Original Article

Participation of the defender and actions of handball goalkeepers during throws from pivot and wing positions

PAWEŁ KRAWCZYK¹, SŁAWOMIR BODASIŃSKI²

¹Division of Physical Education and Sport, Medical University of Warsaw, Warsaw, POLAND

²Institute of Sports Games, Józef Piłsudski University of Physical Education in Warsaw, Białą Podlaską Branch, Białą Podlaską, POLAND

Published online: November 30, 2020

(Accepted for publication: November 22, 2020)

DOI:10.7752/jpes.2020.s6447

Abstract

The aim of the research was to analyse the actions of handball goalkeepers in the situation of throws from the pivot and wing positions depending on the contact of a throwing player with a defender. The research covered 11 goalkeepers played in PGNiG Men's Super-League. The research material was a video recording of goalkeeper saves (96 matches) during throws from an pivot position (n=451) (throw without contact with defender n=270, throw in contact with defender n=181) and wing position (n=524) (throw without contact with defender n=433, throw in contact with defender n=91). Contact with the defender was categorized into groups: without contact, in contact with the defender. The observation method categorized according to Norkowski's concept was used. The following parameters were registered: type of save (after reducing the defensive area within the stance, after reducing the defensive area with a step out/dive, without reducing the defensive area within the stance, without reducing the defensive area with a step out/dive), the moment of the initiation of the save (earlier (anticipation), fast-paced after a delay, and late), the accuracy of the goalkeeper's movement relative to the ball's trajectory (correct direction and height; correct direction, wrong height; wrong direction, right height; wrong direction and height), save technique (correct, inadequate) and effect of the save (unsuccessful (goal), successful (defended throw)). Mann-Whitney U test was used to compare the parameters. There are difference in goalkeepers' actions between throws with and without contact with defender from pivot positions. There is no difference between the effectiveness of saves from pivot positions. There are difference between goalkeepers' actions in the wing positions throws depending on the contact with the defender. There are a difference in the effectiveness of the save depending on the contact with the defender in throw from wing positions (successful effect of the save: without contact with defender-33.41%, in contact with defender-55.74%, $p<0.01$). The presented results suggest that contact with the defender differentiates the actions of goalkeepers.

Key words: save, effectiveness, performance, analysis, players

Introduction

Trends in modern sport indicate the increasing involvement of scientific research and its results in the training process in order to improve sports performance. Studies focus on technical, tactical, motor and psychological preparation, and also include quantitative and qualitative analysis of games. This is evident in many coaching staffs that include statisticians dealing with targeted analysis.

The analysis of the literature shows that studies focus on the multifaceted analysis of sportsfight in handball. Many authors point to changing tendencies in handball, both in attack and in defence. The analyses of sports fight include men's teams (Ferrari, Sarmanto&Vaz, 2019; Gryko, Bodasiński, Bodasińska& Zieliński, 2018; Prieto, Gomez &Sampaio, 2015; Bilge, 2012), women's teams (Skoufas, 2019; Milanovic, Vuleta&Ohnjec, 2018; Yamada, Aida, Fujimoto&Nakagawa, 2014) and youth teams (Hianik, 2008). The literature on the subject also includes studies differentiating sportsfight between senior and youth teams (Ferrari, Vaz, Sousa, Couceiro& Dias, 2018). Many researchers focus on the search for factors that differentiate sports results achieved by teams (Molfetas, Hatzimanouil, Papadopoulou, Skandalis&Vrabas, 2019; Konstantinos, Elissavet, Panagiotis, Ioannis&Konstantinos, 2018, Milanovic et al., 2018; Pic, 2018; Krawczyk, 2015, Ferrari, dos Santos &Vaz, 2014). The studies conducted so far indicate a strong, negative relationship between throwing velocity and effectiveness (Vila, Zapardiel&Ferragut, 2020). In the handball literature, there are works analysing the game of players in various positions, including in pivot and wing positions. The reports have so far focused on the descriptive analysis of throws from the wing and pivot positions depending on the level of game (Gryko et al., 2018; Curitianu&Neamtu, 2014; Bilge, 2012), match results (win-lose) (Milanovic et al., 2018; Karastergios, Skandalis, ZapartidisandHatzimanouil, 2017; Celes, Vojvodican&Skender, 2014; Ferrari et al., 2014), as well as the number and effectiveness of throws (Hatzimanouil, Giatsis, Kepesidou, Kanioglu&Loizos, 2017; Hansen et al., 2017). Research also indicates the most common places in the goal at which throws from these positions are directed (Hatzimanouil, 2019b; Costa et al., 2017).

Previous studies have indicated differences in the number of goals thrown from the pivot and wing positions at top-level events (Gryko et al., 2018; Bilge, 2012) and differences in the number of unsuccessful throws in won and lost matches (Molfetas, 2019; Milanovic et al., 2018; Celes et al., 2014). Analyses show a greater number of actions finalised from the wing position, as well as their higher effectiveness among teams with a high sports level (Almeida, Merlin, Pinto, Torres & Cunha, 2019; Bajgoric, Rogulj, Cavala & Burger, 2017). The presented research results on throws from the pivot and wing positions show that both their number and effectiveness are different for championship tournaments and teams of different sports levels. Also the results showing that the effectiveness of throws from the indicated positions differentiate the final result of the match, this issue should be addressed in order to determine the causes of unsuccessful throws. The results of the analyses undertaken can be used to optimize sport training. The handball literature also includes works focusing on the analysis of the effectiveness of saves performed by handball goalkeepers in percentage terms (Bilge, 2012). Research indicates a difference in the effectiveness of saves in won and lost matches (Karastergios et al., 2017; Daza, Andres & Tarrago, 2017; Saavedra, Porgeirsson, Kristjansdottir, Chang & Halldorsson, 2017). The literature also includes studies examining the effectiveness of a goalkeeper's game depending on the goal sector at which a throw is directed (Hansen et al., 2017). Scientific reports indicate differences in the effectiveness of defences in throws from the pivot and wing positions at World Cup tournaments (Gryko et al., 2018; Hansen et al., 2017). The literature on the subject also includes works showing a difference in the number of throws saved by goalkeepers depending on the place and tactical situation of a throw (Hatzimanouil et al., 2017), and the defence system used (Gkagkanas, Hatzimanouil, Skandalis, Dimitriou & Papadopoulou, 2018). Šliz and Dziadek (2017) indicate an increase in the effectiveness of defences in throws from the first line (from over the goal area) and penalty throws, and a decrease in the situation of throws from the wing position and in a quick attack in the last 19 years. Krawczyk et al. (2020) prove that there is a difference in the actions of goalkeepers saving throws from the position of field players (first and second lines) depending on the contact of a throwing player with a defender, which, in a way, indicates the need for further research on throws from other positions.

In addition to the descriptive analysis of sports fight in handball, scientific reports focus on throwing players. The literature on the subject indicates a higher effectiveness of throws performed without contact with a defender than in contact in the situation of throws from the second line. Throws from the first line are more effective in the situation of contact of a thrower with a defender than without it (Zapardiel et al., 2019). Wagner et al. (2010) prove that players throwing in contact with a defender use different throwing techniques and decide on the direction of the throw based on the actions of the defender and goalkeeper. Studies show a decrease in the ball's flight velocity when defenders and goalkeepers are highly active (Rivilla-Garcia, Calvo and van den Tillaar, 2016; Rivilla-Garcia, Grande, Sampedro and van den Tillaar, 2011). Research conducted by Baena-Gonzalez et al. (2020) also shows that in a handball match many goals are scored when a throwing player contacts a defender, which indicates that players' actions are analysed at the time of physical contact with an opponent.

The analysis of sports fight in handball indicates specific predictors influencing sports results, which make it possible to observe game trends. On their basis, conclusions can be drawn and activities aimed at optimising the training process at various stages of training can be carried out. Research to date on playing in the pivot and wing positions indicates the need to deepen the knowledge through further analysis of various aspects of the game. The analysis of the game of handball goalkeepers focusing only on the assessment of the final effect (effective-ineffective) is insufficient (Hatzimanouil, 2019a) as it does not indicate reasons for ineffective saves, which can be eliminated in individual work with players. Differences in throws performed without and in contact with a defender also indicate the need for further exploration of this issue in reference to the pivot and wing positions. It is also necessary to look for differences in the actions of goalkeepers in these tactical situations of the game. The presented research results indicate that contact with a defender is a factor that differentiates both the technique of the throw and its effectiveness, which indicates the specific actions that a handball goalkeeper must take in order to save effectively. Research by Krawczyk et al. (2020) indicate high differences in actions, reasons for ineffective interventions, and in the effectiveness of interventions in the situations of throws from backcourt positions depending on the contact throwing player with the defender. The observed results suggest that an attempt should be made to determine which handball goalkeepers' actions in the situations of pivot and wing throw are the most effective and which mistakes are the most common causes of ineffective interventions. In addition, the results presented above indicate that the assessment of the game of handball goalkeepers', which only includes the effectiveness of the game as a percentage, is insufficient, as it does not make it possible to determine which mistakes of the goalkeepers' game are the cause of the goal loss. Understanding the reasons for ineffective interventions may constitute the basis for undertaking specialized training of goalkeepers in order to eliminate them and increase the effective defense coefficient.

In connection with the results presented, the aim of the research was to analyse the actions of handball goalkeepers in the situation of throws from the pivot and wing positions depending on the contact of a throwing player with a defender.

Methods

Participants The research covered 11 goalkeepers who played in PGNiG Men's Superligue (Poland) in the 2015/2016 sport season. Four goalkeepers were members of the national team, while seven of them played only

in club teams. The average age of the subjects was 30.45 ± 5.45 . The professional experience of the goalkeepers involved in the research was 19.82 ± 5.55 .

Measurements The research material was a video recording of goalkeeper saves (96 matches) during throws from an pivot position ($n=451$) (throw without contact with defender $n=270$, throw in contact with defender $n=181$) and wing position ($n=524$) (throw without contact with defender $n=433$, throw in contact with defender $n=91$). At the time the data was collected, inaccurate throws and those in which the thrower was fouled with the referee stopping the game were not included. The video complies with the guidelines of the Handball Association in Poland. The video registered the defender's participation during the attacker's throw. It was divided into two groups: throw without contact with the defender and throw in contact with the defender.

The observation method categorized according to Norkowski's concept was used (Norkowski, 1996, 1997; Krawczyk et al. 2019, 2020). The following parameters were registered: type of save (after reducing the defensive area within the stance, after reducing the defensive area with a step out/dive, without reducing the defensive area within the stance, without reducing the defensive area with a step out/dive), the moment of the initiation of the save (earlier (anticipation), fast-paced after a delay, and late), the accuracy of the goalkeeper's movement relative to the ball's trajectory (correct direction and height; correct direction, wrong height; wrong direction, right height; wrong direction and height), save technique (correct, inadequate) and effect of the save (unsuccessful (goal), successful (defended throw)).

Statistical analysis The gathered data was subjected to statistical analysis. We determined basic statistical characteristics: mean, standard deviation and percentage calculations. Due to the qualitative nature of the data, nonparametric tests were carried out for comparisons between the groups. The Mann-Whitney U test was performed to compare the parameters in two independent groups. Statistical significance was set at $p < 0.05$. The eta-square (η^2) was used to determine the effect size [ES] (< 0.01 -no effect, 0.01 - 0.059 -small effect, 0.06 - 0.139 -intermediate effect, > 0.14 -large effect) (Cohen, 1988). All statistical analyses were performed using Statistica and Microsoft Office Excel software.

Results

Data on the actions of goalkeepers depending on the contact with a defender in the case of throws from the pivot position are presented in Table 1. The analysis of the table shows statistically significant differences between the studied groups of throws in saves after reducing the defensive area within the stance ($Z = 2.99276$, $p < 0.01$, $ES = 0.461$) and without reducing the defensive area within the stance ($Z = -3.14328$, $p < 0.01$, $ES = 0.5$). Analysing the moment of the initiation of a save, significant differences can be noticed in the earlier moment of the initiation of a save ($Z = 3.1688$, $p < 0.01$, $ES = 0.51$), a fast-paced save after a delay ($Z = -2.21816$, $p < 0.05$, $ES = 0.276$) and in late save ($Z = -2.28858$, $p < 0.05$, $ES = 0.291$) depending on a thrower's contact with a defender. Table 1 shows statistically significant differences in the accuracy of a goalkeeper's movement with respect to the ball trajectory in the analysed groups of throws. The differences occur in the correct direction and at the correct height of a save ($Z = -2.7463$, $p < 0.01$, $ES = 0.397$), and in the wrong direction and at the wrong height of a save ($Z = 2.78151$, $p < 0.01$, $ES = 0.406$). There are differences in the number of defences performed in the right direction and at the wrong height in the situation of a throw without and in contact with a defender, and their statistical significance is close to the adopted threshold of $p = 0.052$. The analysis of Table 1 shows that the effectiveness of saves is 23.19% in throws without contact with a defender and 37.40% in throws in contact with a defender. However, this is not a statistically significant difference.

Table 1. The actions of goalkeepers in throw from pivot position depending on contact with a defender

Goalkeepers' actions	1	2	p-value	ES
	Mean $\pm$ SD [%]	Mean $\pm$ SD [%]		
Type of save				
after reducing the defensive area within the stance	87.51 $\pm$ 9.69	67.93 $\pm$ 12.81	$p < 0.01$	0.461
after reducing the defensive area with a step out/dive	2.42 $\pm$ 2.50	0.93 $\pm$ 2.05	ns	0.113
without reducing the defensive area within the stance	6.00 $\pm$ 6.82	19.92 $\pm$ 8.34	$p < 0.01$	0.5
without reducing the defensive area with a step out/dive	4.08 $\pm$ 4.96	11.16 $\pm$ 10.57	ns	0.182
The moment of the initiation of the save				
earlier (anticipation)	74.09 $\pm$ 13.47	47.66 $\pm$ 14.71	$p < 0.01$	0.51
fast-paced save after a delay	8.10 $\pm$ 7.44	21.27 $\pm$ 13.49	$p < 0.05$	0.276
late	17.44 $\pm$ 10.80	31.08 $\pm$ 12.38	$p < 0.05$	0.291
The accuracy of the goalkeeper's movement relative to the ball's trajectory				
correct direction and height	49.16 $\pm$ 10.14	65.10 $\pm$ 11.39	$p < 0.01$	0.397
correct direction, wrong height	16.14 $\pm$ 8.61	9.11 $\pm$ 7.39	$p = 0.052$	0.22
wrong direction, right height	5.74 $\pm$ 7.14	11.36 $\pm$ 7.37	ns	0.201
wrong direction and height	28.96 $\pm$ 10.52	14.43 $\pm$ 7.20	$p < 0.01$	0.406

Range of goalkeeper's movement relative to the ball's trajectory

3300-----

optimal	74.20±15.61	80.87±10.64	ns	0.091
too small	13.93±10.74	11.02±8.53	ns	0.028
too wide	11.87±9.40	8.10±7.41	ns	0.064
Save technique				
correct	73.74±15.11	80.84±13.67	ns	0.091
inadequate	26.26±15.11	19.16±13.67	ns	0.091
Effect of the save				
unsuccessful (goal)	70.87±10.79	62.60±17.00	ns	0.095
successful (defended throw)	23.19±10.79	37.40±17.00	ns	0.095

1=throw without contact with the defender. 2=throw in contact with the defender. SD=standard deviation. ns=no significant. ES=effectsize

Data on the actions of goalkeepers depending on the contact of a throwing player with a defender in throws from the wing position are presented in Table 2. Analysing the type of save, it can be noticed that there are statistically significant differences in saves after reducing the defensive area within the stance ($Z = 2.81103$, $p < 0.01$, $ES = 0.461$), after reducing the defensive area with a step out/dive ($Z = 2.73505$, $p < 0.01$, $ES = 0.442$), and without reducing the defensive area within the stance ($Z = -3.72271$, $p < 0.001$, $ES = 0.717$) in the case of throws without contact and in contact of attackers with a defender. The data in Table 2 show statistical differences at the moment of the initiation of a save (earlier ($Z = 2.43116$, $p < 0.05$, $ES = 0.371$)) and in a fast-paced save after a delay ($Z = -3.26687$, $p < 0.01$, $ES = 0.582$) in the groups of throws under study. When analysing the accuracy of the goalkeeper's movement relative to the ball's path, the following parameters should be indicated: correct direction and height ($Z = -2.54512$, $p < 0.05$, $ES = 0.397$) and wrong direction and height ($Z = 2.01330$, $p < 0.05$, $ES = 0.283$) depending on a thrower's contact with a defender. There are also differences in the technique of goalkeepers' saves (correct ($Z = -2.84901$, $p < 0.01$, $ES = 0.417$), inadequate ($Z = 2.84901$, $p < 0.01$, $ES = 0.471$)) in the studied groups of throws. The data in Table 2 show statistically significant differences in the effectiveness of defences in the situation of a throw performed by attacking players without contact with a defender (33.41%) ($Z = 2.58311$, $p < 0.01$, $ES = 0.406$) and in contact with a defender (55.74%) ($Z = -2.58311$, $p < 0.01$, $ES = 0.406$).

Table 2. The actions of goalkeepers in throw from wing positions depending on contact with a defender

Goalkeepers' actions	1	2	p-value	ES
	Mean ± SD [%]	Mean ± SD [%]		
Type of save				
after reducing the defensive area within the stance	83.87±9.61	68.33±11.81	$p < 0.01$	0.461
after reducing the defensive area with a step out/dive	11.86±10.22	2.22±6.67	$p < 0.01$	0.442
without reducing the defensive area within the stance	2.99±3.78	29.44±11.93	$p < 0.001$	0.717
without reducing the defensive area with a step out/dive	1.28±1.53	0	ns	0.22
The moment of the initiation of the save				
earlier (anticipation)	71.32±8.06	47.65±20.95	$p < 0.05$	0.371
fast-paced save after a delay	12.57±8.46	41.48±18.29	$p < 0.01$	0.582
late	16.11±5.91	10.86±11.79	ns	0.099
The accuracy of the goalkeeper's movement relative to the ball's trajectory				
correct direction and height	56.65±7.47	71.06±10.28	$p < 0.05$	0.397
correct direction, wrong height	15.09±6.43	9.43±10.48	ns	0.171
wrong direction, right height	5.47±2.70	7.05±10.01	ns	0.099
wrong direction and height	22.78±9.04	12.45±9.00	$p < 0.05$	0.283
Range of goalkeeper's movement relative to the ball's trajectory				
optimal	81.32±9.84	91.39±10.69	ns	0.24
too small	10.49±6.36	6.44±9.59	ns	0.171
too wide	8.19±8.41	2.18±4.67	ns	0.254
Save technique				
correct	48.39±12.69	70.14±13.51	$p < 0.01$	0.471
inadequate	51.61±12.69	29.86±13.51	$p < 0.01$	0.471
Effect of the save				
unsuccessful (goal)	66.59±6.82	44.26±18.57	$p < 0.01$	0.406
successful (defended throw)	33.41±6.28	55.74±18.57	$p < 0.01$	0.406

1=throw without contact with the defender. 2=throw in contact with the defender. SD=standard deviation. ns=no significant. ES=effectsize

Discussion

The research results indicate differences in the actions of handball goalkeepers in the situation of throws from the pivot and wing positions, depending on the contact of a throwing player with a defender.

There are more saves after reducing the defensive area within the stance in pivot throws without contact with a defender, (87.51%) than in throws performed in contact with a defender (67.93%). The results also show a greater number of saves without reducing the defensive area within the stance (19.92%) in a situation of contact with a defender than without contact (6.00%). It can be presumed that in the absence of contact with a defender, a goalkeeper has a large defensive area, which he reduces by leaving it during a save. In the case of a throw in contact with a defender, the defender, through his actions, prevents a throw at certain sectors of the goal, which makes the goalkeeper's defensive area smaller. The research results showing a decrease in the ball's flight velocity during increased defensive actions (Rivilla-Garcia et al., 2016, 2011) and studies on the reaction time and motor time of handball goalkeepers indicating their high level (Przednowek et al., 2019; Krawczyk, Bodasiński, Bodasińska, & Słupczyński, 2018) may explain the fact that goalkeepers do not reduce the defensive area in the event of a throw in contact with a defender in order to extend the time needed to react. The same arguments may explain the differences in the moment of the initiation of a save (earlier-anticipation, a fast-paced save after a delay). The observed differences in delayed saves may indicate that at the moment of a defender's contact with a throwing player, goalkeepers wait for the throw-in to be prevented (the game is interrupted by a foul by a defender), which is why they may not be prepared for the save and surprised by the fouled player's throw. It can be presumed that this state of affairs may also be influenced by the fact that when pressure is exerted by defenders, throwing players use various throwing techniques (Wagner et al., 2010), which may also affect a greater number of late defences (the element of surprise).

The differences in the accuracy of the goalkeeper's movement relative to the ball trajectory between the studied groups of throws indicate that a defender's participation determines this element of save. When a throw is performed in contact with a defender, it is difficult for the throwing player to throw the ball at certain sectors of the goal, which means that the goalkeeper's defensive area is smaller, which may result in more saves in the right direction and at the right height (and fewer in the wrong direction and at the wrong height). When a throw is performed without contact with a defender, the goalkeeper has a larger defensive area, which may make it difficult to choose the correct direction and height of the save. In combination with a higher percentage of earlier defences, it gives more opportunities for a thrower to change the direction of a throw. The same arguments should explain the difference at the threshold of statistical significance between the studied groups in defences with the right direction and at the wrong height.

These results show a difference in the effectiveness of saves in throws without contact (23.19%) and in contact with a defender (37.40%), but this difference is not statistically significant. A high standard deviation (17.00%) in the group of throws in contact with a defender indicates that in this element there are large differences between the examined goalkeepers, proving that the group is not homogenous. As a result, there are individual differences between the examined goalkeepers. The research results obtained in the field of defence effectiveness correspond with the results of other authors (Karastergios et al., 2017). The results are higher than those obtained by other authors (24-27%) (Gryko et al., 2018; Saavedra et al., 2017), and the difference may be related to the sports level of throwing players and the tournaments of the highest rank (World Championships, Olympic Games). There are also studies reporting higher defence effectiveness scores (39.7%) (Hatzimanouil et al., 2017), which should also be explained by the difference in the sports level of throwing players and the difference in the level of games between the highest leagues in Poland and Greece.

The data presented in Table 2 show that an attacking player's contact with a defender at the time of a throw from the wing position differentiates the actions of goalkeepers during saves. Analysing the type of save, one can notice differences in the number of saves after and without reducing the defensive area within the goalkeeper's stance in the studied groups of throws. It may be presumed that during throws without contact with a defender, a goalkeeper increases the defensive area by shortening the distance to a thrower. When a throw is performed in contact with a defender, the defensive player closes certain directions of a throw and forces the thrower to throw within the goalkeeper's range of movement. The differences in the number of defences after reducing the defensive area with a step out/dive and without reducing the defensive area within the stance should also be explained by the structure and technique of a throw from the position of a winger, who moves towards the axis of the pitch by running and jumping in order to increase the throw angle (the most perpendicular position in relation to the goal, thus increasing the area in the goal at which the ball may be thrown). If a throw is performed without contact with a defender (where a winger's jump is not restricted), a goalkeeper must correct the position of a thrower, which is reflected in the results obtained in saves after reducing the defensive area with a step out/dive. If a throw is performed in contact with a defender, a winger has a limited jump, which means that the throw angle is small and so the throw is within the goalkeeper's range of movement, who does not have to correct the position relative to the thrower. The research by Krawczyk et al. (2019) also shows differences in the number of defences after reducing the defensive area with a step out/dive depending on the level of simple reaction time in the situation of a throw from the wing position, which indicates the future direction of research to determine if there are differences in the actions of goalkeepers in the situation of throws from the wing position with and without the participation of a defender depending on the level of straight reaction time.

Analysing the results concerning the moment of the initiation of a save, it is necessary to point out the differences in the number of earlier defences and a fast-paced save after a delay in the studied groups of throws. Research on the reaction time and motor time of goalkeepers (Przednowek et al., 2019; Krawczyk et al., 2018) may explain that in the situation of a wing throw without contact with a defender, the distance between a thrower and a goalkeeper is small enough to prevent the correct reaction. Therefore, goalkeepers anticipate their opponent's behaviour and intervene earlier in order to have time to perform a correct save. If a throw is performed in contact with a defender, a winger has difficulty throwing in certain sectors of the goal and jumping into the goal area (reducing the distance with a goalkeeper), which gives the goalkeeper enough time to react. Moreover, research indicates a decrease in the ball's flight velocity at the time of increased defensive actions (Rivilla-Garcia et al., 2016, 2011), which may also explain the higher percentage of fast-paced saves after a delay, in which a goalkeeper has sufficient time to react and perform a correct save. Krawczyk et al. (2019) also shows a trend in fast-paced saves after a delay when throws are performed from the wing position depending on the level of anticipation of direction, which should be taken into account in conducting future research on a holistic understanding of the mechanisms of handball goalkeepers.

Differences in the accuracy of the goalkeeper's movement relative to the ball trajectory occur between the studied groups of throws: correct direction and height, wrong direction and height. If a throw is performed without contact with a defender, a goalkeeper has a greater defensive area, and a thrower has increased possibilities of throwing in a certain direction, which may explain fewer saves in the correct direction and at the right height, and more in the wrong direction and at the wrong height. If a throw is performed in contact with a defender, a winger has limited possibilities of throwing into certain sectors of the goal, which makes it easier to determine the correct direction and height of the save. This may result in a high percentage of saves in the correct direction and at the correct height, and a lower percentage of saves in the wrong direction and at the wrong height.

The differences in the studied groups of throws in a goalkeepers' save technique should be seen in the large goal area to be defended in the event of a throw without contact with a defender and the possibility of throwing into a larger area of the goal. In a situation of a throw in contact with a defender, a winger has difficulty throwing in certain sectors of the goal, which reduces the goalkeeper's defensive area, at the same time facilitating the selection of an appropriate save technique due to the smaller number of variants of a throwing player's throw.

The effectiveness of a save in a throw without contact with a defender (33.41%) is lower than during a throw in contact with a defender (55.74%). The differences are statistically significant. Reasons for this should be seen in the limited freedom of a throw and a small throw angle in a throw performed in contact with a defender. It can also be presumed that this is the result of a greater number of defences in the right direction and at the correct height of the save, as well as the correct technique, which somehow confirms that the save is a sequence of mental operations, and the effect of the save is its last phase (Norkowski 1996). A high standard deviation in the group of throws in contact with a defender (18.57%) indicates a low homogeneity of the group and thus individual differences between the players included in the study. Comparing the average effectiveness of defences with other authors, it can be indicated that it is higher than in the research by Gryko et al. (2018), Hansen et al. (2017) and Saavedra et al. (2017). This can be explained by the difference in the levels of throwing players and the level of matches for which it was recorded (World Championships, Olympic Games). The obtained research results correspond with the results of Hatzimanouil et al. (2017). It is impossible to compare the research results in terms of the effectiveness of saves depending on the contact between a thrower and a defender as no such analyses have been found in the literature on the subject, which somehow confirms that this direction of analysis is correct.

The research results correspond with the results obtained by Krawczyk et al. (2020), which confirms that the contact between a thrower and a defender differentiates the actions of handball goalkeepers during saves. Therefore, these parameters should be taken into account in the conceptualisation of future research on the analysis of handball goalkeepers in order to take a holistic approach to the problem of playing in the discussed position, as well as to plan a specialised training process.

Limitations

The study included goalkeepers ($n = 11$) at a high sports level and at one level of competition (PGNiG Superliga). In order to analyse in depth and generalise conclusions, research should be carried out on a larger sample of goalkeepers and at various levels of competition, including major international events and lower leagues.

Conclusions

The analysis of the research results shows that the contact of a defender with a player throwing from the pivot and wing positions determines the actions of goalkeepers during saves. The indicated reasons for ineffective interventions in the situation of throws from the pivot and wing position, depending on the contact of the throwing player with the defender, constitute the basis for planning and organizing specialized goalkeeper training aimed at their elimination. In specialized goalkeeper training, technical and tactical actions of goalkeepers should be taken into account, depending on the contact between the throwing player and the

defender. The analysis of the effectiveness of goalkeepers' in throws from wing positions should be differentiated in terms of contact between the thrower and a defender. The presented results indicate that training and preparation for the competition should also be focused on the organization of a defensive game aimed at creating situations in which wing players throw in contact with a defender, which may translate into higher effectiveness of goalkeepers' saves. Further research should be carried out according to the adopted concept, depending on the place and tactical situation of a throw, and factors differentiating the actions of goalkeepers during saves and affecting their effectiveness should be searched.

Conflict of interest

Authors have declared that no competing interest exists.

References

- Almeida, A.G., Merlin, M., Pinto, A., Torres, R.S., & Cunha, S.A. (2020). Performance-level indicators of male elite handball teams. *International Journal of Performance Analysis in Sport*, 20(1), 1-9.
- Baena-Gonzalez, R., Lozano, D., Gallardo, A.M., Chavarria-Ortiz, C., & Garcia-Tascon, M. (2020). Influence of the handball goal anti-tip system through the game actions observation method: 2019 Four Nations International Handball Junior Tournament. *International Journal of Performance Analysis in Sport*, 20(3), 357-372.
- Bajgoric, S., Rogulj, N., Cavala, M., & Burger, A. (2017). Difference in attack situational activity indicator between successful and less successful teams in elite men's handball. *Sport Sciences for Health*, 13(1), 515-519.
- Bilge, M. (2012). Game analysis of Olympic, World and European Championship in Men's Handball. *Journal of Human Kinetics*, 35(1), 109-118.
- Celes, N., Vojvodic, M., & Skender, N. (2014). A Comparative analysis of shooting efficiency in handball at Euro 2012. *Sport Science and Health*, 4(2), 131-137.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.
- Costa, G.D.T., Pedrosa, G.F., de Souza, N.P., Gemente, F.R.F., Freire A.B., & Castro, H.D. (2017). Type of game practiced in handball according to the positions of the attackers: analysis of the Women's World Handball Championship 2015. *International Journal of Performance Analysis in Sport*, 17(3), 360-373.
- Curitianu, I., & Neamtu, M. (2014). A comparative study on the evolution of left wings, right wings and pivots at male handball teams H.C.M. Constanta and F.C. Barcelona in "Champions League" 2011-2012. *Procedia-Social and Behavioral Sciences*, 116, 3859-3863.
- Daza, G., Andres, A., & Tarrago, R. (2017). Match statistics as predictors of team's performance in elite competitive handball. *RICYDE. Revista internacional de ciencias del deporte*, 13(48), 149-161.
- Ferrari, W., dos Santos, J.V., & Vaz, V. (2014). Offensive process analysis in handball: Identification of game actions that differentiate winning from losing teams. *American Journal of Sports Science*, 2(4), 92-96.
- Ferrari, W., Sarmiento, H., & Vaz, V. (2019). Match analysis in handball: A systematic review. *Montenegrin Journal of Sports Science & Medicine*, 8(2), 63-76.
- Ferrari, W., Vaz, V., Sousa, T., Couceiro, M., & Dias, G. (2018). Comparative analysis of the performance of the winning teams of the Handball World Championship: senior and junior levels. *International Journal of Sports Science*, 8(2), 43-49.
- Gkagkanas, K., Hatzimanouil, D., Skandalis, V., Dimitriou, S., & Papadopoulou, S.D. (2018). Defense tactics in high-level teams in Beach Handball. *Journal of Physical Education and Sport*, 18(2), 914-920.
- Gryko, K., Bodasiński, S., Bodasińska, A., & Zieliński, J. (2018). Offensive and defensive play in handball in a 2-year world championship cycle: characteristics and tendencies. *Polish Journal of Sport and Tourism*, 25(3), 10-16.
- Hansen, C., Sanz-Lopez, F., Whiteley, R., Popovic, N., Ahmed, H.A., & Cardinale, M. (2017). Performance analysis of male handball goalkeepers at the World Handball championship 2015. *Biology of Sport*, 34(4), 393-400.
- Hatzimanouil, D. (2019a). Goalkeepers' rating, evaluation and classification, according to the number of games, participation time and effectiveness at the Women's European Handball Championship in 2018. *International Journal of Performance Analysis in Sport*, 19(3), 595-607.
- Hatzimanouil, D. (2019b). Throwing effectiveness per throwing area and playing position among high level handball players. *Journal of Physical Education and Sports Management*, 6(1), 13-20.
- Hatzimanouil, D., Giatsis, G., Kepesidou, M., Kanioglu, A., & Loizos, N. (2017). Shot effectiveness by playing position with regard to goalkeeper's efficiency in team handball. *Journal of Physical Education and Sport*, 17(2), 656-662.
- Hianik, J. (2008). Women U17 Handball Championship-Slovakia qualitative trend analysis. *Acta Kinesiológica*, 2, 22-29.

- Karastergios, A., Skandalis, V., Zapartidis, I., & Hatzimanouil D. (2017). Determination of technical actions that differentiate winning from losing teams in woman's handball. *Journal of Physical Education and Sport*, 17(3), 1996-1969.
- Konstantinos, N.S., Elissavet, R.N., Panagiotis, M.G., Ioannis, B.A., & Konstantinos, B.D. (2018). Performance indicators and competition ranking in women's and men's World Handball Championship 2017. *Journal of Physical Education and Sport*, 18(3), 1761-1766.
- Krawczyk, P. (2015). Technical errors and the venue of the match in handball. *Polish Journal of Sport and Tourism*, 22(1), 25-29.
- Krawczyk, P., Bodasiński, S., Bodasińska, A., & Słupczyński, B. (2018). Level of psychomotor abilities in handball goalkeepers. *Baltic Journal of Health and Physical Activity*, 10(3), 64-71.
- Krawczyk, P., Bodasiński, S., Bodasińska, A., & Słupczyński, B. (2019). The level of psychomotor abilities as a factor differentiating handball goalkeepers' action in saves from the wing position. *Polish Journal of Sport and Tourism*, 26(4), 3-10.
- Krawczyk, P., Cackowski, M., Dziubek, Ł. (2020). The participation of the defender and the actions of handball goalkeepers in the situation of throws from back court positions. *International Journal of Performance Analysis in Sport*, 20(3), 445-455.
- Milanovic, D., Vuleta, D., & Ohnjec, K. (2018). Performance indicators of winning and defeated female handball teams in matches of the 2012 Olympic Games Tournament. *Journal of Human Kinetics*, 64(1), 247-253.
- Molfetas, A., Hatzimanouil, D., Papadopoulou, Z., Skandalis, V., & Vrabas, I.S. (2019). Analyses of technical and tactical data in attack and defense at high level handball teams. *Journal of Physical Education and Sport*, 19(1), 193-200.
- Norkowski, H. (1996). *Handball – goalkeeper, rules, technique, tactics, training*. Warsaw: AWF, Polish.
- Norkowski, H. (1997). Goalkeeping in handball throwing situations. *Trening*, 1, 59-70, Polish.
- Pic, M. (2018). Performance and home advantage in handball. *Journal of Human Kinetics*, 63(1), 61-71.
- Prieto, J., Gomez, M.A., & Sampaio, J. (2015). From a static to a dynamic perspective in handball match analysis: a Systematic Review. *The Open Sports Sciences Journal*, 8(1), 25-34.
- Przednówek, K., Śliz, M., Lenik, J., Dziadek, B., Cieszkowski, S., Lenik, P., Kopeć, D., Wardak, K., & Przednówek, K.H. (2019). Psychomotor abilities of professional handball players. *International Journal of Environmental Research and Public Health*, 16(11), 1909.
- Rivilla-Garcia, J., Calvo, J.L., & van den Tillaar, R. (2016). Comparison of throwing velocity between first and second offensive line handball players. *Kinesiologia Slovenica*, 22(3), 5-15.
- Rivilla-Garcia, J., Grande, I., Sampedro, J., & van den Tillaar, R. (2011). Influence of opposition on ball velocity in the handball jump throw. *Journal of Sport Science and Medicine*, 10(3), 534-539.
- Saavedra, J.M., Porgeirsson, S., Kristjansdottir, H., Chang, M., & Halldorsson, K. (2017). Handball game-related statistics in men at Olympic Games (2004-2016): Differences and discriminatory power. *Retos: nuevas tendencias en educación física, deporte y recreación*, 32(2), 260-263.
- Skoufas, D. (2019). Game analysis of the last World's Championship in Women's Handball. *European Journal of Physical Education and Sport Science*, 5(4), 61-70.
- Śliz, M., & Dziadek, B. (2017). The analysis of changes of handball goalkeepers effectiveness during the European Men's Handball Championship between 2000 and 2016. *Scientific Review of Physical Culture*, 7, 105-112.
- Vila, H., Zapardiel, J.C., & Ferragut, C. (2020) The relationship between effectiveness and throwing velocity in a handball match. *International Journal of Performance Analysis in Sport*, 20(2), 180-188.
- Wagner, H., Buchecker, M., von Duvillard, S.P., & Muller, E. (2010). Kinematic comparison of team handball throwing with two different arm positions. *International Journal of Sports Physiology and Performance*, 5(4), 469-483.
- Yamada, E., Aida, H., Fujimoto, H., & Nakagawa, A. (2014). Comparison of game performance among European National Women's Handball Teams. *International Journal of Sport and Health Science*, 12, 1-10.
- Zapardiel, J.C., Vila, H., Manchado, C., Rivilla-Garcia, J., Ferragut, C., & van den Tillaar, R. (2019). Effect of opposition and effectiveness of throwing from first and second line in male elite handball during competition. *Kinesiologia Slovenica*, 25(1), 35-44.