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Original Article

Relationship between the numerical condition and court position in goal scoring in women's handball

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Abstract:
Introduction: Handball is characterized by the constant action of attacking and defending, using a common space in the court. In this highly dynamic sport, one of the main factors that affect performance is the numerical condition. Despite its importance, studies concerning female handball lacks investigations regarding the numerical condition and the court position during attacks. Thus, the present study aimed to analyze the relationship between the numerical condition and the court position during the shoots in female handball world championships. **Materials and Methods:** The analysis was performed using indirect observation of the match recordings. Twenty-five matches of the three last championship teams of the handball world championships were observed, and information regarding the numerical conditions (inferiority, superiority, and equality), and court positions during the attacks were collected. **Results:** The results showed that most of the shots were goals scored (57.6%), and most of the goals occur in numerical equality (80.6%). Brazil scored 55.2% (264 goals) of the occasions. France scored in 59.6% (238 goals), and Norway scored in 58.7% (193 goals). Also, there are differences between the numerical condition and the distance to the goalpost concerning the goals scored, but no differences were found between the numerical condition and the regions of the court, or goals scored and numerical condition of each team. **Conclusions:** The findings demonstrate that the numerical condition and the court position during female handball games can influence the shoots, being important variables to coaches and team preparation, which need to be taking to account during the season.Understanding this relationship can also be imperative for the organization of training and game planning. The studied variables show the main idea of the champion team's game model, being important to understand goals and winners in handball matches.
KeyWords: **Performance, data analysis, players, sport.**

Introduction

Study and interpreting the conditional and situational variables that underlyinghandballperformance is an important income for coaches to plan training sessions andprepare forcompetitions(Marcelino et al., 2012). Those performance indicators,collected from the selection of multiple action variables in team sports, can be used to analyze the team's performance.As an invasion team sport (based on the opposition between two teams, in which success depends on team action)(Prieto et al., 2015), handball is an intermittent sport whose manifestation of technique and tactics emerges from the players' interactions (cooperation and opposition)(Garganta, 2001). Characterized by the constant action of attacking and defending in a common space, handball is a complex, often unpredictable, and highly dynamic sport.

Factors such as fatigue and neuromuscular recovery (Ronglan et al., 2006),emotional states (Popovych et al., 2020), anthropometric profile (Milanese et al., 2011), injury prevention (Petersen et al., 2005), and performance indicators (Milanovic et al., 2018) are very important and often studied in female handball. One of the main factors that affect performance in sports is the numerical condition (Carabas, 2009), manifested in two ways: 1) numerical equality (i.e. when teams have the same number of players on the court or in a specific situation of the play); and 2) numerical asymmetry(when one team has a different number of players compared to the opponent, in a specific situation during the match). The most common relationships in handball are 6 vs. 6, 6 vs. 5, 5 vs. 6, and 5 vs. 5 with goalkeepers (since the change of the goalkeeper rule, the 7 vs. 6 and 6 vs. 6 game situations with the empty goal are becoming more common) (Prudente et al., 2019).Thus, these conditions can change the relationships between players, the creation of productive spaces and vulnerable regions

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(defensive and offensive), resulting in movement adaptations and different patterns of play. From the learning of the various variables of the game, the coach gathers information to build the team's game model, which can directly impact his actions with the team.

Even though studies concerning female handball do exist (Paula et al., 2020; Trejo-Silva et al., 2020), few wereperformed to study the numerical condition in female handball matches. Controversially, the results are not conclusive, since similar benefits to team performance were displayed in superiority and equality numerical conditions (Chirosa et al., 2012; Prieto et al., 2015). So, the real influence is not yet known.Trejo-Silva et al. (2020)analyzed the situations of numerical inequality due to exclusions in female handball tournaments and found that the winningteams showed a more efficient performance in their attack efficacy while playing in inferiority conditions. Prieto et al. (2015) found that fewer players on defense allow more spaces and less physical demands to the offensive team, providing better performance. Besides, the effects of court position on shoot performance also need further investigation since studies still show a discrepancy in results. Karastergios, Skandalis, Zapartidis, & Hatzimanouil (2017) showed that most of the shots were from the lateral region (left and right) compared to the center of the court. On the other hand, central region is preferred to score (Bilge, 2012; Costa et al., 2017; Ohnjec et al., 2008).

Assuming that this relationship can be essential for the organization of training and game planning, we believe thatis important to study how the relation of the numerical condition and the court position can affect game performance and shoot efficiency. This study aimedto analyze the relationship between the numerical condition and the court position during the shoots in female handball world championships. Specifically, were analyzed the position in court and the numerical conditions of the three champion teams in the last three different editions.

Material & methods

This study is a post-facto quasi-experimental study (Paula et al., 2020; Tenenbaum & Driscoll, 2005). Data were collected from games of 2013, 2015, and 2017Women's World Handball Championship. All matches were intentionally selected, andthe analysis was performed through indirect observation (the analysts watched the recordings for the data collection).

Participants

Our sample was chosen intentionally due to the small number of free videos from these competitions available on the internet, thus it was decided to analyze only the games of the winning teams in each edition. Twenty-five matches of the three last female's Handball World Championships were observed (Brazil, n=9; France, n=9; and Norway, n=7). All matches from the group and knock-out stage of the tournaments were used as samples. Two games of Norway cannot be found to analyze (Norway vs Kazakhstan and, Norway vs Puerto Rico).

Procedures

The notational process was performed by two blinded and independent researchers (the analysts – one former handball player and currently the assistant coach of a collegehandball team, and one Physical Education teacher with 8 years of experience). High scores for test-retest reliability between baseline and pre-training evaluations were obtained. An almost perfect (Landis & Koch, 1977) result was observed for intra-observer (0.822, p = .05) and inter-observer (0.901, p = .01). Thus, the analysts carried out the observation and evaluation of the variables of interest. In each match, all the offensive processeswere observed (n = 1206). An offensive processstarts at the moment the team recovers the ball possession until the moment the ball is lost (by shots oroffensive fouls, for example) (Prudente et al., 2019). To the purpose of the present research, the following variables were recorded: (a) shots (Goal; Goalkeeper save; and shots missed); (b) numerical condition (equality, superiority, and inferiority); and (c) position in court (see figure 1). Positions were transformed to provide further information of the: (1) Distance of the shot to the goalpost (P1, P3, and P6 = near to the goalpost; P2, P4, P5, and P7 = far from the goalpost); (2) the region of the court (P1 and P2 = left; P3, P4, and P7 = center; P5 and P6 = right). As all games are freely available on the internet and television, informed consent is not necessary. Also, the study was conducted under the Helsinki Protocol.

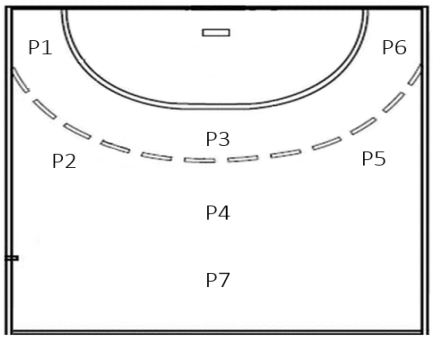

Figure 1. Scheme showing the court positions **Source:** the authors .

Statistical analysis

Descriptive analysis was used to characterize the data collected. Due to the nature of the variables (numerical conditions, court position, and shots), nonparametric statistical tests were used. An intra-class correlation coefficient (ICC) was used to determine test-retest reliability between baseline and pre-training values. Reliability was interpreted according to Landis and Koch's (Landis & Koch, 1977) scales as: <0.00 poor, 0.0–0.2 slight, 0.21–0.4 fair, 0.41–0.6 moderate, 0.61–0.8 substantial, and 0.81–1.0 almost perfect. Chi-square tests were used to understand the associations between the variables. The Software Statistical Package for Social Sciences TM (SPSS 25.0) was used, and in all analyses, the alpha level was set at .05.

Results

During the 2013 edition, Brazil outperformed their group opponents (10 points in total). In the knockout stage, Brazil won four matches (8 points). Brazil scored 264 goals during the tournament. In the 2015 edition, Norway qualified for the final stages with 8 points in the group stage, and in the knockout had four wins. Norway scored 238 goals in total. In the last analyzed edition, France made 7 points in the qualifiers, and inthe knockout stagewon four games. The French team alsoscored 193 goals during the tournament. Table 1 shows that, regardless of teams, more than three-quarters of the shots occur during numerical equality conditions.

Table 1. Descriptive values of shoots concerning the numerical condition of the attack.

	Numerical Condition	Shots	%
Brazil	Equality	382	79.9
	Superiority	54	11.3
	Inferiority	42	8.8
	Total	478	100.0
France	Equality	335	84.0
	Superiority	41	10.3
	Inferiority	23	5.7
	Total	399	100.0
Norway	Equality	255	77.5
	Superiority	42	12.8
	Inferiority	32	9.7
	Total	329	100.0
Total	Equality	972	80.6
	Superiority	137	11.4
	Inferiority	97	8.0
	Total	1206	100.0

The results showed that of the 478 shots recorded, Brazil scored in 55.2% of the occasions, France scored in 59.6% (238 goals), and Norway scored in 58.7% (193 goals). Table 2 presents the descriptive values of the shoots, showing the differences found among the three national teams.

Table 2. Descriptive values of shoots about attack definition.

	Attack definition	Shots	%
Brazil	Goal	264	55,2
	Goalkeeper saves	130	27,2
	Goals missed	84	17,6
	Total	478	100,0
France	Goal	238	59,6
	Goalkeeper saves	104	26,1
	Goals missed	57	14,3
	Total	399	100,0
Norway	Goal	193	58,6
	Goalkeeper saves	93	28,3
	Goals missed	43	13,1
	Total	329	100,0
Total	Goal	695	57,6
	Goalkeeper saves	327	27,1
	Goals missed	184	15,3
	Total	1206	100,0

Table 3presents the relationship between goals and the numerical condition of each national team. The results showed that the three teams scored more often during numerical equality situations. Besides, no differences were

found between goals scored and the numerical condition, analyzing the three teams separately [x^2 (4) = 5.484, p = .241]. Cramer's V indicates that there is no association between the variables (Cramer's V = .063, p =.241).

Table 3. The relation between goals scored and the numerical condition by the team.

			Team			Total
			Brazil	France	Norway	
Numerical Condition	Equality	n	210	206	153	569
		Within Numerical Condition	36,9%	36,2%	26,9%	100,0%
		Within Team	79,5%	86,6%	79,3%	81,9%
	Superiority	n	32	19	25	76
		Within Numerical Condition	42,1%	25,0%	32,9%	100,0%
		Within Team	12,1%	8,0%	13,0%	10,9%
	Inferiority	n	22	13	15	50
		Within Numerical Condition	44,0%	26,0%	30,0%	100,0%
		Within Team	8,3%	5,5%	7,8%	7,2%
Total		n	264	238	193	695
		Within Numerical Condition	38,0%	34,2%	27,8%	100,0%
		Within Team	100,0%	100,0%	100,0%	100,0%

Our data also provide results concerning the distance of shots to the goalpost. Table 4 shows the relation of the goals scored and the distance to the goalpost for each team. Differences among the three teams were found [x^2 (2) = 10.591, p = .005], showing that Brazil scored more goals close to the goalpost, compared to the other two teams. Cramer's V indicates association between the variables (Cramer's V = .123, p =.005).

Table 4. The relation between goals scored and the distance to the goalpost by the team.

			Team			Total
			Brazil	France	Norway	
Distance to the goalpost	Near the goalpost	n	191	143	139	473
		Within distance to the goalpost	40,4%	30,2%	29,4%	100,0%
		Within Team	72,3%	60,1%	72,0%	68,1%
	Far from the goalpost	n	73	95	54	222
		Within distance to the goalpost	32,9%	42,8%	24,3%	100,0%
		Within Team	27,7%	39,9%	28,0%	31,9%
Total		n	264	238	193	695
		Within distance to the goalpost	38,0%	34,2%	27,8%	100,0%
		Within Team	100,0%	100,0%	100,0%	100,0%

Analyzing the attacking about the regions of the court, differences were found among the three teams [x^2 (2) =9.722, p =.044], showing that most of the goals scored occur in the centerof the court. Cramer's V indicates association between the variables (Cramer's V = .084, p =.044).

Table 5. The relation between goals scored and the region of the court by the team.

			Team			Total
			Brazil	France	Norway	
Regions of the court	Left	n	42	57	34	133
		Within regions of the court	31,6%	42,9%	25,6%	100,0%
		Within Team	15,9%	23,9%	17,6%	19,1%
	Central	n	184	135	127	446
		Within regions of the court	41,3%	30,3%	28,5%	100,0%
		Within Team	69,7%	56,7%	65,8%	64,2%
	Right	n	38	46	32	116
		Within regions of the court	32,8%	39,7%	27,6%	100,0%
		Within Team	14,4%	19,3%	16,6%	16,7%
Total		n	264	238	193	695
		Within regions of the court	38,0%	34,2%	27,8%	100,0%
		Within Team	100,0%	100,0%	100,0%	100,0%

Data independently the teams were also analyzed. Table 6 shows there are differences between the numerical condition and the distance to the goalpost concerning the goals scored [x^2 (2) =, p =.026]. The results showed that most of the goals were scored near to the goalpost, despite the numerical condition. Cramer's V indicates association between the variables (Cramer's V = .103, p =.026).

Table 6. The relation between goals scored regarding the numerical condition and the distance to the goalpost.

			Near the goalpost	Far from the goalpost	Total
Numerical Condition	Equality	n	379	190	569
		Within Numerical Condition	66,6%	33,4%	100,0%
		Within distance to the goalpost	80,1%	85,6%	81,9%
	Superiority	n	62	14	76
		Within Numerical Condition	81,6%	18,4%	100,0%
		Within distance to the goalpost	13,1%	6,3%	10,9%
	Inferiority	n	32	18	50
		Within Numerical Condition	64,0%	36,0%	100,0%
		Within distance to the goalpost	6,8%	8,1%	7,2%
Total		n	473	222	695
		Within Numerical Condition	68,1%	31,9%	100,0%
		Within distance to the goalpost	100,0%	100,0%	100,0%

The relations between the numerical condition and the regions of the court are present in table 7. No statistical differences were found [x^2 (4) =, p =.481]. Cramer's V indicates that there is no association between the variables (Cramer's V = .050, p =.481).

Table 7. The relation between goals scored regarding the numerical condition and the region of the court.

			Left	Central	Right	Total
Numerical Condition	Equality	n	103	370	96	569
		Within Numerical Condition	18,1%	65,0%	16,9%	100,0%
		Within regions of the court	77,4%	83,0%	82,8%	81,9%
	Superiority	n	19	43	14	76
		Within Numerical Condition	25,0%	56,6%	18,4%	100,0%
		Within regions of the court	14,3%	9,6%	12,1%	10,9%
	Inferiority	n	11	33	6	50
		Within Numerical Condition	22,0%	66,0%	12,0%	100,0%
		Within regions of the court	8,3%	7,4%	5,2%	7,2%
Total		n	133	446	116	695
		Within Numerical Condition	19,1%	64,2%	16,7%	100,0%
		Within regions of the court	100,0%	100,0%	100,0%	100,0%

Discussion

The relationship between the numerical condition and the court position during the shoots in the female handball world championship was analyzed. Our findings suggest that there are important considerations for the teams' game model.The Brazilian team shot close to the opposing goalpost, mainly in the central region of the court (which presupposes great participation of the pivot). Also, despite creating many opportunities for goals, the Brazilian team had the highest score of missed goals (see table 2).The French team showed a slight preference for the left region of the court, shot from long distances, and presented thehighest score of goals scoredwhen compared to the other teams.The Norwegian team, on the other hand, presented a better balance between the right and left regions of the court, and a preference for short distance shots (with greater participation of the wing players).These findings revealed different strategies that led the teams to win the championship, based on the characteristics/potential of the players of each team. However, there is no ideal game model, but one that best meets the demands of each team (and in a very particular way).

Our results showed that most of the goals occur during numerical equality conditions (80.6%). Although have more players in the court permit huge variations and less physical effort, our results did not show advantages when teams are in numerical superiority. The reasons are many: the number of attacks in numerical asymmetry(or superiority) was lower than numerical equality,which involves huge physical demands (i.e., strength, stamina, movement variations, and speed), and players can't use it often during games; and it is difficult to have many superiority conditions because most of the defenders are close to their goalposts.

Contrary to what was presented in table 3, the numerical superiority condition improves the team's scoring performance, and that this is not affected by match status or quality of opposition(EHF, 2012; Prieto et al., 2015).The time played in each condition is not the same, and the numerical equality represented the largest proportion of ball possessions in handball games (and superiority/inferiority conditions occur, mostly, during

fastbreak situations or players' exclusion)(EHF, 2012). Our results showed that during numerical equality, teams seek the imbalance of the opposing defenders, especially from actions that allow them to finish from regions close to the goalpost (see table 6) and from the central region of the court (see table 7), which reinforce the importance of coordinated actions between the playmakerand the pivot. Thus, if the majority of playing time occurs during numerical equality, it is plausible to expect a more significant number of shots and goals to be during this condition.

Studying men's handball matches inthe 2017 World Championship, Prudente et al. (2019)showed that the players' movement patterns are different according to the numerical condition. The authors' results revealed that the center back's playing patterns change depending on the numerical condition; when playing with seven court players (7 vs. 6), the attacking team usually uses two pivots;in numerical equality with the defense and empty goal, the playmaker opted for greater security and less risk of loss of the ball. Chirosa et al. (2012) showed that the decision-making process in handball is related to the numerical condition of the teams.

Innumerical equality conditions, players can process better the available information on the court, improving their decision making. On the other hand, situations of offensive numerical inferiority increase the pressure on attackers, hindering the choice for the best decision and, consequently, and the development of individual and team actions. Our results following Chirosa et al. (2012), by showing that the numerical inferiority provides just 7.2% of the goals and that 66.0% of the goals during attacking in numerical inferiority conditions occur in the center of the court (see table 7). These results can be alsoassociated with the actions involving the pivot (directly or indirectly).

The numerical inferiority must be trained to improve players' and teams' performance (Prieto et al., 2015). The authors claimed that handball coaches should design specific practice tasks simulating all numerical conditions to benefit their athletes. From the results found, we believe that training sessions should consider these situations, both in the offensive and defensive phases, to improve shot performance, especially in offensive numerical superiority and inferiority. In fact, (1) in numerical equality, the teams scored from regions closest to the goalpost. This data shows the importance of the pivot and wing players for the conclusion of the offensive actions and, also, for the creation and exploration of productive spaces to attack; (2) in numerical superiority, results revealed shots from regions closer to the goalpost, which reinforces the importance of the wings and pivots, either to shot or to support in the creation and exploration of spaces for the approach of other players (i.e., right back, playmakerand left back); (3) in numerical inferiority, long shots were common, perhaps due to the difficulty of infiltration by the playmaker, the marking closer to the wing players and the double marking against the pivot, in addition to the strong appeal to pivot (central region of the court). These continuous and dynamic modifications allow players to use different attack and fastbreak strategies, by adapting their movements to score (Agulló et al., 2012; Gutiérrez Aguilar et al., 2010; Hill-Haas et al., 2011; Silva et al., 2014).

We also found that most of the goals were scored near the goalpost (68.1%) and in the centerof the court (64.2%), which agrees with previous studies (Bilge, 2012; Costa et al., 2017; Ohnjec et al., 2008), which showed thata centralized position seems to be fundamental for better shot accuracy. The positions farthest from the goal tend to be less effective. According to Costa et al. (2017) finishing from a long-distance makes the shot more predictable and reduces its effectiveness,in addition to allowing more time for the goalkeeper to make decisions.Thus,optimal performance depends on the association of multiple factors, such as physical, technical, physiological, and psychological (Bilge, 2012; Milanese et al., 2011).

Conclusions

Our results showed that the numerical conditions influenced the players' interactions and actions. The variables above-identified seem to offer a general idea of the champion team's game model, revealingthat the numerical conditions and court positions are important to understand goals in handball matches.

There is no doubt that the patterns are different depending on the configuration of play related to the numerical relation. Knowing that numerical equality is more frequent in matches, it provides more opportunities to score and that most of the goals were scored near the goalpost are important results to improve game performance. Thus, this kind of analysis has the potential to improve training sessions and drills of female handball teams.

Despite the interesting results, our study had some limitations. The time of each numerical condition was not accounted for, which may have hampered the better understanding of this variable. Knowing the meantime in each condition could help us to verify the importance of the time and its influence on shots. Future investigations could observe all teams of each tournament to get more information about the champion teams' opponents. Also, other variables could be analyzed, such as defensive actions, substitutions, the specific numeric condition of the play, losses of possession, and type of shot to the goal.Thus, we believe that our findings can help coaches improving the training process and increase athletes' performance. The present study showed that the matchanalysis could be important to handball development, by promoting effective strategies.Although our study has some limitations, the findings are important because they improve the knowledge of the patterns of play of elite female handball teams.

Conflicts of interest - There are no conflicts of interest to declare.

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