ORIGINAL ARTICLE

Physical fitness among elite female football and handball players: A comparative analysis

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ABSTRACT

This study examined the differences in physical fitness between elite female football and handball players competing at the highest level. A total of 38 athletes participated, divided into two groups: football players (N = 20) and handball players (N = 18). Anthropometric characteristics, body composition, and motor abilities, including speed, agility, and explosive strength, were assessed using standardized tests. The results revealed significant differences in body composition, with handball players being taller (173.6 ± 4.7 cm vs. 165.7 ± 4.7 cm, p = .00) and heavier (69.7 ± 10.9 kg vs. 60.9 ± 8.0 kg, p = .00), while football players had a higher percentage of muscle mass (42.9 ± 3.4% vs. 32.2 ± 2.7%, p = .00) and lower body fat (22.4 ± 6.1% vs. 27.6 ± 6.0%, p = .01). Regarding physical performance, football players outperformed handball players in agility, particularly in the zig-zag test (5.74 ± 0.32 s vs. 6.08 ± 0.38 s, p = .00). Conversely, handball players demonstrated superior explosive strength, as evidenced by better results in the countermovement jump with arm swing (CMJa: 32.5 ± 5.0 cm vs. 28.8 ± 3.4 cm, p = .01). No significant differences were found in sprint performance over 10m (1.84 ± 0.16 s vs. 1.89 ± 0.12 s, p = .25), 20m (3.35 ± 0.22 s vs. 3.33 ± 0.18 s, p = .78), and 30m (4.66 ± 0.20 s vs. 4.75 ± 0.24 s, p = .20). These findings highlighted the influence of sport-specific demands on athletes' physical profiles and motor abilities. Understanding these differences could assist coaches in designing targeted training programs to optimize performance and address specific fitness needs. Future research should incorporate a larger sample size and explore additional physiological and biomechanical variables to further elucidate the distinctions between these two sports.
Keywords: Performance analysis, Anthropometric characteristics, Agility, Explosive strength, Body composition, Speed.

Cite this article as:
Stanković, M., Đorđević, S., Rančić, D., Antonijević, M., Katanić, B., Jelaska, G., Govindasamy, K., Ardelean, V. P., & Jelaska, I. (2026). Physical fitness among elite female football and handball players: A comparative analysis. *Journal of Human Sport and Exercise, 21*(1), 51-62. https://doi.org/10.55860/zpa7rv13

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Submitted for publication July 09, 2025.
Accepted for publication August 18, 2025.
Published October 02, 2025.
Journal of Human Sport and Exercise. ISSN 1988-5202.

doi: https://doi.org/10.55860/zpa7rv13

INTRODUCTION

Over the past decade, female team sports have seen significant growth and received a lot of attention (Elliott-Sale, Minahan, de Jonge, Ackerman, & Hackney, 2021). Contemporary intermittent team sports demand a diverse set of physiological characteristics to be able to meet the requirements of the game (Dasa, Kristofersen, Ersvær, Bovim, & Haukenes, 2021). In team sports, the quickness and explosive force of game activities enhance via training and competition. Regarding that, experts in this area are exploring novel approaches to help athletes improve their physical and technical abilities (Bush, Barnes, Archer, Hogg, & Bradley, 2015).

Football is rapidly becoming the worldwide leading female sport (Read, Mehta, Rosenbloom, Jobson, & Okholm Kryger, 2022). Elite football players usually cover approximately 10 km throughout a single match, demonstrating a high level of activity. High-intensity running and sprinting account for 22-28% of the overall match distance and require additional metabolic and physiological resources, such as the anaerobic energy system (Ramos, Nakamura, Penna, Wilke, & Coimbra,2019). The usual sprint interval is between 2 and 4 seconds and happens at key moments throughout a match, while nearly all sprints occur over distances shorter than 20 meters (Andrašić, Gušić, Stanković, Mačak, & Trajković, 2021).

On the other hand, handball success demands scoring more goals than the rival after two 30-minute halves. Analysing aspects of performance is crucial for achieving victory (García-Sánchez, Navarro, Mon-López, Nieto-Acevedo, & de la Rubia, 2024). Handball is a team sport that alternates between low-intensity motions and high-intensity actions, including constant and intense physical contact with rivals (Wagner, Fuchs, Fusco, Fuchs, & von Duvillard, 2019). Throughout various high-intensity occasions, players are required to execute a variety of basic movement patterns (directional changes, accelerations, decelerations, jumps, sprints) as well as handball-specific movements (hits, throws, blocks and pushes) (Iacono, Eliakim, & Meckel, 2015). Elite female handball players travelled approximately 4 kilometres in one competitive match. The overall distance completed throughout a match includes around 9.2% sprinting and 26.7% quick running, highlighting the sport's reliance on agility and speed (Papaevangelou, Papadopoulou, Michailidis, Mandroukas, & Metaxas, 2023).

When it comes to previous research, several studies have dealt with similar topics in female football and handball. In this regard, two studies, in both genders (Stankovic, Malacko, & Doder, 2009; Gusic, Popovic, Molnar, Masanovic, & Radakovic, 2017) reported differences in height, weight, and subcutaneous fat, where handball players had higher values compared to soccer players. Previous studies (Petruţ-florin, Lepciuc, & Florentina-Petruţa, 2021) demonstrated significant differences in body mass (kg) between female soccer (57.44 ± 9.12) and handball (70.03 ± 8.33). The same study also confirmed differences in explosive power of lower limbs in the countermovement jump (CMJ) (37.01 ± 4.29 vs. 39.21 ± 4.69), squat jump (SJ) (34.62 ± 3.66 vs. 37.69 ± 4.27) and free jump (FJ) (42.78 ± 5.31 vs. 44.14 ± 3.90) tests, as well as isometric strength (60.63 ± 10.84 vs.70.43 ± 9.37) in favour of handball players. When we looked at speed and agility, it was reported that handball players from first division showed better results on the zig-zag test than soccer players same rank of competition (Freitas, Pereira, Alcaraz, Comyns, & Loturco, 2022). On the other hand, the same study confirmed that soccer players displayed inferior sprint momentum when compared with the other sports (handball, rugby).

Given the fact that there is a difference in the aforementioned variables between sports, as well as the specific requirements of the two previously mentioned team sports, it is very important to determine the differences in physical fitness between sports. Understanding these differences is crucial for developing sport-specific training programs to optimize performance and fill existing gaps in research, as studies involving female athletes remain underrepresented in sports science. Previous studies have examined differences between female athletes in various sports, but only one has specifically compared female soccer and handball players. Most existing research has either included additional sports, such as rugby, or primarily focused on anthropometric characteristics and body composition. However, there is a lack of studies that provide a comprehensive analysis both body composition and various physical fitness qualities, such as strength, speed and agility in these two groups of athletes. Studies with female participants account for only 20% of total sport and exercise science research, indicating several knowledge gaps still exist on this topic in general (Stankovic, Djordjevic, Trajkovic, & Milanovic, 2023). Furthermore, the level of performance necessary to be identified as an elite athlete could differ over the years as sports improve and players grow stronger and quicker (Fitzgerald, & Jensen, 2020). Thus, the purpose of this study is to examine and investigate differences in physical fitness among female football and handball players in the highest rank of competition.

MATERIALS AND METHODS

Participants

The sample included 39 elite female athletes, consisting of football and handball players, all competing at the highest level of competition (Super League). However, it is important to note that one participant had to withdraw from the study due to an injury sustained prior to or during the research process. Players were divided into two groups: handball players (N = 18, age 20.22 ± 4.67, body height 173.64 ± 4.71, body mass 69.73 ± 10.85) and football players (N = 20, age 21.79 ± 3.77, body height 165.70 ± 4.73, body mass 60.92 ± 8.04). All participants were informed about the purpose as well as the risks and benefits of the research. Each participant gave their written agreement to participate in the testing after being informed about the details. The testing procedure and regulations were explained to participants, sports professionals, and club management. Additionally, the club's management gave their approval for the data collected during testing to be used for scientific research. Recruited players had at least 5 years of sport (football and handball) experience, a history of regular training (more than 4 times per week) in the previous 12 months, a weekly training schedule of more than 7 hours, and no medical conditions that would prevent them from participating. The protocol was approved by the Ethics Committee of the Faculty of Sport and Physical Education, University of Niš, Serbia (protocol code 04-1769/2, date of approval 18th of October 2024).

Procedures

Measurements of the physical performance and anthropometric characteristics of participants were conducted in a multidisciplinary diagnostic centre, as well as in the club premises and testing lasted one day for each sport. The time period for measuring the aforementioned variables in both cases was from 9 to 11 a.m. Testing was done by the same measurers on both days, at the same tests. All participants performed a standard warm-up protocol which lasted 20 minutes and included consisting of running (6 min), dynamic stretching (5 min), progressive running (3 min) and change of direction (3 min). After this protocol participants performed the following in order: anthropometric assessments, followed by physical performance tests, starting with vertical jumps (CMJ, CMJ with arm swing (CMJa), SJ), 30 m sprint with time recorded at 10 m and 20 m, t-test, Zig-Zag test and Illinois test.

Anthropometric assessment

Martin's anthropometer GPM 101 (GPM GmbH, Zurich, Switzerland) was used to assess body height with an accuracy of 0.1 cm. The subjects stood in an upright position, barefoot on a firm surface, with their feet together, the measurer made sure that the anthropometer was in a vertical position along the back of the body and then lowered the sliding compass of the anthropometer to the top of the subject's head, the reading is made on the upper opening along the line that is the read indicator.

The following variables were collected after assessing body composition with the InBody instrument: body weight (BW), body mass index (BMI), body fat percentage (FM%) and muscle mass percentage (MM%). The InBody 770 instrument (InBody Co., Seoul, Republic of Korea) was utilized for the body composition assessments, and instrument validity has been demonstrated elsewhere (Gonzalez, Orlandi, Santos, & Barros, 2019). Furthermore, this approach has been used in research with adult elite athletes (Čoh, Vodičar, Žvan, Šimenko, & Maćkala, 2018; Stanković, Čaprić, Đorđević, Đorđević, & Sporiš, 2023).

Physical performance assessment

Speed (10m, 20m, 30m)

The speed assessment was performed using 10 m, 20 m, and 30 m sprint tests concordant to the described protocol (Zabalov et al.,2022). Photocells were used to estimate the speed for the 10, 20, and 30-meter sprint (Witty, Microgate, Italy). Participants repeated the speed test three times, and the fastest attempt was included in the statistical analyses. Photocells were placed at waist height, and the participants began the linear sprint. Test was performed by determining a 30-meter, players ran as fast as possible from the starting point to the last gate. Participants moved 1 m behind the first gate to prevent early gate activation. Testing was conducted after the intended warm-up. They had three attempts, the best result was taken for statistical analysis.

Agility Assessment (T-test, zig-zag and Illinois test)

Agility was assessed using Illinois, t-test, and zig-zag test. All tests were evaluated using a photocell system (Witty, System, Microgate, Bolzano, Italy).

In the t-test, three cones are placed in the same plane at a distance of 4.57 meters. The participant runs as fast as possible in a straight line from the gate to the first cone which is located in the middle at a distance of (9.14 m) and touches the top of the cone with his right hand, then with a lateral movement moves to the right cone (4.57 m from the middle cone), touches the cone with his right hand, touches the left cone with a lateral movement to the left, touches the middle cone again and then runs back to the starting position to pass through the gate. The reliability and validity were confirmed in a study (Pauole et al., 2000).

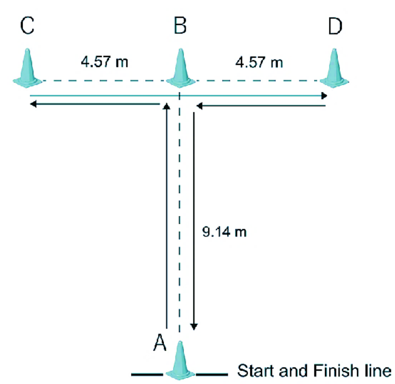

Figure 1. Agility T-test.

For the zig- zag test (ZZ) demands the examinee to complete what was planned in the shortest period of time. The test consists of four cones positioned at the corners of a rectangle (5 m x 4), with another cone put in the centre of it. If the cones placed at the corners are marked 1 to 4, starting from the longer side, and the central one is marked C, the test starts at cone 1, and continues running around the cones to C, 2, 3, C, 4, and back to 1. The participants took a standing start position, with both legs behind the starting line. Six cones were positioned at a 2-meter distance, with the first cone 1m from the starting line. Each examinee stood facing the starting line, legs apart. Following the signal, participants ran from the first cone to the second, moving around it with their right side. After that, they kept running around the cones, going left and right, until they came to the final one. They pivoted and proceeded to slap their way to the finish or starting line. The reliability and validity were confirmed in a study (Kutlu, & Dogan, 2018).

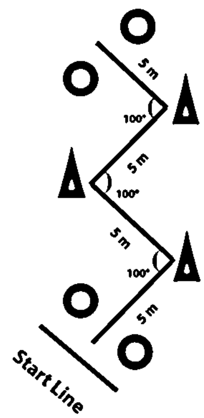

Figure 2. Zig-zag agility test.

Illinois agility test (IL), the participants start at the lower left cone, run in a straight line to the upper left cone, then go around it and return to the lower middle cone and begin slaloming, forming a figure eight. After leaving the figure eight, they run to the upper right cone, go around it, and finish the test at the lower right cone. The test is performed on a 10-meter-long and 5-meter-wide course, with four cones marking the start, finish, and turning points, and an additional four cones placed in the centre at 3.3-meter intervals to create the slalom section.

Participants were given three attempts to take each test, with two-minute rests in between. The rests between tests were three to five minutes. The reliability and validity were confirmed in a study (Hachana et al., 2013).

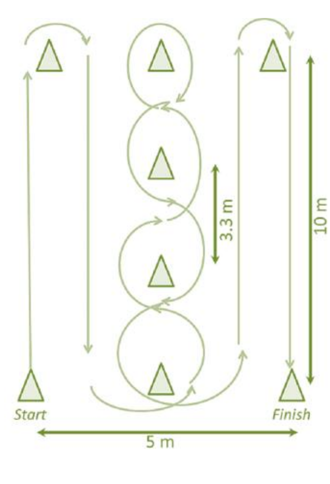

Figure 3. Illinois agility test.

The explosive strength of the lower extremities
Photoelectric cells (Optojump, Microgate, Bolzano, Italy) were used to assess the explosive strength of the lower extremities, the reliability and validity were confirmed in a study (Healy et al., 2016). The countermovement jump (CMJ) starts from a standing position with arms at the sides. Then, a flexion is performed in the knee joint without disturbing the previously mentioned position, and immediately after the extension in the knee joint, so that the body goes up and lands in the same place. The countermovement jump with arm swing (CMJa) is performed in the same way as the previously mentioned test but with the help of arm swing during the execution. Squat jump (SJ) starts from a squatting position with limited arm movement, hands are on the hips and then the subject jumps as high as possible. Each test is performed three times, with a rest between attempts were two minutes. These tests are valid and reliable to measure explosive power (Markovic et al., 2004).

Statistical analysis
Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS), version 20.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics, including mean values, standard deviations, and 95% confidence intervals, were calculated for all measured variables. The Kolmogorov-Smirnov test was used to assess the normality of the data, confirming that all variables followed a normal distribution. To compare body composition and motor abilities between the handball (HB) and football (FB) groups, independent samples t-tests were performed. Statistical significance was set at $p < .05$. Results are presented as mean ± standard deviation (SD) with 95% confidence intervals (CI). Cohen's d effect size was calculated to determine the magnitude of differences between groups, with thresholds of 0.2, 0.5, and 0.8 indicating small, medium, and large effects, respectively.

RESULTS

Table 1 presents the mean values and standard deviations of body composition variables, including participants' age, body height, body mass, body mass index, body fat percentage, and muscle mass for the handball (HB) and football (FB) groups. The results of the Kolmogorov-Smirnov test indicate that all variables have a normal distribution. Also, Cohen's d effect size was computed to assess the magnitude of differences between the groups.

Table 1. Descriptive statistics and group comparison of body composition variables.

	HB (N = 18)	**FB (N = 20)**	**K-S**	***p*-value**	**Cohen's d**
	Mean ± SD (95% CI)	Mean ± SD (95% CI)			
AGE	20.22 ± 4.67 (17.90-22.55)	21.79 ± 3.77 (20.70-22.88)	.851	.164	0.370
BH (cm)	173.64 ± 4.71 (171.29-175.98)	165.70 ± 4.73 (163.48-167.91)	.557	**.000****	1.682
BM (kg)	69.73 ± 10.85 (64.34-75.13)	60.92 ± 8.04 (57.15-64.68)	.879	**.000****	0.922
BMI (cm/kg^2)	23.04 ± 2.73 (21.68-24.40)	22.05 ± 2.57 (20.74-23.25)	.908	.266	0.373
%FM	27.62 ± 6.00 (24.63-30.60)	22.44 ± 6.14 (19.57-25.31)	.250	**.013****	0.853
%MM	32.18 ± 2.70 (30.83-33.52)	42.96 ± 3.43 (41.36-44.56)	.265	**.000****	3.492

*Note. N-number of participants; K-S-Kolmogorov Smirnov test; BH-body height; BW-body weight; BMI-body mass index; %FM-percentage of body fat; %MM-percentage of muscle mass; p < .05; ** p < .01*

Table 2 presents the mean values and standard deviations for motor abilities, in speed (10m, 20m, 30m), agility (TT, ZZ, IL), and jump tests (CMJ, CMJa, SJ) for the HB and FB groups. The Kolmogorov-Smirnov test confirmed that all data have a normal distribution. Additionally, Cohen's d effect size was calculated to determine the magnitude of differences between the groups.

Table 2. Descriptive statistics and group comparison of motor abilities.

	HB (N = 18)	FB (N = 20)	K-S	*p*-value	Cohen's d
	Mean ± SD (95% CI)	Mean ± SD (95% CI)			
10m (s)	1.89 ± 0.12 (1.83-1.95)	1.84 ± 0.16 (1.76-1.91)	.792	.254	0.353
20m (s)	3.33 ± 0.18 (3.24-3.42)	3.35 ± 0.22 (3.25-3.45)	.962	.778	0.099
30m (s)	4.75 ± 0.24 (4.63-4.87)	4.66 ± 0.20 (4.56-4.75)	.709	.201	0.407
TT (s)	10.69 ± 0.70 (10.34-11.04)	10.47 ± 0.38 (10.29-10.65)	.390	.233	0.390
ZZ (s)	6.08 ± 0.38 (5.89-6.26)	5.74 ± 0.32 (5.56-5.89)	.521	**.000****	0.968
IL (s)	16.99 ± 0.52 (16.85-17.40)	16.90 ± 0.79 (16.53-17.27)	.772	.745	0.134
CMJ (cm)	27.41 ± 3.57 (25.63-29.18)	25.84 ± 2.66 (24.60-27.08)	.694	.136	0.499
CMJa (cm)	32.47 ± 4.97 (30.00-34.94)	28.80 ± 3.40 (27.21-30.39)	.389	**.013***	0.862
SJ (cm)	25.07 ± 4.13 (23.02-27.13)	24.19 ± 2.77 (22.89-25.48)	.529	.448	0.250

*Note. N-number of participants; K-S-Kolmogorov Smirnov test; 10m-10 meters speed test; 20m-20 meters speed test; 30m-30 meters speed test; TT-T test; ZZ-Zig zag test; IL-Illinois test; CMJ-Countermovement jump; CMJa-Countermovement Jump with arm swing; SJ-Squat Jump; BH-body height; BW-body weight; BMI-body mass index; %F-percentage of body fat; %M-percentage of muscle mass; p < .05; ** p < .01*

The comparison between the HB and FB groups revealed significant differences in several body composition and motor abilities variables. The HB group had significantly greater body height (173.64 ± 4.71 vs. 165.70 ± 4.73; *p* = .00) and body mass (69.73 ± 10.85 kg vs. 60.92 ± 8.04 kg, *p* = .00). In terms of body composition, the HB group also exhibited a higher percentage of body fat (27.62 ± 6.00 vs. 22.44 ± 6.14; *p* = .01) and a lower percentage of muscle mass (32.18 ± 2.70 vs. 42.96 ± 3.43; *p* = .00) compared to the FB group. Regarding motor abilities, the HB group demonstrated significantly better results in the change of direction speed (ZZ test: 6.08 ± 0.38 s vs. 5.74 ± 0.32; *p* = .00) and the countermovement jump with arm swing (CMJa: 32.47 ± 4.97 cm vs. 28.80 ± 3.40; *p* = .01). However, no significant differences were observed between the two groups for the 10m, 20m, or 30m sprint times, agility tests (TT and IL), and other jump metrics such as the squat jump (SJ) and countermovement jump without arm swing (CMJ).

DISCUSSION

This research aimed to examine and investigate differences in physical fitness among female football and handball players in the highest rank of competition. The results of the conducted research indicated a significant difference in the parameters of body composition, primarily height, weight and fat percentage in favour of handball players, while the percentage of muscle mass was on the side of soccer players. Also, significant differences were found in individual tests, i.e. basic motor skills. The tests in which soccer players had statistically significantly better results was agility, that is, the zig-zag test, while handball players were better in explosive power, that is, the CMJ test.

The results of anthropometric measurements, height and weight, showed a significant difference in favour of the test subjects who practiced handball. These results are consistent with previous research (Milanese, Piscitelli, Lampis, & Zancanaro, 2012; Oyón, Franco, Rubio, & Valero, 2016). Which can be explained by highly selected athletes who are in accordance with the modern requirements of handball as a sports game, i.e. its specificities (Iacono, Eliakim, & Meckel, 2015). The specifics, first of all, of the longitudinal dimensions of the skeleton, must be as high as possible due to covering a large part of the field in defensive actions, but also in attack, where the largest number of shots directed at the opponent's goal end with high jumps in order to avoid blocking the opposing players and get into a more favourable position for a shot on goal (Gusic, Popovic, Molnar, Masanovic, & Radakovic, 2017). Also, differences in the percentage of muscle mass and fat were observed, where the percentage of muscle mass is significantly higher in soccer players, while the percentage of fat is statistically higher in handball players. The results obtained in this way are in accordance with the authors' earlier research (Hewitt, Norton, & Lyons, 2014; Mala, Maly, Zahalka, Bunc, Kaplan, Jebavy, & Tuma, 2015; Papaevangelou, Papadopoulou, Michailidis, Mandroukas, Nikolaidis, Margaritelis, & Metaxas, 2023). Where the average height values for female handball players ranged from 167cm to 176 while for male soccer players it was 164-167cm, the body mass of female handball players was on average from 63.1 to 72.5 kg while for female soccer players it was from 58.7 to 61.3 kg. The average body fat percentage was around 26, while the average body fat percentage was around 20. The authors also explain such results by the nature of the sport, i.e. female soccer players have much greater physical efforts over a longer period of time because the match itself lasts much longer, the field is larger, as well as the weight of the props, i.e. the ball used to play (Hewitt, Norton, & Lyons, 2014; Mala, Maly, Zahalka, Bunc, Kaplan, Jebavy, & Tuma, 2015; Papaevangelou, Papadopoulou, Michailidis, Mandroukas, Nikolaidis, Margaritelis, & Metaxas, 2023).

The results in the basic motor areas that were analysed did not always indicate the same results, that is, out of the three motor areas that were analysed with nine tests (three for each), only in the speed tests there were no statistically significant differences. The results of earlier research that determined the speed of the tests applied to the sample of this paper also showed that no statistically significant difference was observed (Saavedra, Kristjánsdóttir, Einarsson, Guðmundsdóttir, Þorgeirsson, & Stefansson, 2018; Freitas, Pereira, Alcaraz, Comyns, Azevedo, & Loturco, 2022). The reason for the results obtained in this way can be found in statistical analysis during football and handball matches where there is no difference in the percentage of time spent running a distance of 20-30 meters (Andrašić, Gušić, Stanković, Macak, & Trajković, 2021). Earlier research highlights that the specifics of sports games in the field of basic motor skills often lead to no statistically significant differences in the initial stages of action development. However, differences become apparent in certain segments of motor performance, influenced by the length of actions and the spatial demands unique to each sport. These variations underscore the impact of sport-specific requirements on the physical abilities of athletes (Popowczak, Cichy, Rokita, & Domaradzki, 2021; Freitas, Pereira, Alcaraz, Comyns, Azevedo, & Loturco, 2022). However, statistically significant differences between soccer players and handball players in favour of soccer players were shown in the zig-zag test. Female soccer players had better values in this test, earlier research also supports the obtained result (Popowczak, Cichy, Rokita, & Domaradzki, 2021; Freitas, Pereira, Alcaraz, Comyns, Azevedo, & Loturco, 2022). The explanation for such results can also be seen in the lower centre of gravity, which is more characteristic of female football players (Hewitt, Norton, & Lyons, 2014; Mala, Maly, Zahalka, Bunc, Kaplan, Jebavy, & Tuma, 2015), both because of the longitudinal dimensionality of the skeleton and because of the sport approach, but also in the higher body mass, which is more present in handball players, which can affect the speed of mobility, i.e. changes in the direction of movement at maximum speed (Hewitt, Norton, & Lyons, 2014; Popowczak, Cichy, Rokita, & Domaradzki, 2021). Also, a statistically significant difference was observed in the explosive strength parameter, specifically in the CMJ test, which, when exercising this subspace of basic motor skills, has the characteristic of activating the whole body. The results showed a statistically significant advantage in the height of this jump among handball players. The data obtained in this way can be explained by the specificity of the handball game, which in its technical and tactical elements has a fair amount of jumps with a shot or passing the ball, which primarily affects the development of the explosive strength of the whole body, which was also confirmed in earlier research (Gorostiaga, Granados, Ibanez, & Izquierdo , 2005; Iacono, Eliakim, & Meckel, 2015; Cichy, Rokita, & Domaradzki, 2021).

In accordance with the aforementioned, the advantage of this study is reflected in the application of sophisticated cutting-edge technology for determining the value of the monitored parameters of basic motor skills in soccer and handball players. In addition to these advantages, it can be pointed out that the sample of participants consisted of elite soccer and handball players of the senior category. Furthermore, the strength of this study lies in the fact that it encompassed a large number of physical fitness parameters, providing a detailed examination of this field among elite female athletes. Also, it should be emphasized that the same tests were used to assess the analysed motor skills, and that each of the motor fields was assessed in three different tests that included the same body segments. The obtained values enable completeness in providing information about the differences in the analysed fields of basic motor abilities for certain body segments in female competitors at the highest level of the senior category, which is important knowledge for fitness coaches in the formation of plans for basic motor preparation of players of different sports.

The limitations of this study can be reflected in the relatively small number of monitored players on whom the analysis was performed, that is, it would be recommended that a larger number of respondents be included in future research. Also, it is necessary to include a segmental analysis of body composition parameters because it is about sports where there is a difference in the dominance of the extremities used when performing sport-specific techniques. In addition to the above, as far as basic motor abilities are concerned, the inclusion of a larger number of motor fields would give an even more precise difference between these two groups of respondents-sports. While this study encompassed a large number of motor tests, adding additional tests could further enhance the comprehensiveness of the analysis. Since the focus is on physical fitness, future research could also include the assessment of cardiovascular endurance, as well as muscular strength and muscular endurance, to provide an even more complete insight into the differences between these athletes. By determining the limitations in more detail, it can be seen that the analysis of basic motor fields through field tests should cover both the upper and lower extremities as well as the whole body, as this would give a more complete insight into possible diversity.

Also, the surface on which the basic motor skills tests are performed, if they were the same, could have an even more precise effect on possible differences. This would create a complete picture within the basic motor area based on sport, level of competition and age selection. Such analysis could make it much easier for coaches and experts in the process of selection itself regarding the physical profiling of players for a certain sport, but also for fitness coaches who could have a lot of influence with their training plans on the preparation of athletes during certain levels of competitions and sports.

CONCLUSION

In conclusion, this study provides valuable insights into the differences in anthropometric and motor performance characteristics between elite female football and handball players. Significant differences were observed in body composition, with handball players being taller and heavier, while football players exhibited a higher percentage of muscle mass and lower body fat. These differences are likely influenced by the specific physical demands and tactical requirements of each sport. While there were no significant differences in sprinting performance, football players excelled in agility tests such as the zig-zag test, likely due to their lower centre of gravity and enhanced mobility. On the other hand, handball players demonstrated superior explosive strength in the countermovement jump with arm swing, reflecting the sport's emphasis on power for actions such as jumping and shooting. Our findings revealed that handball players were taller and heavier, while football players had a higher percentage of muscle mass and lower body fat, with football players excelling in agility and handball players demonstrating superior explosive strength. Overall, these findings emphasize the role of sport-specific demands in shaping athletes' physical and motor abilities, highlighting the importance of tailored training regimens to optimize performance in each discipline.

AUTHOR CONTRIBUTIONS

Conceptualization, M.S. and M.A.; methodology, D.R.; software, S.Đ. and B.K.; validation, I.J.; formal analysis, G.J.; investigation, D.R. and G.K.; resources, V.P.; data curation, M.A.; writing—original draft preparation, M.S. B.K.; writing—review and editing, S.Đ. and G.K.; visualization, M.S. and B.K.; supervision, M.S.; project administration, I.J. and V.P. All authors have read and agreed to the published version of the manuscript.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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