

ORIGINAL SCIENTIFIC PAPER

Differences in Specific Power Performance among Playing Positions in Top Level Female Handball

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Abstract

Since all activities in handball should be performed as fast and as powerful as possible, power is involved in almost all players' movements. There is an evident lack of studies that monitored this ability during matches. The study aimed to determine the situational differences in power among playing positions in top-level female handball. Variables included: body height, average game time, fastest shot, fastest sprint, and highest jump. Subjects were 227 female handball players that participated in the European handball championship 2020. Analysis of variance with the post-hoc Scheffe test was calculated. Results showed significant differences among playing positions in body height, fastest sprint and highest jump performed in real game situations. The largest differences were noticed in anthropometrics, with significant differences between back- and pivot-players on one side, and wing-players on the other. The fastest sprinting was recorded for wingers (26.5 ± 1.12 km/h), who were significantly faster than other players. Jumping performance was most diverse among playing positions, with back-players being superior in this performance (47.24 ± 17.61 cm, 48.44 ± 20.71 cm, and 50.35 ± 16.76 cm for centre-backs, left-backs, and right-backs, respectively). Evidenced differences are explainable knowing the specific positions' roles and typical game situations which players encounter during the match.

Keywords: *jump, sprint, shoot, back player, wing player, pivot player*

Introduction

Handball is a team sports game with specific morphological, technical, tactical and physical demands (Karcher & Buchheit, 2014). In two teams, 14 players play against each other, exchanging offensive and defensive manoeuvres on a 40x20 m court, with the main goal being to outscore the opponent. From a physical point of view, the game is fast and explosive, brimming with high-intensity movements (Barbero, Granda-Vera, Calleja-González, & Del Coso, 2014). Even the performance of the main technical elements is significantly influenced by power abilities (Hespanhol Junior, Giroto, Alencar, & Lopes, 2012; Póvoas, Seabra et al. 2012).

Power is defined as the ability of an athlete to recruit as many motor units as possible in as short a time as possible (van der Kruk, van der Helm, Veeger, & Schwab, 2018). In various sports, it manifests itself in specific explosive movement patterns (Šimonek, Horička, & Hianik, 2017). The most common

manifestations of power in handball are specific jumps, throws, shots, runs and sprints (Karcher & Buchheit, 2014). Jumps can be performed with one or two legs. Two-legged jumps are typically used to defend in block jump actions, while one-legged jumps are a constitutive part of jump shot executions (Srhoj, Rogulj, Papić, Foretić, & Čavala, 2012). Depending on the game situation and playing position, players also perform long or vertical jumps (Davila, Garcia, Montilla, & Ruiz, 2006). Long jumps are performed on individual fastbreaks and on shots from the wing positions, while vertical jumps dominate on shots from the outside positions (Vila et al., 2012). Although throwing is one of the natural forms of movement in handball, it is specifically performed during shots. Shots can be executed from the ground or after jumping. Shooting speed is one of the most important individual characteristics of players (Sarvestan, Riedel, Gonosová, Linduška, & Přidalová, 2019). Research shows that shots from the ground are signifi-



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cantly faster than shots from the jump (Šibila, Pori, & Bon, 2003; Saavedra, Halldórsson, Kristjánsdóttir, Forgeirsson, & Sveinsson, 2019). Handball players run at different intensities. The "handball sprint" is the fastest of them and is usually noticed when a player runs in an individual fastbreak, where he/she has to run over the defender. Although it is called "sprinting", it is not, because "sprinting" is a synonym for maximum speed, which can only be developed after running sixty meters. The handball court is only 40 metres long and does not allow a player to develop maximum speed. Therefore, the term "handball sprint" refers to the power rather than the speed of the player.

As mentioned earlier, the playing positions in handball have different roles that influence the positional differences in morphology and physical fitness (Karcher & Buchheit, 2014; Wagner, Finkenzeller, Würth, & Von Duvillard, 2014). One of the abilities that is most pronounced at the different positions is power. More specifically, the characteristics of shots and jumps differ especially among backcourt, wing and pivot players (Foretić, Veršić, Uljević, Pavlinović, & Modrić, 2021). Specific playing position morphology may also be an important factor for power actions in handball. For example, a review of the literature suggests that body mass or height can significantly improve a player's shooting speed (Massuça & Fragoso, 2013; Gümüş & Gençoğlu 2020; Foretić et al., 2021).

It is obvious that power is of great importance for successful performance in handball. Therefore, a rational and effective conditioning plan in handball should be based on current data on the specific and situational power load that players endure in real game situations at their playing positions. However, a review of the current literature shows that there is a lack of data on situational power activities during a handball game. Most studies were conducted under controlled conditions and evaluated only basic and very rarely specific power performance in handball, mostly in male players.

Therefore, the main aim of this study was to determine the differences in situational power performance between the six playing positions in top female handball.

Methods

The subjects of this study were 227 female handball players participating in the 2020 European Handball Championship in Denmark. Variables included basic anthropometric data: body height (BH) and body weight (BW), fastest shot (FS), fastest sprint (FSP), highest jump (HJ), average playing time (AM). All data was collected from the official championship website.

Shooting speed, sprint and jump performance were collected with iBall (SELECT, Denmark) and Player Tracking System (Kinexon, Germany). PTS is ultra-wideband local positioning system that assess specific movements in handball (Fleureau, Lacome, Buchheit, Couturier, & Rabita, 2020). The system used consisted of 14 antennas positioned around the handball playing field at three different heights. The tag is placed in the centre of the players' upper back using the manufacturer harness. The data were collected at 20 Hz and processed via the specific Kinexon Software. The signals were transmitted to the antennas using UWB technology in a frequency range of 4.25–7.25 GHz. The field position of the tag is calculated by a proprietary algorithm based on a combination of different methods such as Time Difference of Arrival, Two-Way Ranging and Angle of Arrival (Blauburger, Marzilger, & Lames, 2021). A 12-camera Vicon motion analysis system (Vicon Nexus T40,

Vicon Motion Systems, Oxford Metrics, UK) is implemented in the two configurations. Data were collected at 250 Hz. Only one 14 mm reflective marker (B&L Engineering, Santa Ana, USA) is placed on the Kinexon tag. The data obtained from the three-dimensional marker position are used for further analysis. The loss of the marker signal is never longer than 25 successive images (i.e., 0.1 s) and automatically extrapolated with the Vicon 3D software using the marker position immediately before and after the loss. The average Vicon calibration errors (Image and World Error, respectively) are 0.09 and 0.17 mm for data collected in the centre of the field, and 0.08 and 0.16 mm for those collected on the side of the field. The original datasets from Kinexon were oversampled from 20 to 250 Hz for subsequent fine synchronization with Vicon data. Signals from both systems are filtered using a 3rd order zero phase shifting low pass Butterworth filter with a 10 Hz cut-off. Each pair of Kinexon and Vicon data sets for each movement repetition is manually synchronized to determine a common start and end. The distance travelled is then calculated as the sum of the instantaneous positions in the horizontal plane (x, y). Velocity and acceleration data are obtained by successive derivation and low pass filtering (10 Hz, 3rd order zero phase shifting Butterworth filter). Peaks in speed, acceleration and deceleration are calculated from the raw data and utilised for the analysis. They are respectively computed as the maximum mean speed, acceleration and deceleration over a 500 ms window (Aughey 2011, Buchheit & Simpson, 2017).

All players were divided into 6 playing positions: left wing (LW), right wing (RW), pivot (P), centre back (CB), left wing (LB) and right wing (RB). The ethics committee of the author's institution approved the research experiment.

Statistical analyses included calculation of descriptive statistical parameters (arithmetic means and standard deviations) and analysis of variance with post hoc Scheffe test to determine differences between playing positions in the observed variables. Statistica 13.0 (TIBCO Software Inc, USA) was used for all analyses and a p-level of 95% was applied.

Results

Table 1 shows the results of the descriptive statistics and the differences between playing positions calculated with the Scheffe test.

The analysis of variance showed significant differences between the playing positions in the following variables: BH, FSP, and HJ. No statistically significant difference was found in the variables representing fastest shot (FS) and average minutes spent in the game (AM). The range of playing time was from 23.12±16.62 (LB) to 28.53±13.12 (RW) minutes per game. Although there was no statistical difference in playing time, it can be observed that the line players (pivots and wings) play slightly more than the back players (about 3-5 minutes more). Although no statistical difference was found between playing positions in shooting speed, it is noted that P shoots the slowest and RB is the fastest compared to the other positions. It is also very interesting that RW players shoot faster than LB. The biggest differences were found in body height. Obviously, backcourt and pivot players have this morphological characteristic more pronounced than wing players. The best results in sprinting performance were obtained for wing players, with a significant difference between LW and RW and LB playing position. Faster sprinters were wing players who reached almost the same maximum speed (about 26.5 km/h). The analysis of spe-

Table 1. Descriptive statistics and differences between playing positions (post hoc Scheffe test)

VAR	All (N=227)	CB (N=41)	LB (N=49)	RB (N=37)	P (N=41)	LW (N=32)	RW (N=27)
	M±SD	M±SD	M±SD	M±SD	M±SD	M±SD	M±SD
BH (cm)	175.86±6.51	174.68±4.48 LB, LW, RW, P	179.92±4.73 CB, LW, RW	178.11±6.25 LW, RW	179.76±4.87 CB, LW, RW	169.81±4.20 CB, LB, RB, P	168.44±4.28 CB, LB, RB, P
FS (km/h)	89.29±23.83	92.29±23.57	88.98±35.57	98.89±7.43	82.15±20.16	83.78±23.61	89.48±10.78
FSP (km/h)	24.53±3.57	24.27±1.57	22.92±5.47 LW, RW	24.49±1.45	23.98±1.56	26.41±5.03 LB	26.52±1.12 LB
HJ (cm)	41.84±19.41	47.24±17.62 P	48.45±20.71 LW, P	50.35±16.76 LW, P	30.12±15.57 CB, LB, RB	33.84±19.50 LB, RB	37.26±15.56
AM (min)	25.88±14.44	23.44±13.32	23.12±16.62	25.40±11.32	28.34±15.54	28.41±14.73	28.53±13.12

Legend: All – all payers, CB – centre back, LB – left back, RB – right back, P – pivot, LW – left wing, RW – right wing, BH – body height, BW – body weight, FS – fastest shot, FSP – fastest sprint, HJ – highest jump, AM – average minutes

cific jumping performance shows that the back players jump higher than the line players. For example, the highest jumps were performed by RB (50.35±16.76 cm) and the shortest by P (30.12±15.57 cm). Overall, the line players jump on average 14.64 centimetres lower than the back players.

Discussion

Similar playing times for all playing positions, averaging 25.88 minutes per game, point to the high physical demands of modern women's handball at the highest level. Under these conditions, coaches are forced to divide playing time evenly among players and positions. In this way, injuries and poor performance due to fatigue can be more easily avoided.

Although the main aim of this study is to describe situational power performance in handball, the analysis of basic anthropometric characteristics can give a better insight into the differences between playing positions. The results show that wing players have a below average BH (169.12±4.24 cm), LB, RB and P players have an above average BH, while CB has an average BH (174.68±4.48 cm). Such positional differences have been found in previous studies (Granados, Izquierdo, Ibanez, Bonnabau, & Gorostiaga, 2007; Čižmek, Ohnjec, Vučetić, & Grujić, 2010; Bon, Pori, & Šibila, 2015). Overall, BH is one of the most important selection criteria in handball, especially for back and pivot positions. It is very difficult to play effectively in the backcourt position without having an advantage in BH, as the main task of BP is to shoot over big defenders (Urban & Kandrāč, 2013). Moreover, P players are constantly fighting for position through various types of phys-

ical contact with opposing defenders (Michalsik, Aagaard, & Madsen, 2013). In these colliding, pulling, checking and blocking activities, BH and body weight are very beneficial for P performance (Bojić-Čačić 2018). On the other hand, shorter BH of wing players is regularly associated with lower body mass (Burger, Foretić, & Čavala, 2015). Lighter players are faster and more agile and these abilities are most important for winger positions (Karcher & Buchheit, 2014). Therefore, the fastest sprinting was found in wing players in our study. This phenomenon is well described in the literature. For example, Haugen, Breitschädel and Seiler (2019) found that wing players differ from the other positions by superior 10-m and 40-m sprint times (Haugen et al., 2019). In a review study, Karcher and Buchheit (2014) found that wing players complete significantly more sprints than backcourt and pivot players (Karcher & Buchheit, 2014). In addition, Luig et al. (2008) reported that pivot players complete sprints over 5-7 m, backcourt players over 8 m, and wing players over 15-18 m (Luig, Manchado-Lopez et al. 2008). A longer running distance gives wing players a greater advantage in speed development. Together with the advantageous somatotype (shorter-lighter), the role of wing players, who are more involved in fast breaks and counterattacks during the game than the other playing positions, logically explains the difference in "handball sprint performance" (Foretic, Rogulj, N., & Papić 2013). Despite the fact that jumping is a very important element of handball, present in the techniques of defensive and offensive players, it has not been investigated in any study in real game situations in women's handball (Figure 1).

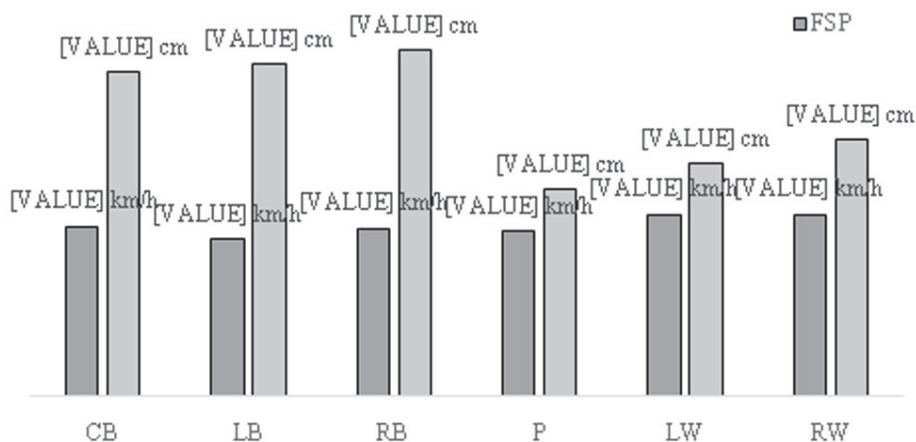


FIGURE 1. Distribution of fastest sprint (FSP) and highest jump (HJ) among playing positions

In our study, jumping shows the greatest diversity between playing positions compared to sprinting and shooting. In general, backcourt players jump 5 to 8 cm higher than P and wing players. Similar results were reported by Foretic et al. (2021), where male handball back players at the highest level jumped 16.76 cm higher than other playing positions (Foretic et al., 2021). On superficial inspection, this could be beneficial as most previous studies characterised wing players as the highest "jumpers" or at least at the same level as back players (Vila et al., 2012; Krüger, Pilat, Ückert, Frech, & Mooren, 2014; Hammami, Gaamouri, Aloui, Shephard, & Chelly, 2019). However, a more thorough analysis of the tasks, roles and technical activities at the back and wing positions could lead to a better understanding of this phenomenon. First, back players are the most involved in defensive and offensive actions of all playing positions and consequently jump the most. Secondly, the main task of back players during attack is to shoot over the defensive centre, where the tallest players are located (Foretic et al., 2013). To overcome these obstacles, they have to jump as high as possible before shooting. In contrast, wing players have to jump as far as possible. This is because they need to have an "open shooting angle" and thus increase the possibility of scoring (Foretic et al., 2013). In summary, backcourt players predominantly shoot with vertical jumps during situational activities, while wing players shoot with a horizontal jump (Póvoas, Seabra et al. 2012; Karcher & Buchheit, 2014). In this study, we only observed and analysed the vertical jump characteristics where backcourt players show dominance during a situational jump performance, while the previously mentioned studies evaluated the overall power performance.

The most interesting finding of this study is the lack of statistically significant differences in shooting speed between playing positions, although BP had a faster shooting speed than the line players (P and wing players). In contrast to our finding, many studies conducted on male and female handball players reported differences in shooting speed between playing positions (Rivilla-Garcia, Grande, Sampredo, & Van Den Tillaar, 2011; Zapartidis, Kororos, Christodoulidis, Skoufas, & Bayios, 2011; Ferragut, Vila, Abalades, & Machado, 2018; Foretic et al., 2021). Most of these studies reported a positive influence of longitudinal body measurements, such as BH (Gorostiaga, Granados, Ibanez, & Izquierdo, 2005; Sarvestan

et al., 2019). Despite the differences in BH, no differences in shooting speed were found in our study. This may be related to a curious fact that almost certainly affected statistical significance during data analysis: RW players shot faster than LB (RW 89.48 km/h vs LB 88.98 km/h). This is somehow an unexpected result, since in all previous studies BP had the fastest throwing and/or shooting performance (van den Tillaar & Ettema, 2004; Van Den Tillaar & Cabri, 2012; Ferragut et al., 2018). It becomes even more interesting when we see that RW are the shortest (168.44 cm) and BP the tallest (179.92 cm) players in top female handball. Understanding this phenomenon requires a deeper tactical analysis of shooting from the RW position. We can only speculate that RW players were involved in shooting situations that required quicker shots than from other line positions (P and LW). There is a possibility that RW players took shots at empty netters more than other positions, which is a very common result of an unsuccessful 7 vs 6 attack. Shots from these situations allow players to take quicker shots without tactical problem solving. However, as we mentioned earlier, these are only speculations and possible reasons for the observed phenomenon, which should be investigated separately in future studies along with some other influencing variables.

Conclusion

This study is the first study to describe situational power performance and determine the differences between playing positions in situational power performance in women's handball at the highest level. The results show significant differences between playing positions in height, sprinting, and jumping. The greatest differences were observed in jumping performance, where backcourt players jumped significantly higher than line players. The differences observed are related to the roles in the playing positions and the game situations in which the players in each position encounter. A limitation of the study is that only the best performance results in jumping, sprinting and shooting were analysed. Nevertheless, the results of this study may help handball coaches to better identify situational power demands in top female handball. In addition, the reported positional differences and similarities may contribute to more effective explosive power training in women's handball.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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