

Morphological Characteristics of Elite-Level Cadet Female Handball Players in European Competition

Características Morfológicas de Jugadoras de Balonmano Cadetes de Élite en Competición Europea

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SUMMARY: This study aimed to determine differences in morphological characteristics and body composition between female handball players from the national teams of Montenegro and Kosovo (U16). Thirty-four participants were included in the study, divided into two subgroups. The first subgroup consisted of 18 players from the Montenegro national team, with an average age of 14.68±0.58 years. The second subgroup consisted of 16 players from the Kosovo national team, with an average age of 15.33±0.66 years. Testing was conducted during the qualification rounds for the European Championship took place in Podgorica in 2021. All players were assessed for anthropometric measurements and body composition, with a total of twelve variables: Body height, body weight, hand length, arm span, triceps skinfold, biceps skinfold, subscapular skinfold, abdominal skinfold, calf skinfold, thigh skinfold, body mass index (BMI), and body fat percentage (BF). The Tanita - model BC-418MA was utilized for the assessment of body composition. Differences in morphological characteristics and body composition of the female handball players from the two national teams were determined through discriminant parametric procedures using the T-test for independent samples with statistical significance set at $p < .05$. The results indicated that the players from the Montenegro team were significantly younger, had significantly greater average body height, body weight, and hand length compared to players from the Kosovo team. Statistical differences between the two treated teams were found in the variable thigh skinfold, while no significant differences were observed in BMI and BF.

KEY WORDS: Handball; Young female players; Morphological characteristics; Body composition; European Championship qualifiers.

INTRODUCTION

Handball is an alternating high-intensity team sport that requires a combination of aerobic and anaerobic endurance to execute sequences of coordinated and complex motor activities (Chelly *et al.*, 2011). Changes leading to faster gameplay in handball have altered the demands on specific positions, thereby changing the requirements for players' morphological characteristics and motor abilities. When considering game situations, the execution of attacks or defenses depends on the players' abilities their morphological characteristics and motor skills. In this context, there is ample empirical and scientific evidence of the positive correlation between certain morphological characteristics and sports performance (Ghobadi *et al.*, 2013; Massuca & Fragoso, 2015; Saavedra, 2018). The characteristic of player activity is continuous movement with and without changes of direction, punctuated by rapid and sharp sprints, high jumps, various landings, and duels in contact with opponents (Pavlin *et al.*, 1982).

Handball is one of the most popular sports in Montenegro. With the acquisition of state independence and through the performances of our national teams, Montenegro has had the opportunity to showcase the potential of Montenegrin handball to Europe and the world. The Montenegrin women's senior handball team won its first gold medal in 2012 in Serbia, a silver medal at the 2012 Olympic Games in London, and then a bronze medal at the latest European Championship in 2022 in Ljubljana. It is also worth noting that the cadet selections are regular participants in the European Championship, which is a significant achievement considering the size of the country and the size of the sample from which the selection is made (Ljubojevic *et al.*, 2020). Small countries like Montenegro and Kosovo, in addition to sporting success, should use handball as a form of promotion on the international stage. Modern sport represents an international cultural phenomenon that can best

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demonstrate the social value of fame and success. The greatest success of a country can be best demonstrated by sporting achievements in major competitions (Muratovic, 2014). This study aimed to analyze the morphological characteristics of female handball players from two national cadet teams (U16) competing at the highest level of competition.

MATERIAL AND METHOD

Sample of Participants. The sample consisted of 34 elite female cadet players who were members of two cadet national teams participating in the European Championship qualification tournament.

The first subset of participants comprised 18 players from the national team of Montenegro, with the following basic characteristics: mean±SD age of 14.67±0.57 years, body height of 170.48±5.31 cm, and body weight of 69.95±6.23 kg. The second subset included 16 players from the Kosovo national team, with the following basic characteristics: mean age of 15.33±0.65 years, body height of 166.14±5.10 cm, and body weight of 64.69±6.31 kg. The players were tested in Podgorica during the European Championship qualifications in 2021. The study was conducted in accordance with the guidelines of the Helsinki Declaration.

Research Design

Anthropometry. Anthropometric measurements were conducted according to the recommendations of the International Biological Program (IBP). For the purposes of this study, 10 morphological measures were taken into account: body height, hand length, arm span, triceps skinfold, biceps skinfold, subscapular skinfold, abdominal skinfold, calf skinfold, and thigh skinfold. Body height was measured using a Martin anthropometer with a precision of 0.1 cm, while skinfolds were measured using a John Bull caliper.

Body Composition. For the assessment of body composition, BMI, BF, and body weight, the Tanita body fat scale - model BC-418MA was used. The Tanita scale, thanks to its athletic mode, enables athletes to carefully monitor their body weight, health status, and fitness with all relevant parameters.

Statistical Analysis. The data obtained from the research are processed using descriptive and comparative statistical procedures. Central and dispersion parameters, as well as measures of asymmetry and kurtosis, were calculated for each variable. Differences in morphological characteristics and body composition of the two national handball teams

were determined using discriminant parametric procedures with a T-test for small independent samples with statistical significance set at $p < .05$. The data were processed using the IBM Statistics 25 statistical package.

RESULTS

The basic descriptive statistical parameters of anthropometric variables and body composition of the handball players from the two teams are presented in Tables I and II. Central and dispersion parameters were calculated for each variable: minimum (Min) and maximum (Max) values, arithmetic mean (Mean), standard deviation (SD), skewness coefficient (Skewness), and kurtosis coefficient (Kurtosis).

Considering the results presented in Table I, based on central and dispersion parameters, it can be observed that the results of the players from the Montenegro national team are within expectations and logically distributed around the arithmetic mean. However, through the indicators of the normality of result distribution, via the skewness coefficient (Skewness) and kurtosis coefficient (Kurtosis), significant deviations are noted in some analyzed results. Namely, when it comes to skewness in the Triceps skinfold variable, there is a significant negative asymmetry, indicating that relatively dominant results are higher than the arithmetic mean in the statistical series, while in the subscapular skinfold variable, there is also significant asymmetry, with the difference being of a positive nature. Regarding kurtosis, for the variables Arm span, Triceps skinfold, and Subscapular skinfold, most results are observed around the center of distribution, indicating a homogeneous distribution. Considering the kurtosis results for the Age and Biceps skinfold variables, it is noticed that the results are heterogeneously distributed within the statistical series.

Analyzing Table II, which pertains to the Kosovo team, it can be observed that significant deviations exist in some variables regarding measures of normal distribution of results, while they fall within logical distribution when considering central and dispersion parameters. Specifically, when it comes to skewness in the Subscapular skinfold variable, there is a significantly positive asymmetry, indicating that smaller results predominate in the statistical series compared to the arithmetic mean, while in the Thigh skinfold variable, significant negative asymmetry is present, indicating a large number of results higher than the arithmetic mean in the statistical series. Regarding kurtosis, significant homogeneity of results is observed for the Subscapular skinfold and Thigh skinfold variables, while for the Arm span variable, significant heterogeneity of results within the statistical series is noticed.

In the analysis of the T-test results, as shown in Table III, significant differences are observed between the female handball players of the Montenegro and Kosovo national teams. Specifically, it is noted that the players from the Montenegro national team are significantly younger compared

to those from the Kosovo national team ($t = -3.09, p < .004$). Additionally, players from Montenegro have a significantly greater average body height ($t = 2.42, p < .021$), body weight ($t = 2.44, p < .020$), as well as significantly greater hand length ($t = 3.02, p < .005$), at a significance level of $p < .05$.

Table I. Descriptive data for Montenegro's U16 female handball players.

	Min	Max	Mean	SD	Skewness	Kurtosis
Age	13.8	15.6	14.678	.5766	-.022	-1.385
Body height (cm)	159.8	181.5	170.483	5.3187	.006	.134
Body weight (kg)	55.2	80.2	69.956	6.2317	-.427	.446
Hand length (cm)	20.0	24.1	21.706	1.0795	.325	.087
Arm span (cm)	150.3	182.0	167.706	7.0050	-.302	1.942
Triceps skinfold (mm)	2.1	20.1	14.867	4.2345	-1.501	4.006
Biceps skinfold (mm)	5.2	11.4	8.011	1.9174	.252	-1.220
Subscapular skinfold (mm)	8.4	19.2	11.767	2.8738	1.090	1.088
Abdominal skinfold (mm)	8.8	24.1	15.650	4.4841	.229	-.588
Thigh skinfold (mm)	24.1	33.5	28.056	2.3004	.626	.748
Calf skinfold (mm)	11.2	29.2	17.861	5.0247	.544	-.121
Body mass Index (kg/m ²)	21.62	28.47	24.0894	2.15171	.914	.019
Percentage of fat (%)	17.0	29.7	23.402	3.0165	-.227	.791

Table II. Descriptive data for Kosovo U16 female handball players.

	Min	Max	Mean	SD	Skewness	Kurtosis
Age	14.1	16.2	15.331	.6580	-.452	-.933
Body height (cm)	160.1	175.5	166.144	5.1042	.664	-.710
Body weight (kg)	53.1	75.2	64.694	6.3176	-.280	-.724
Hand length (cm)	19.0	22.1	20.625	.9990	-.102	-.865
Arm span (cm)	152.1	174.1	163.125	7.4640	-.014	-1.084
Triceps skinfold (mm)	10.5	22.3	15.112	3.5771	.571	-.721
Biceps skinfold (mm)	5.5	16.1	9.437	2.8277	.711	.503
Subscapular skinfold (mm)	6.3	20.1	11.100	3.7736	1.299	1.465
Abdominal skinfold (mm)	6.2	26.5	16.356	5.9625	.421	-.523
Thigh skinfold (mm)	10.2	29.7	23.581	5.2987	-1.453	1.903
Calf skinfold (mm)	11.2	23.2	16.537	3.5794	.655	-.228
Body mass Index (kg/m ²)	19.62	27.41	23.4413	2.15621	.272	-.502
Percentage of fat (%)	17.0	30.1	22.856	3.9060	.519	-.370

Table III. Differences in morphological characteristics among U16 female handball players

Times	Montenegro	Kosovo	T-test	
	Mean±SD	Mean±SD	t	p
Age	14.68±.58	15.33±.66	-3.09	.004
body height (cm)	170.48±5.32	166.14±5.10	2.42	.021
body weight (kg)	69.96±6.23	64.69±6.32	2.44	.020
hand length (cm)	21.71±1.08	20.63±1	3.02	.005
arm span (cm)	167.71±7	163.13±7.46	1.84	.074
triceps skinfold (mm)	14.87±4.23	15.11±3.58	-.182	.857
biceps skinfold (mm)	8.01±1.92	9.44±2.8	-1.74	.092
subscapular skinfold (mm)	11.77±2.87	11.103.77	.583	.564
abdominal skinfold (mm)	15.65±4.48	16.36±5.96	-.393	.697
thigh skinfold (mm)	28.06±2.30	23.58±5.30	3.12	.005
calf skinfold (mm)	17.86±5.02	16.54±3.58	.874	.389
Body mass index (BMI)	24.09±2.15	23.44±2.16	.876	.388
Percentage of fat (%)	23.40±3.02	22.86±3.91	.459	.650

Note: t-values for t-test; p - significant value

DISCUSSION

Contemporary handball over the past twenty years demands significant physical exertion from elite players. A significant component comprises morphological characteristics, which represent the ideal model of a player in any sport. Therefore, anthropometric diagnostic procedures become increasingly important from the perspective of athlete selection, for which sports-specific morphological profiles are created (Srhoj *et al.*, 2002). The constitution of players falls under the so-called internal factors of player performance, along with gender, age, genetics, and physiological characteristics (Michalsik, 2018). Body height and weight provide the first insight into players' morphological characteristics (Ramos-Campo *et al.*, 2014).

According to the obtained results of body height, it is noticeable that the female handball players from Montenegro are significantly taller, with an average height of 170.48 cm compared to the players from Kosovo with an average height of 166.14 cm. Additionally, it is observed that the players from Montenegro are significantly younger, with an average age of 14.68 years compared to the players from Kosovo with an average age of 15.33 years, indicating an important fact that the Montenegro players are taller and significantly younger for that age group. The results obtained in this study can be related to the research by Popovic (2018), who first established the average height of young adult Montenegrin women at 169.36 cm, thereby identifying that the female population of Montenegro ranks among the tallest nations in the world, ranking second only to Lithuanians with an average height of 169.8 cm. Regarding the height of the female population in Kosovo, the average body height was 165.72 cm, indicating that they do not rank among the top ten tallest nations in the world (Arifi *et al.*, 2017). When analyzing the results of body height in the Russian national team players who won first place at the European Championship for the U17 age group and younger, with a height of 175.62 cm (Urban *et al.*, 2011), we see that they are taller compared to the players from Montenegro and Kosovo, while the results of body weight are approximately the same. The differences evident in body height can be attributed to the younger age of the analyzed national team players.

The significance observed in the variables of body weight (69.96±6.23 kg) and hand length (21.71±1.08 cm) between the national teams of Montenegro and Kosovo, in favor of the Montenegro players, may be directly proportional to body height, which could certainly affect their success when considering the demands of the handball game.

Sarvestan *et al.* (2019), in their study on elite junior female handball players, presented hand length results of 18.0±2.1 cm, indicating a significantly lower result compared to the Montenegro players with a result of 21.71±1.08 cm and Kosovo players with a result of 20.63±1 cm. A study conducted on elite players of the U16 category of the Al-Ahli handball club (Bahrain) also showed lower results in hand length, at 19.13±0.95 cm (Banjevic *et al.*, 2022). This suggests that players from the elite teams of Kosovo and especially Montenegro have high hand length values, which can positively impact their performance.

When analyzing the results of skinfold measurements, it can be noted that a greater number of variables exhibit approximately homogeneous results. Significant statistical significance ($p < .005$) was obtained in the thigh skinfold variable. Other variables such as triceps skinfold, biceps skinfold, subscapular skinfold, and abdominal skinfold show lower values in the Montenegro players compared to the Kosovo players, while in the thigh skinfold and calf skinfold variables, lower results are observed in the Kosovo players compared to the Montenegro players.

The BMI results of the Montenegro team (24.09±2.15 kg/m²) and Kosovo team (23.44±2.16 kg/m²) showed no significant differences between these two national teams. Comparing the obtained results with some previous studies, similar results can be observed as with Croatian elite junior players 24.13±1.82 kg/m² (Vuleta *et al.*, 2020). Similar results are also observed in Spanish junior and senior national team members (Expósito *et al.*, 2011), as well as in players of the Italian first league aged between 17-26 years with a BMI of 23.35±4.01 kg/m² (Milanese *et al.*, 2011). These indicators are limited by the fact that they belong to an age group whose morphological rounding process is not completed. The U16 and junior age groups follow an acceleration of growth and development with continuous changes in body weight, proportions, and physiological functions.

The percentage of body fat showed no statistically significant difference between the Montenegro team (23.40 %) and Kosovo team (22.86 %). A study on the morphological profile conducted during the U17 European Championship with 15 national teams presented much lower values of body fat percentage at 11.31±4.11 % (Urban *et al.*, 2011). Comparing with the results of Croatian players (Vuleta *et al.*, 2020) with values of 18.37 %, as well as Slovenian junior and senior national team handball players (Bon *et al.*, 2015) with values of 20.03 %, a lower percentage of body fat is noticeable. An interesting finding is noticeable in Spanish elite professional players aged 23.1±4 years (Granados *et al.*, 2007), where the percentage

is 20.5 %, showing a lower value compared to the two younger national teams of Montenegro and Kosovo. Due to all activities and demands that handball entails, it is known that excess body fat has a disruptive factor in the expression of physical performance (Strel, 2006; Nikolaidis & Vassilios Karydis, 2011). Additionally, higher body fat is associated with lower aerobic capacity in adolescents (Hermassi *et al.*, 2020). Puberty onset in girls leads to specific physiological changes that include an increase in body mass, different rates of physical and muscular strength development, the onset of menstruation, increased joint laxity, and the valgus angle of the knees. All these factors have been identified as potentially increasing the risk of injury in adolescence (Myer *et al.*, 2009).

CONCLUSION

The morphological characteristics of young female handball players are not a common topic in scientific literature, and previous studies mostly focus on the morphological characteristics of older handball players. This research aimed to determine the morphological characteristics of elite cadet female handball players from the national teams of Montenegro and Kosovo who participated in the European Championship qualifications. According to the obtained results, we highlight a slightly higher percentage of BF in both national teams compared to other studies that have shown significantly lower values. This indicates that handball experts from both treated selections should first focus on reducing body fat through planned training processes, and importantly, that players change their dietary habits. Considering that the Montenegro national team ranked seventh in Europe in the cadet age group (European Championship, 2023), we can use the obtained results for comparison with other selections that have achieved better placements in major competitions.

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RESUMEN: Este estudio tuvo como objetivo determinar las diferencias en las características morfológicas y la composición corporal entre jugadoras de balonmano de los equipos nacionales de Montenegro y Kosovo (U16). Se incluyeron en el estudio 34 participantes, divididas en dos subgrupos. El primer subgrupo consistió en 18 jugadoras del equipo nacional de Montenegro, con una edad media de 14,68 ± 0,58 años. El segundo subgrupo consistió en 16 jugadoras del equipo nacional de Kosovo, con una edad media de 15,33 ± 0,66 años. Las pruebas se llevaron a cabo durante las rondas de clasificación para el Campeonato Europeo que tuvo lugar

en Podgorica en 2021. A todas las jugadoras se les evaluaron las medidas antropométricas y la composición corporal, con un total de doce variables: altura corporal, peso corporal, longitud de la mano, envergadura del brazo, pliegue cutáneo del tríceps, pliegue cutáneo del bíceps, pliegue cutáneo subescapular, pliegue cutáneo abdominal, pliegue cutáneo de la pantorrilla, pliegue cutáneo del muslo, índice de masa corporal (IMC) y porcentaje de grasa corporal (GC). Para la evaluación de la composición corporal se utilizó el modelo Tanita BC-418MA. Las diferencias en las características morfológicas y la composición corporal de las jugadoras de balonmano de los dos equipos nacionales se determinaron mediante procedimientos paramétricos discriminantes utilizando la prueba T para muestras independientes con significación estadística establecida en $p < 0,05$. Los resultados indicaron que las jugadoras del equipo de Montenegro eran significativamente más jóvenes, tenían una altura corporal media, un peso corporal y una longitud de la mano significativamente mayores en comparación con las jugadoras del equipo de Kosovo. Se encontraron diferencias estadísticas entre los dos equipos tratados en la variable pliegue cutáneo del muslo, mientras que no se observaron diferencias significativas en el IMC y el GC.

PALABRAS CLAVE: Balonmano; Jugadoras jóvenes; Características morfológicas; Composición corporal; Clasificatorias del Campeonato Europeo.

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