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COMPARISON OF BODY COMPOSITION OF VOLLEYBALL, HANDBALL AND FOOTBALL FEMALE PLAYERS

PRIMERJAVA TELESNE SESTAVE IGRALK ODBOJKE, ROKOMETA IN NOGOMETA

ABSTRACT

Body composition is an important factor in the physical fitness and health of athletes. The aim of this research is to identify and compare body composition (BC) of female players including volleyball (VB) (X with Age=21.48±2.64), handball (HB) (X with Age =18.42±2.62), and soccer (SOC) (X with Age =18.37±2.41). Total and regional body composition of each player were evaluated with dual-energy X-ray absorptiometry method (DXA). According to the results of the MANOVA, there was a statistically significant difference between female players from different team sports on the combined dependent variables (F=2.14; p=.007; Pillai's Trace=1.45; η^2=.73). When the results for the dependent variables were considered separately, SOC players had significantly lower lean arm mass (F=6.27; p=.004; η^2=.23), lean leg mass (F=7.92; p=.001; η^2=.27), lean android mass (F=8.85; p=.001; η^2=.29), lean gyonoid mass (F=9.01; p=.001; η^2=.30), and Total BMC (F=7.25; p=.002; η^2=.25) than those of VB and HB players. In addition, while SOC players had significantly lower lean body mass (F=4.97; p=.011; η^2=.19) than VB players; HB players had significantly higher leg fat mass (F=4.77; p=.013; η^2=.18) and gyonoid fat mass (F=4.37; p=.019; η^2=.17) than SOC players. In conclusion, body compositions of female team players of SOC, VB, and HB varied. Coaches and sports scientists are advised to plan training considering the differences between sports branches.

Keywords: body composition, DXA, measurement, female players, team sports

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IZVLEČEK

Telesna sestava je ključni dejavnik dobre telesne zmogljivosti in zdravja športnikov. Namen te raziskave je ugotoviti in primerjati telesno sestavo igralk odbojke (VB) (X=21,48±2,64), rokometa (HB) (X=18,42±2,62) in nogometa (SOC) (X=18,37±2,41). Skupna in regionalna telesna sestava vsake igralke je bila ocenjena z metodo dvoenergijske rentgenske absorpciometrije (DXA). Glede na rezultate analize MANOVA je bila med igralkami različnih ekipnih športov statistično značilna razlika pri kombiniranih odvisnih spremenljivkah (F=2,14; p=,00; Pillai's trace = 1,45; η2=,73). Ko smo rezultate za odvisne spremenljivke obravnavali ločeno, smo ugotovili statistično pomembno razliko pri starosti (F=7,07; p=,00 ; η2=,25), telesni masi (F=5,67; p=,00; η2=,21), telesni višini (F=10,57; p=00, η2=,33), indeksu telesne mase (F=3,52; p=,04; η2=,14). Scheffejev test večkratne primerjave je pokazal, da je bila telesna masa nogometašic manjša od telesne mase igralk rokometa (p=,00) in odbojke (p=,04). Če smo rezultate telesnih komponent obravnavali ločeno, so imele nogometašice bistveno nižje vrednosti puste telesne mase, mase rok, nog in maščevja kot igralce odbojke in rokometa. Pomembna razlika je bila ugotovljena tudi pri maščobni masi okrog nog in bokov ter vsebnosti mineralov v kosteh. Vendar med igralkami SOC, VB in HB ni bilo ugotovljenih pomembnih razlik pri drugem skupnem/regionalnem % telesne maščobe (p>0,05). Zaključimo lahko, da se je telesna sestava igralk ekip SOC, VB in HB razlikovala. Trenerjem in športnim znanstvenikom svetujemo, naj pri načrtovanju vadbe upoštevajo razlike med športnimi panogami.

Ključne besede: telesna sestava, DXA, meritve, športnice, ekipni športi

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INTRODUCTION

Body composition (BC) is an important factor in the physical fitness and health of athletes (Malá et al., 2015). Generally, a high ratio between the fat-free mass (FFM) and fat mass (FM) and low body fat percentage (%BF) are desirable criteria for athletes (Fields et al., 2018). In addition, the existence of insufficient or excess BF might cause performance degradation and potentially harmful effects on health (Stanforth, Crim, Standforth, and Sutlts-Kolehmainen, 2014).

Body composition (BC) has been used as a significant parameter for monitoring athletes' performance and physical fitness in pre, during, post-season, and multiple seasons (Trexler, Smith-Ryan, Mann, Ivey, Hirsch, and Mock, 2017; Devlin, Kingsley, Leveritt, and Belski, 2017; Hilgemberg-Figueiredo, Carlos-Dourado, Reeberg Stanganelli, and Rossi-Gonçalves, 2021; Madic, Andrasic, Gusic, Molnar, Radanovic, and Trajkovic, 2018; González-Ravé, Arija, and Clemente, 2011; Moss, Mcwhannell, Michalsik, and Twist, 2015; Milanese, Piscitelli, Lampis, and Zancanaro, 2012). For example, %BF and FFM are associated with sports performance indicators such as vertical jump, sprint time, relative power, and maximal strength. (Lidor and Ziv 2010). Moreover, previous studies reported a negative correlation between % BP and muscle performance (vertical jump, agility, and anaerobic power capacity) in elite athletes (Zhang, 2010; Michalsik, Aagard, and Madsen, 2015; Lesinski, Prieske, Helm, and Granacher, 2017; Kale and Akdoğan, 2020).

Given the variety of sports, athletes may have different physical demands, and as a result, different athletes may have different BC values. For instance, despite the high level of upper and lower body muscle strength and power required for both volleyball and handball, the body size of the players may vary between these two sports (Fields et al. 2018). In one study, volleyball players were shown to have higher fat-free mass and lower fat percentages than handball players (Bayios, Bergeles, Apostolidis, Noutsos, and Koskolou, 2006). According to a different study, volleyball and handball players had much higher FFM values than soccer players (Malá et al., 2015).

Overall, excess body fat is harmful and lean body mass is beneficial for athletic performance (Boileau and Horswill, 2000). Women reach adult lean body mass levels at 15-16 years of age and reveal an increase in body fat mass and fat percentages in their 20s (Malina, 1989). With intense conditioning programs, female athletes can control BC changes throughout their sports careers.

Although a number of published studies have investigated specific BC variables, there are fewer studies of female athletes than of male ones. As far as we know, few studies have analyzed comparisons of BC among female athletes (Bayios et al., 2006; Stanforth et al., 2014; Malá et al., 2015; Fields et al., 2018). Therefore, there is a need to expand body composition literature studies on female athletes. Another important issue, to our knowledge, only a few studies has described comparisons of BC among female players (DXA-derived measurements) (Carbuhn, Fernandez, Bragg, Green, and Crouse, 2010; Stanforth et al., 2014). The aim of this research is to compare the BC of female volleyball, handball, and soccer players using the dual-energy x-ray absorptiometry (DXA) measurement technique. The hypothesis determined for this purpose is as follows: "There is a significant difference between female players in terms of their sports."

METHODS

Participants

A total of 46 females (X with Age=19.33±2.88) participated in the research, including 14 volleyball players (X with Age=21.48±2.64) and 17 handball players (X with Age=18.42±2.62) from the second league, and 15 soccer players (X with Age=18.37±2.41) from the third league (Table 1). They trained for 60-90 minutes five days a week in their sport-specific cycle. The participants were briefed about the research and took a consent form. If the participant was below 18, the consent form was taken from his parents for participation. This study was conducted in accordance with the principles of the Helsinki Declaration. The local Research Ethics Committee approved the research (Board approval numbers: 44506).

Table 1. Basic anthropometric variables of the sample (Mean±SD).

Sport	n	Age (years)	Body Mass (kg)	Body Height (cm)	BMI (kg-m2)
Volleyball (VB)	14	21.48±2.64	63.04±9.16	173.50±7.49	20.85±1.79
Handball (HB)	17	18.42±2.62	64.43±8.07	167.71±5.89	22.90±2.51
Soccer (SOC)	15	18.37±2.41	54.90±8.28	161.80±7.23	20.96±2.89
Total	46	19.33±2.88	60.90±9.32	167.54±8.18	21.64±2.59

BMI= Body Mass Index

Procedure

All measurements and tests were carried out at the beginning of the in-season period (August). Participants consisted of healthy athletes who played in the same team for at least a year. The test sessions were completed in 3 days between 9:00 and 12:00 a.m. Anthropometry and BC measurements were carried out at the Laboratory of Kinanthropometry at the Faculty of Sport Sciences, Eskişehir Technical University. Participants were warned not to take any drugs and coffee, and get involved in physical activities at least 24 hours before the test day.

Anthropometric and Body Composition Analysis

A scale (Seca, Vogel & Halke, Hamburg) with a precision of 01. kg was used to measure participants' body mass (kg). The height of the players was measured barefoot the heads of players were placed in the Frankfurt plane using a stadiometer (Holtain Ltd, UK) with an accuracy of 0.1 cm. The Dual-electron X-ray absorptiometry (Lunar Prodigy Pro; GE, Healthcare, Madison, WI, USA) was used for the regional and total BC (fat percentage, muscle mass, and fat mass). Phantoms were used in order to calibrate the DXA before the measurements by following the standard guidelines. All the scans and analyses were performed for consistency with the same operator. Before the measurements, the participants were asked not to wear any jewelry or have any metal objects in their bodies while being screened. For a standard supine position during the scans, the subjects' knees and ankles were tied with a Velcro strap and their arms were extended by their sides. The examinations lasted between 6 and 8 minutes depending on the height of the participant.

Statistical Analysis

Descriptive analysis (Mean and SD) and multivariate analysis of variance (MANOVA) was used to assess differences between BC variables. The data were checked for univariate and multivariate normality, outliers, linearity, homogeneity of regression, multicollinearity/singularity, and homogeneity of variance-covariance matrices for MANOVA (Pallant, 2011). Cohen's (1988) effect sizes (ESs) and thresholds (.00, .06 and, .14 as benchmarks for small, medium, and large effect sizes, respectively) were used. The results were tested at the levels of $p<.05$. SPSS 25 package program was used in the analysis of the data.

RESULTS

According to the results of the MANOVA, there was a statistically significant difference between female players from different team sports on the combined dependent variables (F=2.14; p=.007; Pillai's Trace=1.45; η^2=.73).

Table 2. Findings of MANOVA for combined dependent variable.

Pillai's Trace	F	df1	df2	p	η2
1.45	2.14	50	40	.007	.73

When the results for the BC variables were considered separately, there were significant difference on body mass (F=5.67; p=.007; η^2=.21), body height (F=10.57; p=000. η^2=.33), body mass index (F=3.52; p=.038; η^2=.14). Scheffe's multiple comparison tests showed that the body mass of SOC players was lower than the body mass of HB (p=011) and VB (p=.045) players. In addition, It was observed that the body height of VB players was higher than the body height of SOC players (p=.000) (Table 3).

When the results for the dependent variables were considered separately, SOC players had significantly lower lean arm mass (F=6.27; p=.004; η^2=.23), lean leg mass (F=7.92; p=.001; η^2=.27), lean android mass (F=8.85; p=.001; η^2=.29), lean gyonoid mass (F=9.01; p=.001; η^2=.30), and Total BMC (F=7.25; p=.002; η^2=.25) than those of VB and HB players. In addition, while SOC players had significantly lower lean body mass (F=4.97; p=.011; η^2=.19) than VB players; HB players had significantly higher leg fat mass (F=4.77; p=.013; η^2=.18) and gyonoid fat mass (F=4.37; p=.019; η^2=.17) than SOC players. However, no significant difference was found on body fat percentages, body fat mass, arm fat percentages, trunk fat percentages, trunk fat mass, trunk lean mass, android fat percentages, android fat mass, gyonoid fat percentages, whole BMD, and Z score (p>.05) (Table 3).

Table 3. Findings of comparison test between body composition variables by different team sports.

Variables		Volleyball	Handball	Soccer	Univariate ANOVA			Multiple Comparison
		n=14	n=17	n=15	F	p	η^2	Scheffe
Body mass	a	63.04±9.16	64.43±8.07	54.90±8.28	5.67	.007	.21	V>S* H>S*
	b	58.46-67.61	60.28-68.58	50.48-59.32				
Body height	a	173.50±7.49	167.71±5.89	161.80±7.23	10.57	.000	.33	V>S***
	b	169.81-177.19	164.36-171.06	158.23-165.37				
BMI	a	20.85±1.79	22.90±2.51	20.96±2.89	3.52	.038	.14	-
	b	19.53-22.18	21.70-24.10	19.68-22.24				
Body fat percentages (%)	a	27.44±4.04	30.14±4.57	27.68±5.15	1.67	.200	.07	-
	b	24.95-29.92	27.88-32.39	25.28-30.08				
Body fat mass (kg)	a	16.91±5.10	18.80±5.09	14.72±4.62	2.71	.078	.11	-
	b	14.24-19.57	16.38-21.21	12.15-17.29				
Lean body mass (kg)	a	45.38±10.33	42.82±4.70	37.57±4.37	4.97	.011	.19	V>S*
	b	41.69-49.06	39.48-46.16	34.02-41.13				
Arm fat percentages (%)	a	29.19±4.75	30.66±5.25	30.25±5.44	.32	.725	.02	-
	b	26.41-31.98	28.14-33.19	27.56-32.94				
Arm fat mass (kg)	a	1.85±.43	1.98±.52	1.72±.52	1.12	.337	.05	-
	b	1.58-2.12	1.74-2.22	1.46-1.97				
Lean arm mass (kg)	a	4.45±.72	4.42±.48	3.77±.59	6.27	.004	.23	V>S* H>S*
	b	4.13-4.77	4.13-4.71	3.46-4.08				
Leg fat percentages (%)	a	31.11±4.27	34.34±3.84	31.93±4.20	2.67	.081	.11	-
	b	28.90-33.31	32.34-36.34	29.80-34.06				
Leg fat mass (kg)	a	6.82±1.98	7.97±1.80	6.02±1.61	4.77	.013	.18	H>S*
	b	5.85-7.80	7.09-8.85	5.08-6.96				
Lean leg mass (kg)	a	15.61±2.58	15.06±1.75	12.78±1.80	7.92	.001	.27	V>S** H>S*
	b	14.50-16.72	14.05-16.06	11.71-13.85				

Trunk fat percentages (%)	a	25.61±4.78	27.60±5.88	24.80±6.84	.96	.393	.04	-
	b	22.43-28.80	24.71-30.49	21.72-27.88				
Trunk fat mass (kg)	a	7.17±1.98	8.08±2.93	6.23±2.63	2.04	.142	.09	-
	b	5.78-8.56	6.82-9.34	4.89-7.57				
Trunk lean mass (kg)	a	19.91±4.38	20.55±2.20	18.12±2.04	2.76	.074	.11	-
	b	18.30-21.53	19.09-22.02	16.57-19.68				
Android fat percentages (%)	a	22.83±6.27	25.97±7.85	22.80±8.69	.90	.415	.04	-
	b	18.67-26.98	22.20-29.74	18.79-26.81				
Android fat mass (kg)	a	.91±.36	1.05±.53	.78±.44	1.37	.266	.06	-
	b	.66-1.16	.83-1.27	.54-1.02				
Lean android mass (kg)	a	2.97±.39	2.85±.35	2.44±.34	8.85	.001	.29	V>S** H>S*
	b	2.78-3.16	2.67-3.02	2.26-2.63				
Gynoid fat percentages (%)	a	32.06±4.59	35.10±4.62	33.13±5.27	1.60	.214	.07	-
	b	29.45-34.66	32.74-37.46	30.62-35.65				
Gyonoid fat mass (kg)	a	3.35±.92	4.01±1.13	2.99±.88	4.37	.019	.17	H>S*
	b	2.82-3.89	3.53-4.50	2.48-3.51				
Lean gyonoid mass (kg)	a	7.12±.95	6.87±.77	5.94±.66	9.01	.001	.30	V>S** H>S**
	b	6.68-7.55	6.48-7.26	5.52-6.35				
Total BMC (kg)	a	2.56±.24	2.54±.33	2.19±.30	7.25	.002	.25	V>S** H>S**
	b	2.40-2.72	2.40-2.69	2.04-2.35				
Whole BMD ($g \cdot cm^2$)	a	1.16±.09	1.22±.10	1.15±.11	2.58	.087	.11	-
	b	1.10-1.21	1.17-1.27	1.10-1.20				
Z-Score	a	1.04±1.05	1.81±1.26	.89±1.21	2.85	.069	.12	-
	b	.40-1.67	1.23-2.39	.27-1.50				

***p < .001 **p < .01 *p < .05 p > .05; V- Volleyball, H - Handball, S – Soccer; a - mean±sd, b – range;

DISCUSSION

The aim of this study was to identify and compare body composition (BC) in female athletes from three competitive team sports. The results showed that there were significant differences in body mass, body height, and body mass index. Scheffe's multiple comparison tests showed that the body mass of soccer players was lower than the body mass of HB and VB players. In addition, they showed that the body height of VB players was higher than the body height of SOC players.

Significant differences were found among the compared sports in terms of total and regional body mass. SOC players had a significantly lower lean arm mass, lean leg mass, lean android mass, lean gyonoid mass, and Total BMC values than those of VB and HB players. A significant difference was also found in terms of lean body mass between SOC and VB players and leg fat mass and gyonoid fat mass between SOC and HB players. The findings of the present research are consistent with those of previous studies. For example, in the study of Malá et al. (2015), the variability of BC among female athletes in different sports was emphasized. The authors found a significantly lower lean mass in SOC players than VB, HB, and basketball (BB) players. Similarly, Fields et al. (2018) found that lean mass values for SOC players were significantly lower than BB and VB players. Their study also found a lower fat mass in SOC than BB, lacrosse (LAX), rowing (ROW), and VB players. Similar to this study, Stanforth et al. (2014) reported that BB had significantly greater height and lean mass than SOC, swimming (SW), and truck (TR). In addition, SOC weighted significantly less than BB, SW, and VB. It had significantly less lean mass than all other sports

The present research showed that no significant difference was found among SOC, VB, and HB players with other total/regional %BF ($p>0.05$). Due to limited research in the literature, similar studies were used as support in the discussion. Fields et al. (2018) found no significant difference in %BF between SOC and VB players. The authors also stated that soccer and lacrosse players had no differences in %BF and FFM. In another study, Malá et al. (2015) reported insignificant differences in %BF between female softball, BB, HB, VB, and SOC players. Contrary to our study, the results of the study conducted by Bayios et al. (2006) had significantly higher %BF in BB players than in VB and HB players. Similarly Fields et al. (2018) reported BB players had significantly lower %BF and FM, and higher FFM than VB, indicating BB players were leaner. Similar to this study, Stanforth et al. (2014) found that SOC players had lower %BF than BB and higher % BF than TR. Their study also found that VB

players were taller, heavier, and had more lean mass than SOC, SW, and TR. They were lighter and had less %BF than BB and more %BF than TR athletes.

As a valid and reliable testing method for female athletes (Arngrimsson et al., 2000; Ballard et al., 2004; Esco et al., 2015), X-ray absorptiometry (DXA) was primarily used in this research. One should be extra careful when comparing studies using different assessment methods, as BC data may vary depending on the sampled population and measurement technique (Fields et al., 2018). Moreover, the reason for this disparity might be due to different data collection times (pre or during the season), and differences in training programs (for example, strength training frequency) (Phomsoupha, Berger, and Laffaye, 2018; Akdoğan and Güven, 2021).

Considering the sports compared, the reason for the differences between FB, HB, and VB may be due to the fact that the soccer field and the game time are longer than the others' fields and times. Therefore, players need a different motor and metabolic demands. For example, soccer requires significant aerobic endurance, as professional female athletes cover 8.200–11.000m during a game (Vescovi, Fernandes, and Klas, 2021). Volleyball is anaerobic by nature. Speed and power are dominant motor skills in contact sports such as handball, where size and strength can assist in the struggle for the position on the field and athletes can benefit from higher body mass and body height (Malá et al., 2015).

The first limitation of the research is that the sample consists of female athletes. Thus, it is recommended to be prudent while generalizing the results to a larger population, different age groups, competitive levels, and sports positions. The second limitation is that the BC tests and measurements were taken only before the season. Therefore, whether the BC of players revealed a difference during the season is still unknown.

CONCLUSION

In conclusion, while there were significant differences in BC variables between soccer players and other team sports players; it was found that there was no significant difference between volleyball players and handball players. Further research is recommended to examine the BC differences between player positions in team sports. In addition, longitudinal studies with large populations may be helpful for a better understanding of BC.

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Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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