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Original Article

Morphological characteristics of adolescent elite female handball and volleyball players

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Abstract: The aim of the current study is to compare morphological characteristics of adolescent elite female handball and volleyball players and to investigate probable differences between them. The sample of the current study consists of athletes from women's national handball teams (n=32, age=17.8±1.1 years, body height 166.6±4.5 cm, body mass 65.0±5.4 kg) and volleyball (n=16, age=18.0±1.4 years, body height 176.5±5.7 cm, body mass 68.1±7.4 kg). The measurements included five skin folds thicknesses (biceps, triceps, subscapular, suprailiac and calf), three circumferences [calf and biceps girth (relaxed and tensed)] end two widths (femur, humerus). In the initial somatometric parameters, the athletes exhibit higher performance triceps ($p<0.001$), subscapular ($p<0.001$) skinfold (mm) and biceps girth (relaxed) (cm) while volleyball players exhibit body height (cm) ($p<0.05$) and humeral diameter (cm) ($p<0.05$). In the secondary parameters, handball players express statistically significant body mass indices (kg/m²) ($p<0.05$), body fat (%) ($p<0.002$), sum of 5 skinfold (mm) ($p<0.001$), while volleyball players express fat free mass (kg) ($p<0.001$). The handball players' somatotype is taken to be a mesomorph-endomorph (3.9–3.8–1.7) with a much greater component in endomorphy ($p<0.001$), mesomorphy ($p<0.001$), and SDM ($p<0.001$), while volleyball players were taken as balanced endomorph (3.3–2.6–3.1) with a much greater component of ectomorphy ($p<0.001$), και SAM ($p<0.006$). In conclusion, the differences may probably be due to the specific training of the female athletes.
Key Words: Handball, Volleyball, Anthropometry, Body composition, Somatotype

Introduction

Handball and volleyball are two popular and dynamic team sports in the limelight. The success of top level handball, volleyball players, depends on many factors, including morphological, physiological, psychological, technical and tactical characteristics. The morphological characteristics of the female athletes depend on the level of performance and competition. The morphological build of a person is set by their height, body mass, the ratios between them, the percentage fat and their somatotypical characteristics.The nature and level of performance are also likely to influence the physical characteristics associated with training for a sport (Carter, 1990). Successful competition in sports has been associated with specific anthropometric characteristics, body composition and somatotype (Carter & Heath, 1990;Bayios et al., 2006).

The determination of the special characteristics of an athlete's build in various sports has been an area of interest for sports scientists to investigate athletes' orientation and training. The quantification of the morphological characteristics of high level female athletes could become a basic point that concerns body build relative to athletic performance. The recognition of real talent is a very complex process that requires a good knowledge of anthropometrics that are related to high performances (Srhoj et al., 2006). Certain anthropometric characteristics have been referred to as significant discriminatory parameters between top and low level athletes.(Fleck et al., 1985;Bayios et al., 2006). Previous studies have advocated that the ideal athletes' somatotype varies according to the sport (Carter & Heath, 1990; Gualdi-Russo &Zaccagni, 2001). There seems to be little research into selected morphological characteristics concerning adolescent elite female handball (Noutsos et al., 2018; Cavala et al., 2010; Granados et al., 2006) and volleyball players (Gualdi-Russo &Zaccagni 2001; Malá, L. et al., 2010; Martín-Matillas et al., 2014). Current studies do not provide us with a representative view of differences between top young female athletes in the respective sports. Therefore the aim of this study is to determine the morphological characteristics of adolescent elite female handball and volleyball players and to investigate the differences between them.

Material & methods

Participants

Sixty four adolescent elite female handball (n = 32, age = 17.8±1.1 years, years playing = 7.06±1.9 years) and volleyball players (n = 32, age = 18.0±1.4 years, years playing = 6.53±1.6 years) and all members of

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the Greek national team participated in this study. These tests were conducted on the recommendations of the scientific committee of the Greek National Team Handball and Volleyball Federation. The research team in collaboration with national coacheshas incorporated these measurements into the annual preparation plan. This study was approved by the ethical committee of Athens University.

Anthropometric measures

The parameters that were measured were: Body height (BH) with a stadiometer (Seca 220, UK) to the nearest 0.1 cm, body mass (BM) was recorded using a portable scale (Seca alpha model 770, UK) to the nearest 0.1 kg,two widths (femur, humerus), epicondylar breadth of the humerus and femur in cm to the nearest 0.1cm, three circumferences [calf and biceps girth (relaxed and tensed)] in cm with a 0.1cm precision, as well as five skinfolds (biceps, triceps, subscapular, suprailiac and calf) in mm with 0.1 mm precision were taken using a skinfold caliper (J. Bull, USA). The athletic history of all theparticipants was recorded. All tests were conducted under the same conditions by the same research team in the sports hall. The precise anatomical site of measurement by therespective somatometric instruments and the measurement procedures were all carried out according to Norton et al., (2000). The margin of error in measurements of BH, BM, five skinfolds, two widths (femur, humerus) and three circumferences of calf and biceps, relaxed and contracted were 0.292 cm, 0.278 kg, 0.652 mm, 0.532 mm, 0.699 mm, 0.609 mm, 0.580 mm, 0.619 cm, 0.122 cm, 0.346 cm, 0.168 cm and 0.119 cm respectively (Ulijaszek& Kerr, 1999).

The sum of four skinfolds (biceps, triceps, subscapular, suprailiac) was used for the determination of body density which was made taking chronological age into consideration (Durnin&Womersley, 1974). Body Fat percentage was then calculated with the equation provided by Siri (Siri, 1956). Somatotype components (endomorphic – mesomorphic – ectomorphic) was calculated according to the equation recommended by Heath and Carter (Carter & Heath, 1990). The Somatotype Dispersion Mean (SDM) was calculated as the difference of each somatotype from the average of all values in 2D form (Ross & Wilson, 1973) The Somatotype Attitudinal Mean (SAM) was calculated as the difference of each somatoype from the average of all values in 3D form (Ross & Wilson, 1973).

Statistical analysis

Standard descriptive statistics (mean ± standard deviation) were determined for directly measured and derived variables. The t-test for independent samples was employed while the significance level was set at ($p<0.05$).

Results

The means (X) and standard deviations (SD) of the morphological parameters along with levels of statistical significance, for each study group, are shown in table 1.

TABLE 1. Anthropometric characteristics of female Handball, Volleyball players (mean ±SD)

Variables	Handball (n=32)	Volleyball (n=32)	t	P value
Body height(cm)	166.6±4.5	176.5±5.7	7.6	.000
Body mass(kg)	65.0±5.4	68.1±7.4		NS
Biceps skinfold (mm)	7.1±2.6	6.7±2.2		NS
Triceps skinfold (mm)	14.8±4.3	11.5 ±6.1	2.5	.014
Subscapular skinfold (mm)	13.0±2.7	11.3±2.7	2.5	.013
Suprailiac skinfold (mm)	10.8±3.1	10.3±3.7		NS
Calf skinfold (mm)	15.1±4.8	13.1±3.9		NS
Humeral diameter (cm)	6.0±0.2	6.3±0.3	4.4	.000
Femoral diameter (cm)	8.8±0.7	8.9±0.7		NS
Biceps girth (tensed) (cm)	28.5±1.6	27.9±2.0		NS
Biceps girth (relaxed)(cm)	27.5±1.9	26.5±2.1	2.06	.044
Calf girth (cm)	37.6±1.9	37.0±2.1		NS
NS=Not significant				

Statistically significant differences were seen for BH (p=0.000), triceps (p=0.014), subscapular skinfold (p=0.013) and biceps girth in relaxed (p=0.044) with female handball players displaying higher values compared to female volleyball players. Only for the humeral diameter (p=0.000) did the female volleyball players display higher values compared to the female handball players. In body composition, handball players exhibit statistically significanthigher values for BMI (p=0.001), percentage body fat (p=0.002), and for the sum of the five skinfolds (p=0.000) while volleyball players for lean body mass (p=0.002). For the fat mass, no statistically significant differences were recorded with handball players having a higher value. The somatotype of handball players is designated as mesomorph-endomorph (3.9-3.8-1.7) while the volleyball players as balanced endomorph (3.3-2.6-3.1) Fig. 1. As for the somatotype components, significant differences are observed in

endomorphy (p=0.001), mesomorphy (p=0.000) and in ectomorphy (p=0.000) between the two study groups. Moreover, statistically significant difference was observed in SDM (p=0.001) and SAM (p=0.006) (Table 2).

TABLE 2. Body mass index, composition indicators and Somatotype characteristics for adolescent elite female handball and volleyball players (mean ±SD)

Variables	Handball (n=32)	Volleyball (n=32)	t	P value
Body mass index (kg/m²)	23.4±1.7	21.8±1.8	3.5	.001
Body fat (%)	24.8±2.2	22.8±2.6	3.2	.002
Fat mass (kg)	16.2±2.5	15.6±2.7		NS
Fat free mass (kg)	48.8±3.2	52.5±5.7	3.1	.002
Sum of 5 skinfold (mm)	61.1±7.8	53.0±9.5	3.7	.000
Endomorphy	3.9±0.5	3.3±0.7	3.3	.001
Mesomorphy	3.8±1.0	2.6±0.9	4.4	.000
Ectomorphy	1.7±0.9	3.1±0.9	5.7	.000
SDM	4.9±2.2	3.2±1.7	3.3	.001
SAM	1.2±0.6	2.1±0.9	2.8	.006

NS=Not significant

The somatotype categories of the female athletes under study are shown in Table 3.

Discussion

Anthropometric characteristics.

In the analysis of results of the two study groups, the BH values differ significantly. In other studies, handball players are seen to exhibit BH values of 176.2 ± 6.6 cm (Noutsos et al., 2018), 175.4 ±6 8 cm Granados et al., 2006) while in volleyball 179.17 ±6.73 cm (Malá, L. et al., 2010), 179.8±7.1 cm (Martín-Matillas et al., 2014). BH constitutes a basic athletic criterion (Noutsos et al., 2018) and probably differentiates the competitive level (Rousanoglou et al., 2014: Milanese et al., 2011). BH provides handball and volleyball players with an advantage for both defensive and offensive tasks (Noutsos et al., 2016). In BM handball players did not differ from volleyball players.In other studies, BM for handball players exhibit values 70.2 ± 6.2 kg (Noutsos et al., 2018), 69.8±6.7 kg (Granados et al. 2006) while volleyball players 66.83± 6.93 kg (Malá, L. et al., 2010), 72.3±8.4 kg (Martín-Matillas et al. (2014). BM may affect speed, endurance and strength (ACSM, 2009) and because of this, the athletes must achieve ideal BM without loss of muscle tissue as reduction in BM does not improve athletic performance (Thompson &Manore, 2000). For the remaining somatometric parameters of the two study groups, the handball players exhibit higher values for all the skinfolds and peripheries while the volleyball players showed higher values forbone widths. The basic differences between volleyball and handball in game structure is that handball players are characterized by their throwing abilities and direct body contact whilevolleyball players are characterized for their striking abilities without body contact. The differences seen in the protogenic parameters of both sports could be a result of specialization and long-term training in each sport as training promotes muscle development and affects obesity (Gil S., Gil J., Ruiz, Irazusta A., &Irazusta J., 2010: Malina, 1982).

Body composition.

Significant differences in all examined values except for fat mass were noted in the two study groups. Competitive teams in handball express percentage body fat 20.5±5%, fat mass 14.8±4 kg, free fat mass 55.1±4 kg (Granados et al., 2007) and in volleyball percentage body fat 24.0±3.1, fat mass 17.4±3.7 kg, free fat mass 54.9±5.7 kg (Martín-Matillas et al., 2014). Body composition might influence power, flexibility and the appearance of the player (Massuça&Fragoso, 2011). The extra fat load has a negative effect on performance (Gualdi-Russo &Zaccagni, 2001) and might lead to increased need of energy and consequently early fatigue and reduced effectiveness of the athletes (Noutsos K., 2016). Free fat mass is important for speed, power and force, as well as the prevention of injuries (Arden & Spector, 1997). The correct estimation of body composition in sports is important, given that mistakes might lead to incorrect training programs and dietary requirements and therefore affect athletic performance (De Oliveira-Junior et al., 2016).

Somatotype characteristics.

In the current study, the somatotype of the handball players is recorded as mesomorph-endomorph (3.9–3.8–1.7), while that of volleyball players as balanced endomorph (3.3–2.6–3.1) according to Carter (1990).

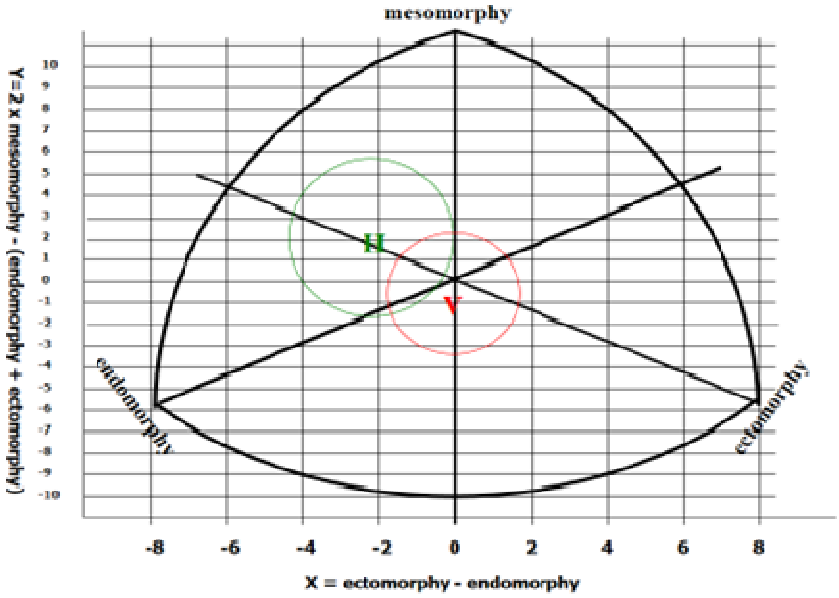

Fig. 1. Somatochart for adolescent elite female handball and volleyball players

Other studies of top level female athletes show handball players as mesomorph-endomorph (3.6-3.7-2.6) (Bayios et al., 2006), central (3.0-2.5-2.6) (Cavala et al., 2010) and volleyball players as balanced endomorph (3.4-2.7-2.9) (Bayios et al., 2006) balanced mesomorphic (2.7–3.6–2.9) (Carvajal et al., 2012). The element of endomorphy was prevalent in both study groups and shows the trend the players have. Between the compositional elements of the somatotype, handball players expressed significant differences in endomorphy compared to volleyball players explained by the significant difference in fat observed. Volleyball players emphasise the element of mesomorphy more which translates to the presence of greater muscle mass which is considered necessary for the athletes to last the intense body contact during the game, both in defense and offense. In this study, the female volleyball players seem to accentuate more the element of ectomorphy compared to handball players which according to Gualdi-Russo &Zaccagni (2001) might constitute an advantage during the game. Significant differences in SDM and SAM were observed between the two study groups. The values of SDM somatotypes for the handball players were higher and exhibited greater scatter compared to volleyball players. The handball players of our study expressed lower values of SAM somatotypes implying greater somatotype homogeneity than volleyball players.

TABLE 3. Definitionsof 13 somatotypecategoriesbased on areasofthesomatochart

	Somatotype categories	Handball(n=32) N (%)	Volleyball(n=32) N (%)
1	Ectomorphic mesomorph	-	1/32 (3.2)
2	Mesomorphic endomorph	7/32 (21.8)	1/32 (3.2)
3	Endomorphic mesomorph	10/32 (31.2)	1/32 (3.2)
4	Ectomorphic Endomorph	2/32 (6.2)	4/32 (12.5)
5	Mesomorph - endomorph	7/32 (21.8)	3/32 (9.3)
6	Endomorph - ectomorph	1/32 (3.1)	2/32 (6.2)
7	Endomorphic ectomorph	-	5/32 (15.6)
8	Central	1/32 (3.1)	7/32 (21.8)
9	Mesomorphic ectomorph	-	-
10	Balanced endomorph	3/32 (9.3)	4/32 (12.5)
11	Balanced mesomorph	-	1/32 (3.1)
12	Balanced ectomorph	1/32 (3.1)	3/32 (9.3)
13	Mesomorph - ectomorph	-	-

In the categorization of the various somatotypes according to Carter (1990) it seems that the higher frequency of somatotypes in handball athletes was endomorphic mesomorph (31.2%) while for volleyball players it was central (21.8%) with the volleyball players expressing the most somatotype categories. Therefore the big fluctuations in the somatotype build of volleyball players can be considered normal as there are different technical andtactical demands placed on the players in the different playing positions according to the game structure.

Conclusions

In conclusion, the current study was carried out on top level handball and volleyball female athletes and the results provide useful information to those concerned with the study of morphological characteristics in matters of athlete selection. Handball players were significantly shorter and exhibited higher values in triceps, subscapular skinfold, biceps girth in relaxed and had significantly lower value of humeral diameter, with a greater percentage body fat and sum of skinfolds, higher BMI, higher value in the component endomorphy, mesomorphy and lower value in the ectomorphy component. The handball player somatotype was mesomorph-endomorph while that of the volleyball players was balanced mesomorphic. Finally it can be seen that in the categorization of somatotypes according to Carter (1990), the volleyball players have more somatotype categories.

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