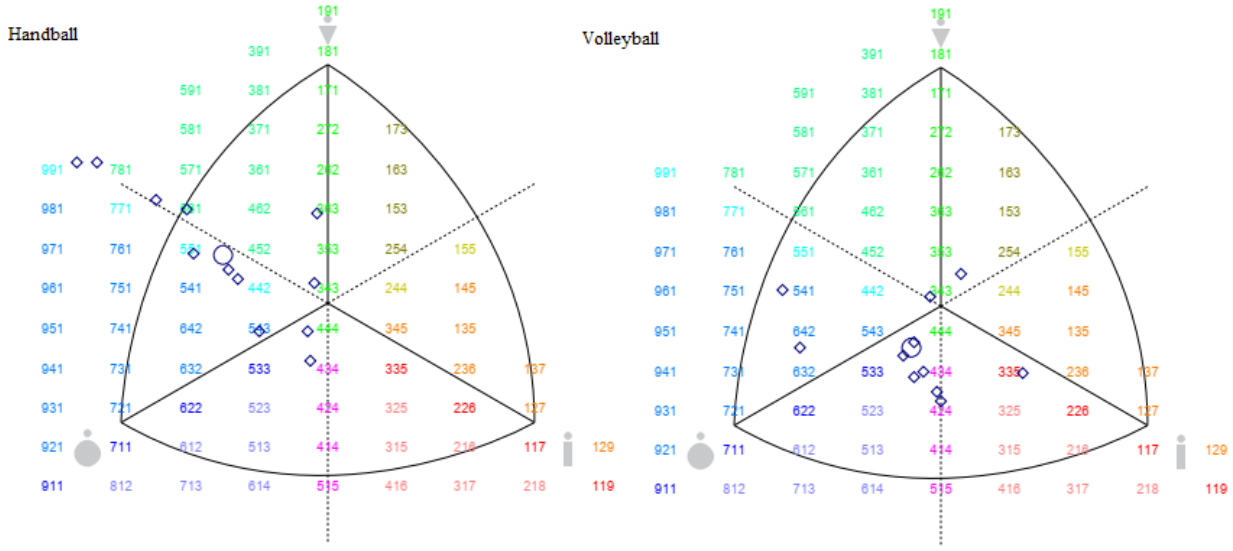

Figure 1. Somatotype of handball and volleyball players

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Table 2. Differences of somatotype between handball and volleyball players

Sport	Mean	SD	F	ANOVA
	Endo-Meso-Ecto	Endo-Meso-Ecto		
Handball	5.01-4.72-1.98	1.33-1.60-1.19	7.76	.001
Volleyball	4.30-2.84-3.45	1.29-0.89-0.92		

Table 3 shows the descriptive values as well as the differences in the FMS test. Inspecting the table shows that statistically significant differences were recorded in two variables (Shoulder mobility and trunk stability push up) in favor of volleyball players, as well as in the overall standings, while in other variables no statistically significant difference was recorded. Lower results of asymmetry in handball players in the Shoulder mobility test are also expected due to the fact that handball as a sport is classified as asymmetric sports. The average values of the FMS test are also shown in figure 1.

Table 3. FMS results of handball and volleyball players

Variables	Handball	Volleyball	ANOVA
	Mean±SD	Mean±SD	p-value
Deep Squat	1.91 ± 0.66	1.72 ± 0.64	p=.05
Hurdle step	2.41 ± 0.51	2.09 ± 0.30	p=.05
In-line Lunge	2.16 ± 0.38	2.31 ± 0.64	p=.05
Shoulder Mobility	1.79 ± 0.86	2.63 ± 0.50	p<.001
Active Straight Leg Raise	2.66 ± 0.49	2.54 ± 0.56	p=.05
Trunk Stability Push-up	2.16 ± 0.57	2.81 ± 0.40	p<.001
Rotatory Stability	1.59 ± 0.14	2.00 ± 0.00	p=.05
Total	14.68 ± 0.51	16.01 ± 0.43	p<.001

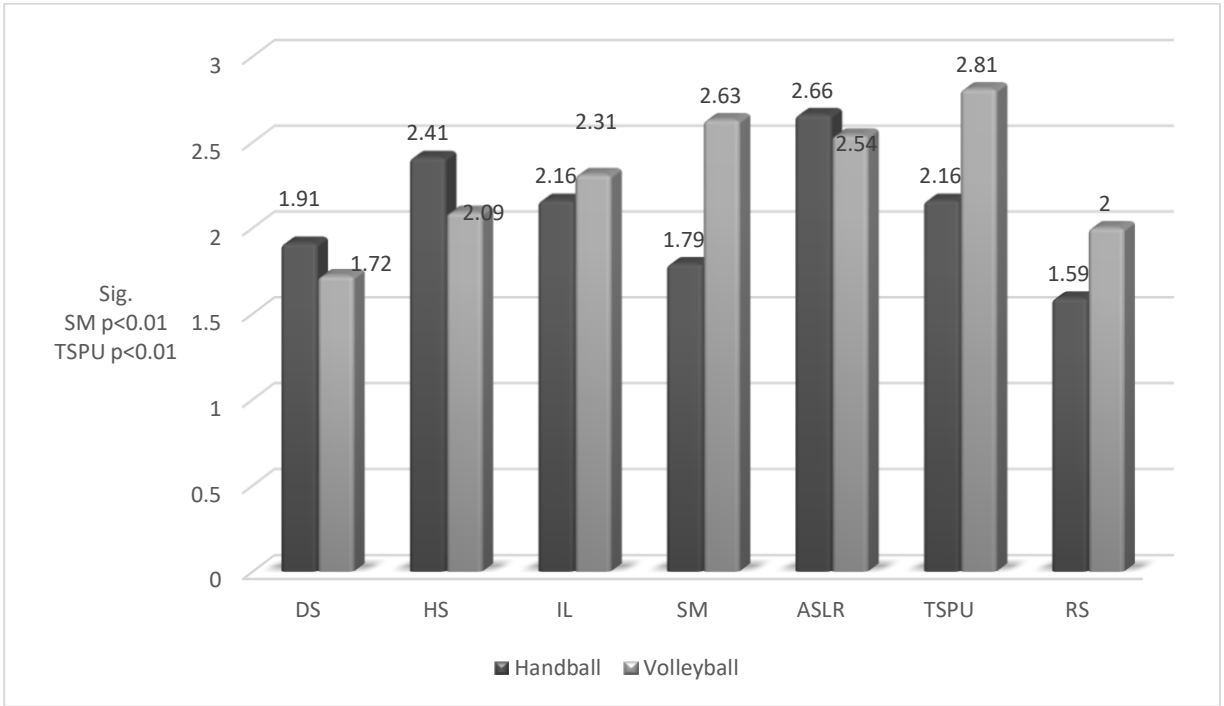

Figure 2. Differences in the FMS test between handball and volleyball players
Note: DS - deep squat; HS - hurdle step; IL - in-line lunge; SM - shoulder mobility; ASTR - active leg raise; TSPU - trunk stability push-up; RS - rotary stability.

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DISCUSION

The aim of this study was to determine the differences in somatotype and morphological characteristics between young handball players and volleyball players as well as the differences in the results of functional body mobility tests between the tested groups. Determining anthropometric characteristics is one of the three most commonly measured dimensions of athletes (Milanović et al., 2005) due to anthropometric characteristics as an integral part of human anthropological status, occupy a very important place in the selection and identification of talents for successful sports. The study of morphological characteristics, their influence and relation to success in sports is an indispensable process, which should be completed as well as possible by defining the equation of specification for a particular sport and thus contribute to more adequate modeling of athletes (Gardašević et al., 2020). Analyzing the anthropometric characteristics shown in Table 1, a statistically significant difference between body height was not observed in this study although female volleyball players were 5.76 cm taller. We can find justification for such results in biological and chronological age and poor selection of young athletes. Chronological maturity is the observed period from birth to a given time determinant (Prieto et al., 2005), while biological maturity is defined by a model of functional, morphological, anatomical and biochemical status of the organism that is characteristic of a particular chronological period, imbalance of biological and chronological maturity (Jovanović, 2019). Assessment of biological maturity of young athletes is an important segment of diagnostics, the observed phenomenon of individual human development represents the need to define and determine the biological basis of each individual. Success in sports activity in most sports is predominantly associated with morphological structure, anthropometric characteristics and motor abilities (Jakovljević et al., 2016). Differences in biological potential within the same generation of athletes are differentiated in these details, which can be a discriminatory factor for achieving sports results. When larger deviations of biological maturity from the chronological standard of biological markers are determined, it is necessary to apply an adequate approach in training work. Acceleration currently contributes to better sports results in the younger selections, but due to reaching the maximum developmental level, the senior performance has been called into question. Coaches often select players who are born in the first half of the year or who are more biologically mature in order to achieve success in competition (Müller et al., 2017). The level of biological maturity of athletes during the selection, especially during the training process, should be considered and taken into account when making decisions. Also, determining the position in the team in team sports that are based on current physical characteristics and physical abilities, can lead to early specialization (Jovanović, 2019). The reason why coaches select athletes who are biologically more mature can be found in the fact that volleyball requires handling the ball above the head, manipulating the skills of passing and blocking high balls, the presence of tall players is an irreplaceable success factor (Gaurav et al., 2010). On the other hand, the presence of tall players with the highest possible body height and a wide range of arms is necessary in handball. Research indicates that when selecting players, players with the widest possible range of hands are necessary, in order to be able to adequately respond to the tasks of defensive handball, when covering as much space, defense zone or when making a block when shooting. Also, players with longer cranial extremities have a huge advantage in the attacking part of handball, because they are able to throw the ball from a greater height, which is extremely inconvenient for the defense, because it reduces the possibility of successfully blocking the ball (Karišik et al., 2015). Considering

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all of the above, it is necessary to point out that coaches who work with adolescents appreciate the impact of biological maturation on motor skills and anthropometric characteristics in terms of training programming. Higher values were received in handball female players in BMI and BF. Excess body fat is detrimental to performing weight-supported physical activities, regardless of whether the activity is vertical (e.g. jumping) or horizontal (e.g. running), because body fat does not contribute to creating the force needed to move the body (Lukaski, 2017). Also, higher body fat is associated with lower aerobic capacity in adolescents (Hermassi et al., 2020). Entering puberty in girls leads to specific physiological changes that include increased fat mass, differential rates of physique and muscle strength development, onset of menstruation, increased joint laxity, and valgus angle of the knee. All of these factors have been identified as potentially increasing the risk of injury in adolescence (Myer et al., 2009). Figure 1 shows the results of somatotypes for volleyball players and handball players. The somatotype results obtained by this study for female volleyball players are 4.30-2.84-3.45 and belong to the ectomorphic-endomorphic somatotype. Gualdi & Zaccagani (2001) state in their research that volleyball players belong to a balanced mesomorph. Rahmawati et al., (2007) in their study with Indonesian volleyball players point out that they belong to the mesomorphic-ectomorphic somatotype with a somatotype score of 2.4-3.5.-3.7. Similar results are found in the study of Gaurav et al., (2010) where volleyball players belong to the meso-ectomorphic somatotype with values of 2.6-3.0-3.5. In handball players, the results indicate that they belong to the mesomorphic-endomorphic somatotype with values from 5.01-4.72-1.98. Urban et al., (2011) measured anthropometric characteristics and calculated the somatotype of female players on a sample of 207 handball players from different representative groups who performed at the 19th Women's European Championships. They concluded that a moderate mesomorphic constitution of players prevails among handball players, followed by endomorphic, and only then ectomorphic constitution of somatotype, which is in line with our results. Interestingly, handball teams from 1st to 8th places in the competition table shared relatively higher values of endomorphism: 2.3 - 2.5 and mesomorphism: 4.3 - 4.5, and lower values of ectomorphism: 1.9 - 2.0, which is an indicator of relatively weak linear stature with higher values body mass and subcutaneous fat, wider skeleton and well-developed muscles. In contrast, teams that finished from 9th to 16th place show a relatively lower value of endomorphism: 2.0 - 2.2, lower value of mesomorphism: 3.6 - 4.1 and more pronounced ectomorphism: 2.2 - 2.6, from which they conclude that these teams are linear in stature with longer segments of individual body parts, lower body mass and subcutaneous adipose tissue values, and relatively lower musculature volume.

While analyzing the obtained results of the FMS test, it is noticeable that in the overall score, the handball players had lower values (14.68 ± 0.51) than the volleyball players (16.01 ± 0.43), while the difference was recorded in two tests, Shoulder mobility $p < 0.01$ and Trunk stability push up $p < 0.01$ in favor of the volleyball players. Minck et al., (2010) point out that individuals who score less than 14 points on FMS screening possess dysfunctional movement patterns that may correlate with a higher risk of injury. The shoulder mobility test is an asymmetric test that tests the left and right arm. During the test, poorer results were recorded when the left hand was in maximum external rotation and the right hand in maximum internal rotation. It is an interesting fact that female athletes in whom asymmetry was found reported the right hand as dominant. The explanation for the results obtained in this study lies in the fact that in sports in which the prop (ball) is thrown over the athlete's head, the increased external rotation is acquired at the expense of reduced internal rotation. Also, excessive

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development and shortening of the pectoralis major or latissimus dorsi leads to changes in postural status in the form of winged scapulae or round shoulders, which leads to a decrease in shoulder-scapular mobility. Our allegations are also confirmed by a study conducted by Almeida et al., (2013) who indicated a characteristic adaptation of the throwing arm called Glenohumeral Internal Rotation Deficit (GIRD). Their observations as well as the results of our study were confirmed (Slodownik et al., 2014). When it comes to the results of the Trunk stability push up test, which are worse in handball players, we come to the conclusion that the ability to perform push-ups for torso stability requires symmetrical torso stability in the sagittal plane during symmetrical movement of the upper extremities. Many functional activities in sports require that torso stabilizers symmetrically transmit force from the upper to the lower extremities and vice versa. Movements such as blockade of shooting in handball, blockade of the head in volleyball or blockade of passing in football are common examples of this type of energy transfer. If the hull does not have adequate stability during these activities, the kinetic energy will dissipate and lead to poor functional performance as well as increased potential for injury (Cook et al., 2006a). Mitchell et al., (2016) points out that poorer results in the FMS test are related to the Body Mass Index, which justifies the results of our study where values of 23.05 ± 3.72 kg / m^2 were recorded in female handball players. Poor performance during this test can be attributed simply to the poor stability of the trunk stabilizers. When an athlete achieves a score less than III, the limiting factor must be identified. Clinical documentation of these limitations can be obtained by using test by Kendall & McCreary, (1983) or Richardson et al., (2004) for upper and lower abdominal and trunk strength. However, the test by Kendall & McCreary, (1983) requires a concentric contraction while a push-up requires an isometric stabilizing reaction to avoid spinal hyperextension. A stabilizing contraction of the core musculature is more fundamental and appropriate than a simple strength test, which may isolate one or two key muscles.

In future research, it is necessary to investigate the relative effect age, peak height velocity and biological maturity, which will give a clear insight into the differences in somatotype and give a clear insight into the emergence of asymmetries in the functionality of movement. These also constitute a limitations of this study.

CONCLUSIONS

The results of the study in female handball players recorded a higher percentage of body fat and body mass index compared to female volleyball players, while no statistically significant difference was recorded in body weight and height. Analyzing the somatotype of players, it is noticeable that handball players have higher values of endomorphism and mesomorphism, while volleyball players have higher values of ectomorphism. Statistically significant differences were observed in mesomorph and ectomorph $p < 0.01$. Determining somatothips must occupy the attention of coaches who work with young athletes. The reason for that is that in addition to the selection of athletes, coaches must make a plan and program for both training and nutrition of young athletes in relation to the obtained values of somatotype, which, if repeated periodically, serves to modify the training and nutrition plan and program. The results of this study in FMS test showed that handball female players are more susceptible to injuries than volleyball female players. This movement-based assessment serves to pinpoint functional deficits (or bio-markers) related to proprioceptive, mobility and stability weaknesses.

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