ORIGINAL ARTICLE

Comparison of Ball Throwing Velocity, Anaerobic Power and Some Anthropometric Characteristics of Team Handball Female Players in Terms of Playing Position

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ABSTRACT

Aim: The purpose of this study is to compare ball throwing velocity (BTV), counter movement jump (CMJ), anaerobic power, and some anthropometric characteristics among young and senior national female handball players (n: 54; age: 21.90 yrs).

Methods: Elite female handball players, who play in different playing positions (19 playmakers, 18 pivot and 17 wing) voluntarily participated in the study. Data were analysed in terms of BTV, CMJ, anaerobic power and some anthropometric characteristics (waist circumference, body mass index, arm span and hand length).

Results: Data were statistically described, and ANOVA test was used for the comparison. As a result of statistical analysis, there is no significant difference in waist circumference, anaerobic power, CMJ, hand length and mean BTV values ($p>0.05$). On the other hand, there is a significant difference between playing positions in the BMI, and arm span values ($p<0.05$). The results of the study show that there is a significant difference between the wing players and the pivot players in terms of body mass index (BMI) values in favour of wing players (21.12, 22.97 respectively). There is a significant difference in the arm span length values between the playmakers and wing players in favour of the playmakers (173.52 cm, 164.88 cm respectively). There is no difference in BTV, CMJ, anaerobic power, waist circumference, and hand length values.

Conclusion: As a result, there are significant differences in some anthropometric characteristics among the elite female national handball players in the playing positions. These information might be helpful for the assessment and evaluation of talents and may help to develop and optimize position-specific training regimes and identification of talents.

Keywords: Anthropometry, ball throwing velocity, counter movement jump, handball

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INTRODUCTION

Modern elite team handball consists of two 30-minute halves separated by a half-time break of 15 minutes. It is characterized by repeated accelerations, sprints, jumps, shots, rapid changes of direction, and a high number of physical confrontations (e.g., tackles and screenings) with opponent players[1,2]. Handball is a game with a large number of explosive movements, therefore, the emphasis is on the anaerobic capacity of the players. However, the significance of the aerobic capacity should not be disregarded[3]. In handball, distances covered at high speed are short. Functional aerobic capacity is the dominant metabolic pathway. However, due to the movements peculiar to handball; strength, velocity and acceleration directly affects the game performance[4].

Handball is a strenuous intermittent team sport with specific requirements for anthropometric characteristics, technical skills, tactical understanding, and physical performance. Recent rule changes and the implementation of the "fast center" have placed greater physical demands on handball players[5]. Determining the characteristics of the game zones in handball is important in terms of scouting, determining the profile of the players and planning suitable methods of training. Because, playing in different zones requires different physical and motor features. Therefore, handball players are mostly qualified according to the zone they play in[6, 7, 8, 9, 10, 11]. In modern handball player model, specific anthropometric characteristics play a supportive role in helping athletes perform better under the actual competitive conditions. More specifically, body height, body mass, hand width and hand length are important in improving athletes' performance and are considered as basic criterion for athletes' selection in various playing positions[12, 13, 14].

Anthropometrical measures of handball players were analyzed in several studies which point out specific positional differences in some measures[12,15]. There were many studies about anthropometric measurements (body height, body weight, body fat), fitness tests (maximum heart rate, 30-m sprint, handgrip, vertical jumps, standing jump and Counter-movement jump, Sit & reach and Yo-Yo Intermittent Endurance Tests), offensive and defensive playing actions (fast breaks, hard tackles, shots, fast running, walking, sprinting, sideways movement, jogging etc.). There is a close relationship between anthropometric data, physical performance characteristics, and the playing position of handball[16]. These parameters were examined in handball players[17, 3, 7, 19, 20, 2, 11, 21]. Karpan et al[17]. stated that there was significant difference in some physiological parameters about heart (VO_{2max} and Hr_{max}) among playing positions (age: 22.8±5.3yrs; female handball players). On the other hand, there were some studies about the

relationship between ball throwing velocity (BTV) and anthropometric and some fitness tests values.

Throwing is considered as one of the most crucial technical skills in handball as it is a major determinant of all actions taken by the players[22,8]. Throwing in handball, refers to movements in transferring the strength to hands occurred during the movements of the body segments and catching the ball and thus releasing the ball. Previous studies show that the BTV is the main performance factor determining the throwing movement[24,25,15]. Throwing velocity has been demonstrated to be a further important skill because a high throwing velocity requires a shorter reaction time of defenders or goalkeepers[26]. Many studies related to handball demonstrate that there is a high relation between lower extremity explosive power and ball velocity[25, 5]. In handball, goal throw velocity and throw hit are key elements in scoring. This is connected with technique, coordination and the capacity of lower-upper extremities to gather strength[27]. Throw velocity values differ by physical profiles of the players[28, 29], their sportive levels (elite, amateur) and handball game zones[30, 31]. There are different shooting types (three-step shot, jump shot and dive shot) in handball. The techniques in these shooting types are different from each other. For this reason, ball throwing velocity also changes in terms of tactic situations. Different methods and tools (radar, photocell system, camera and motion analysis system) are used to measure ball velocity. Studies show that ball velocity values vary between 57.6 - 93.6 km/hour[32, 27, 30, 33, 9]. The most frequently used shooting type in handball is three-step shot[34]. Besides, this shot is the type of shooting with the highest velocity[25].

The purpose of this study is to compare BTV, CMJ, anaerobic power and some anthropometric characteristics *(waist circumference, BMI, arm span and hand length,)* during the 3 step running throw in young and senior national female handball players considering their playing positions (wing players, pivots, playmakers).

MATERIALS & METHODS

Fifty-four elite female handball players (mean: 21.90 years old) [playmaker n: 19 height: 174.37±4.19; weight: 66.63±5.70, pivot n:8, height: 172.39±6.16; weight: 68.67±6.43], wing players n: 17 height: 1684.12±4.37; weight: 59.94±4.60] took part in the study.

Body height was measured using a portable stadiometer *(SECA, Leicester, UK).*

Body weight was determined by Tanita HD-351 (Japan) brand body fat analyzer.

Hand length: Hand length and arm span were measured by a ruler and were expressed in centimetres. Participants were asked to put their hands on a flat surface as their fingers closed. The length between the tip of the middle finger and wrist line was measured. The participants leaned back to the wall with their arms are laterally open and parallel to the ground. The distance between their right and left middle fingertips were measured.

In order to measure the waist circumference of the volunteers, they were asked to be barefoot in anatomic postures when they had t-shirt and shorts on. The smallest diameter between the arcus corticum and the anterior superior of the processus spinailia has been measured by a gullick meter. The values specified as centimetres.

Anaerobic Power (AP) was calculated by the following formula: AP: [$\sqrt{4.9}$ x body weight x $\sqrt{D}$] (D: jump altitude) [35].

Counter Movement Jump Test: Height of each jump was calculated using Ergojump *(Bosco System, Globus, Italy).* Participants were asked to jump with double feet vertically without an obligation to bend knees, and their hands are on their waist. After 1 minute break, each participant performed three trials upward vertically with maximum power. The best of three trial was recorded and expressed in centimetres[36]. Throwing technique: It was measured on a handball court in 1 situation: a 3-step running throw. The participants were asked to take the three steps as big and fast as possible before throwing the ball onto a target 9 meter away from the goal. The contra-lateral leg of the throwing hand was steadily planted on the ground.

Ball throwing velocity: All players were instructed to throw with a standard ball. For senior and junior female, a standard, number 2 ball (54-56 cm perimeter, 325-375 g) was used for the throw velocity tests. After a preparatory throw, subjects performed 2 throws with a 1-minute break between each trial. The maximal throwing velocity was determined by a Sports Radar Gun *(Sports Radar 3300, Electronics Inc, USA).* The fastest throw was used for the analysis.

Ethics committee report was obtained from Bilecik Şeyh Edebali University Ethics Committee before the study started (2021/11037). After all volunteers were verbally informed before they were included in the study, their voluntary permissions were taken in written paper.

Statistical Analysis: All statistical analyses were conducted in Statistical Package for the Social Science (SPSS) (Version 17.0 for Windows). Normality of the data was tested with the Shapiro-Wilk test and homogeneity of variance was tested with the Levene test. In the statistical analysis of the data obtained, Anova was used for the data showing normal distribution, and post-hoc test (Bonferoni) was used. Statistical significance was set at $p<0.05$.

RESULTS

			n	$\bar{x}$	sd	f	p
		Playmakers	19	173.52	4.50	6.60	0.00*
Arm Span(cm)		Pivot	18	170.66	8.10		
		Wing	17	164.88	8.34		
		Playmakers	19	19.31	0.88	2.55	0.08
Hand Length (cm)		Pivot	18	18.94	1.34		
		Wing	17	18.52	0.79		
		Playmakers	19	28.20	2.20	3.02	0.05
Waist Circumference(cm)		Pivot	18	29.27	1.71		
		Wing	17	27.71	1.82		
		Playmakers	19	21.77	1.90	4.42	0.01*
BMI(kg/m^2)		Pivot	18	22.97	2.29		
		Wing	17	21.12	1.19		
		Playmakers	19	79.05	8.33	2.92	0.06
Throw Velocity(km/h)		Pivot	18	78.44	7.30		
		Wing	17	72.64	10.17		
		Playmakers	19	106.38	20.76	1.48	0.23
Anaerobic Power(kgm/sec)		Pivot	18	111.57	23.48		
		Wing	17	99.450	17.81		
		Playmakers	19	32.36	6.94	0.07	0.99
CMJ(cm)		Pivot	18	32.44	7.20		
		Wing	17	32.17	6.03		

Table 1. Results of ANOVA Test
*p<0.05

Table 2. Results of Bonferoni Test

		Playmakers	**Pivot**	**Wing**
Arm Span(cm)		173.52±4.85^{w}	170.66±8.10	164.88±8.34^{pm}
Hand Length(cm)		19.31±0.88	18.94±1.34	18.52±0.79
Waist Circumference(cm)		28.2±2.20	29.27±1.71	27.71±1.82
BMI(kg/m^2)		21.77±1.90	22.97±2.29^{w}	21.12±1.19^{p}
Throw Velocity(km/h)		79.05±8.33	78.44±7.30	72.64±10.17
Anaerobic Power(kgm/sec)		106.38±20.76	111.57±23.48	99.45±17.81
CMJ(cm)		32.36±6.94	32.44±7.20	32.17±6.03

PM: There is statistically significant difference with regards to the playmaker zone. W: There is statistically significant with regards to the wing zone. P: Similarly, there is statistically significant difference with regards to pivot zone.

DISCUSSION AND CONCLUSION

The purpose of this study is to compare ball throwing velocity, CMJ, anaerobic power and some anthropometric characteristics *(waist circumference, BMI, arm span and hand length,)* during the three-step shot in young and senior national female handball players considering their playing positions (wing players, pivots, playmakers).

Significant differences were found among playing positions in the BMI and arm span values (Table 1). The results of the study shows that there is a significant difference between the wing players and the pivot players in the BMI values in favour of wing players (21.12, 22.97, respectively). In addition, there is also a significant difference in the arm span values between the playmakers

and wing players in favour of the playmakers (173.52 cm, 164.88 cm, respectively) (Table 2).

In another study on female handball players of under 18, players were separated into groups. The results of the study presents that there are significant differences among the groups in terms of body weight, fat percentage and muscle percentage[37]. Zapartidis et al. (2009) stated that there was significant difference in arm span, hand length and BMI[8]. They found that wing players had were the best BMI values. Playmakers had the longest arm span and hand length. In addition, playmakers had the highest ball throwing velocity among the other players (age: 14.12±1.09 yrs; n: 181; female handball players). Zapartidis et al[23]. (2011) stated that there was significant difference in ball throwing velocity and some anthropometric parameters *(body height, BMI, arm span, hand length, standing long jump, 30-m sprint, flexibility,VO $_{2max}$).* They found that wing players were shorter, low weight and BMI. In addition, they found that playmakers and wing players were the best in standing long jump, 30-m sprint, flexibility, VO $_{2max}$ tests compared to the other players (age: 14.3 yrs, male handball players).

Other studies also state that wing players move more intensely during the game compared to the playmakers and pivots[20, 2, 11]. The results of this study go along with the results of the previous studies in the literature. In a study conducted with the Norwegian national female handball team, the results show that playmakers and pivots had the highest values, and goalkeepers had the lowest values in terms of game load. On the other hand, playmakers comes as the first, then pivots, wings and goalkeepers come respectively in terms of high intensity moves[38]. Another study was conducted with 176 handball players who play in the first league and national team. The study concludes that playmakers had higher throwing velocity than the other players. It also shows that wing players had faster and better jumping values than the pivots and goalkeepers. Furthermore, the study reveals that playmakers and wings are better in relative strength values. Pivots were reported to be better than wings for bench press values[10]. On the other hand, as a result of the statistical analysis of this study, there were no significant differences among the playing positions in terms of ball throwing velocity, CMJ, anaerobic power, waist circumference, and hand length values ($p>0.05$).

Taşkıran & Şahin (2000**)** stated that there was no significant difference in some motoric tests *(explosive force and speed)* among the athletes (goalkeeper, pivots, wing and playmakers) in the Turkish national female handball players (20.87±2.01 years old) [39]. In a grouped study with 18 years old and younger female handball players, no significant difference was found among groups in anaerobic strength values[37]. The results of this study are parallel with the findings of our study with regards to anaerobic strength. We consider the reason why no difference was found in anaerobic strength values among game zones is that all of the players participated in our study are national team and elite players. Another reason for this is the fact that it was the camp season for the players during the study, and thus they had high level performance.

On the other hand, Rivilla-Garcia et al. (2016) composed groups of players from three different levels (elite, national and amateur). They also decomposed these groups as distant throw group (playmakers) and close throw group (wings and pivots). They found out that playmakers of all three levels shoot faster compared to the pivots and wings[31]. Shalfawi et al. (2014) stated that playmakers had higher throwing velocity compared to players of others positions. Besides, they concluded that pivots could also shoot faster compared to the wings and goalkeepers[30]. Even though there are differences among game zones in terms of throwing velocity, the results were found to be statistically not significant in our study (Table 2).

The literature shows that throwing velocity is related with the physical properties of the players; the heavier and taller players can shoot faster with the mass action[28, 29]. In addition, it was stated that there was a positive relationship between body height, body weight, hand and arm span length, and BTV values in a three-step running throw in elite female handball players[9].

Other studies also report that the difference in throwing velocity is seen among professional and amateur handball playes, that elite players show better throwing performance[40, 31]. Other studies conducted with the female handball players also show that throwing velocity value of the elite handball players is better in three different shooting types (standing, running, three-step jumping) compared to the others[41, 42]. Handball players were tested in seven different teams in a study which examined anaerobic strength values determined by Wingate test. The study shows that anaerobic strength values of the handball players in top ranking teams are better compared to the others[43]. Another study with the same purpose also accomplished similar results. Anaerobic strength values of the handball players of the teams which won the European Championship or the teams which took part in this organisation are higher than the handball players of the teams in the lower ranks. Besides, tall stature, body mass with low fat percentage, and anaerobic strength are emphasized to be very important determinant physical fitness values[44].

We commentate that there is no significant difference was found with regards to the ball velocity values among game zones is due to fact that all of the handball players took part in our study are national team players at elite level.

In the recent study, it is seen that there was a significant difference between the wing players and the pivots in the body mass index values in favour of wing players. In addition, it is seen that there was a significant difference in the arm span values between the playmakers and wing players in favour of the playmakers. In terms of some parameters, results of our study contribute the similar studies in the literature. Consequently, according to the recent research, when the playing positions are considered, significant differences were found in some anthropometric characteristics. On the contrary, there is no difference in the waist circumference, ball throwing velocity, anaerobic power and hand length values among the elite female national handball players. Our data demonstrated a close relationship of anthropometric data, and the playing positions in handball. These information might be helpful for the assessment and evaluation of talents and may help

to develop and optimize position-specific training regimes and identification of talents.

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