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SELF-ORGANIZATION IN MALE AND FEMALE HIGH LEVEL HANDBALL

La autoorganización del balonmano masculino y femenino a alto nivel

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Abstract

The analysis of players and sports teams tries to reveal different performance nuances, and the understanding of the main attractors of the game is shown as a fundamental aspect for the structuring of training in team sports. This work aimed to analyze the handball's self-organization and to compare male and female teams. Thirty-eight matches (19 of each gender) of the 2019 Handball World Championships were analyzed. T-test, ANOVA, and chi-square test were used to data analysis. No differences were found between genders and it was also revealed that there is a tendency of the attacks ending with a throw (> 55%, P < 001), followed by goal (> 34%, p < .001) for both genders. It was also noted the occurrence of defensive violations (> 25%, p < .001). The throws and goalkeepers' saves are important in the handball games results, and that there is no difference between female and male handball games considering it self-organization.
Keywords: team sports; performance; analysis; handball.

Resumen

El análisis de jugadores y equipos deportivos intenta revelar diferentes matices de rendimiento, y la comprensión de la lógica del juego se muestra como un aspecto fundamental para la estructuración del entrenamiento en los deportes colectivos. Este trabajo tuvo como objetivo analizar la auto organización del balonmano y comparar equipos masculinos y femeninos. Se analizaron 38 partidos (19 de cada género) de los Campeonatos del Mundo de Balonmano 2019. Utilizamos el test t, ANOVA y la prueba de chi-cuadrado. No se encontraron diferencias entre géneros y también se reveló que existe una tendencia de los ataques a terminar con un lanzamiento (> 55%, P <001), seguido de gol (> 34%, p <.001) para ambos géneros. También se observó la ocurrencia de violaciones defensivas (> 25%, p <.001). Concluimos que los lanzamientos y las defensas del portero son importantes para los resultados de las partidas de balonmano, y que no hay diferencia entre los juegos de balonmano femenino y masculino cuanto a la auto organización.
Palabras clave: deportes de equipo; rendimiento; análisis; balonmano.

Introduction

The rules in each team sport present some constraints to players' interactions (opposition and cooperation) and team organizations (Gréhaigne & Godbout, 1995), requiring adjustments in their behavior, to solve tactical problems inherent to the game (Villa-Maldonado et al., 2012). In this context, there are some attractors in players and teams organizations, which provides patterns for the game in each sport (Morato et al., 2012). The game's patterns generate a self-organization, contributing to understanding how the rules influence the players' actions and their occurrence (MacGarry et al., 2002; Morato et al., 2012; Passos et al., 2013; Modolo et al., 2022).

In handball, performance analysis researchers have been investigating players' and teams' actions, to predict which kind of variables are related to match results and addressed the team's tactical organization in the highest levels (World Championship and Olympic Games finalists) (Ferrari et al., 2019), Studies analyzing specific situations and comparing teams effectiveness during the game has shown the key variables for the handball game (Daza et al., 2017; Gryko et al., 2018; Hansen et al., 2017; Ohnjec et al., 2003; Saavedra et al., 2017).

Investigations regarding the handball's high level demonstrated that the goalkeeper is crucial to the defensive phase, by identifying correlations between goalkeeper's saves and matches won (Daza et al., 2017; Hansen et al., 2017). For the offensive phase, it was shown that throws are also important to match results. Throw efficacy can be related to match results (Almeida et al., 2020), and can be considered an important performance indicator in both male and female handball (Ohnjec et al., 2003; Daza et al., 2017).

Despite the performance indicators contributing to the sports knowledge evolution, studies have found differences between male and female behaviors in handball. Analyzing positional plays during handball matches, it could be observed that women perform different actions in defense and make different decisions when compared to men (Quiñones et al., 2020). In beach handball it was noted that despite having the same behaviors as women during the matches, men tend to create more scoring 2-point chances (Modolo et al., 2022).

As performance indicators take an important role in sports analysis, it can be observed a lack of studies that help to understand how players and teams behave during matches, especially by investigating the self-organization in male and female handball. A study related to beach handball has analyzed the self-organization in the high level matches and found similarities in male and female games (Modolo et al., 2022), which led to inquiring about the comparisons in handball.

Therefore, from this scenario emerges questions such as: I) "Which are the most frequent actions in handball matches?"; II) "Did the frequencies differ due to gender?". To answer these questions, this study aimed to identify the self-organization system in high level handball matches. Specifically, it aimed to investigate which are the attractors and fluctuations in this system in male and female handball high-level matches.

Methods

Notational analysis was used as a scientific method, without the observers participating in the game context (O'Donoghue et al., 2017; Wright et al., 2014). Due to the video acquisition from searches in public domain sites and the involvement of humans in the research (although they are not identified), this project has been submitted and approved by an Institutional Research Ethics Committee.

Observation protocol and sample

The sample was based on the highest handball level (Marcelino et al., 2011; O'Donoghue et al., 2017). In this study, only main round and playoff matches of the 2019 Male and Female Handball World Championships with full videos were analyzed, to guarantee the control of the opposition's heterogeneous qualities. The preliminary round matches were not analyzed (due to the discrepancy on team levels).

From a total of 22 games for each gender, 19 were analyzed: 15 matches of main round for each gender, and 4 playoffs matches for each gender (semifinals, bronze medal, and final). There were a total of 19 male and 19 female matches, with 2996 and 3204 attacks, respectively. Matches were observed randomly by the researchers using video playback software and the actions were noted in an electronic *ad hoc* sheet. The protocol used in the analysis was based on performance indicators (Hughes & Bartlett, 2002) presented in Table 1.

Table 1. Description of the variables

Variables: Description
Offensive Phase
Concluded: attacks finalized with a throw to the goal. **Interrupted:** attacks finalized without a throw to the goal.
Ball Possession
Kept: the attacking team maintained ball possession at the end of the attack, keeping in the offensive phase. **Changed**: the ball possession changes at the end of the attack, with the attacking team switching to the defensive phase.
Attack Outcome
Attack error: change the ball possession without involving the criteria: pass interception, attack violation, or defense violation. Examples: wrong passes or wrong receptions. **Attack violation**: interruption of the offensive phase originated by a foul or violation of the rules for any player of the attacking team. **Block**: throw blocked by an opponent defender (except the goalkeeper) when the ball trajectory moves towards the goal. **Defense violation**: interruption of the opposition team attack caused by a foul or violation of the rules of the defending team. **Goal:** one point scored by any team. **Goalkeeper save**s: throw saved by the opponent goalkeeper. When a block by the defenders occurred but the ball kept moving towards the goal with goalkeeper intervention, this was noted as the goalkeeper's save instead of a block. **Goalpost**: throw that hits the goalpost and does not score. **Out**: throwing out without touching any player. **Pass interception**: interruption of the ball's trajectory after the pass, or when the defender/goalkeeper anticipated a forward pass from the attacking team. **Referee intervention**: fair play moments or some referee intervention that interrupts the match. **Steal**: the defender recovers the ball possession of the attacking player.

Data reliability

To analyze the data reliability and to ensure replication of this study, the analysis consistency was checked for the same researcher (trustworthiness) and different researchers (objectivity) (O'Donoghue et al., 2017; Thomas et al., 2012). The second match observation was initiated at least 15 days after the first one.

Three observers with a mean of 12 years of experience as players and five years of experience as handball coaches participated in the *ad hoc* sheet organization. After the phase described earlier, the observers practiced their observations and data recordings with a practical application, to reach a consensus agreement and decrease the possible errors (Anguera & Mendo, 2013; O'Donoghue et al., 2017).

The intra and interobserver reliability were verified in 12.5% of the sample and the Kappa Cohen statistics were used to measure the agreement index (Fleiss, Levin & Paik, 2003; James, Taylor & Stanley, 2007). The trustworthiness index intra and interobserver ranged from: 0.88 and 0.98 for the concluded and interrupted sequences variables; 0.91 and 0.99 for kept and lost ball possession; and 0.91 and 0.99 for the outcomes of the attacks.

Statistical analysis

The unit of analysis was the match. For this, the mean percentage of occurrence of each variable for each match was calculated. For intra-gender analysis, paired-samples t-test was ran to compare attacks concluded *vs.* interrupted and ball possession kept *vs.* changed; and one-way ANOVA to compare the mean percentage of attack outcome variables in attacks concluded to the goal (block, goal, goalkeeper save, goalpost, or out) and in attacks interrupted (attack error, attack violation, defense violation, pass interception, referee intervention, or steal). For inter-gender analysis, crosstables with chi-square test were ran to compare attacks concluded *vs.* interrupted and ball possession kept *vs.* changed, and independent sample tests to compare each attack outcome variable. The level of significance was set at $p < .05$ and the mean percentage of the 19 matches for each gender is presented in the results. Although some data violated the assumptions of normality and homogeneity of variances, the choice was to parametric tests because they are more powerful than their non-parametric equivalents (O'Donoghue & Holmes, 2014).

Results

Significantly, most attacks in handball high level ended with a throw to the goal direction, both female (57.4 ± 4.6%, $t_{18} = 7.1$, $p < .001$) and male (55.3 ± 5.1%, $t_{18} = 4.5$, $p < .001$), and it was not found significantly difference comparing genders $\chi^2(1) = 0.08$, $p = .776$. In both genders was observed, significantly, the ball possession changed after attacks finalized with a throw to the goal and it will be kept after interrupted attacks (Table 2).

Table 2. Ball possession at the end of the offensive process in female and male handball elite matches.

Gender	Ball possession		Intra Gender		Inter Gender	
	Kept	Changed	Test T	p-value	Chi-square	p-value
Attacks with a throw						
Female	3.6±1.5%	53.6±4.5%	-43.6	< .001		
					< .01	.959
Male	3.6±1.7%	51.7±4.8%	-40.1	< .001		
Attacks without a throw						
Female	28.4±4.2%	14.4±2.7%	11.5	< .001		
					.72	.395
Male	33.4±4.4%	11.3±3.5%	15.7	< .001		

The goal was the most common action of the offensive process outcomes, both in female ($F_{4,72} = 302.3$, $p < .001$) and male matches ($F_{4,72} = 505.2$, $p < .001$). In interrupted attacks, the defensive violation was the most occurring action in both genders also (female, $F_{5,90} = 298.7$, $p < .001$; male, $F_{5,90} = 579.7$, $p < .001$). Only the defensive violation and the attack error presented a significant difference between genders (Figure 1).

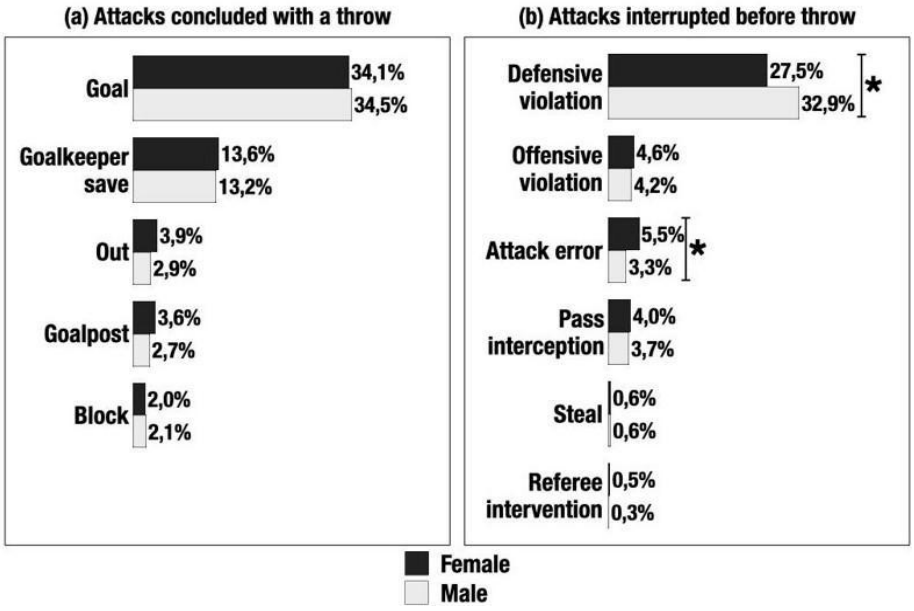

Figure 1. Occurrence of the different results of the attacks completed or not in elite female and male handball matches. * $p < .05$.

Discussion

This study sought to identify the self-organization of handball games and to compare it in both genders. The results showed no difference between the occurrence of actions for both genders, except in defensive violation and attack error. It was noted a predominance for actions in which throws were taken, with a highlight to the goal scored. When the action does not involve a throw, the most recurrent action was the defensive violation (or foul).

There were similarities in the game for both genders, so it can be noted that gender may not interfere in handball self-organization. These results corroborate the affirmation that the occurrence of actions during a game are mostly influenced by the rules restrictions and permissions (Gréhaigne & Godbout, 1995). By the way, it was identified differences between gender in the occurrence of defensive violation (with predominance for males) and attacker error (with a predominance for women). These findings revealed that in male defense the fouls occur more often, compared to the attempt to cause an error in opponents' attack as in females. So, it can be attributed to their different game models, which take into account the players' main characteristics (Mendes et al., 2021).

The findings related to the occurrence of the actions pointed out that most attacks end with a throw, with a greater probability to be scored compared to other actions. Some studies corroborate the findings related to throws, as they pointed out that in high-level handball there is an increase in the number of throws over the years (Espina-Agulló et al., 2016) and a predominance of the attack against the defense. This also can be confirmed in studies that investigate throws and goal scores as performance indicators. Comparing winning and losing teams of the Olympic Games from 2004 to 2016, it was found that winners had a significant predominance in the number of throws (Saavedra et al., 2017). In an analysis of male World Championships, it was concluded that the best-qualified teams had higher throw effectiveness during the tournaments (Almeida et al., 2020).

Other studies also compare the performance of male (Daza et al., 2017) and female (Ohnjec et al., 2003) high-level handball, and demonstrate that the winning teams had better throw effectiveness than the losers. So, for both genders the attacker's decision making when progressing and throwing to the goal takes an important role in handball matches results. This consideration must be made because once the attack is finished without a goal score, the team will be dealing with a negative fluctuation of the system and can provide positive momentum to the opponent (Mortimer & Burt, 2014).

As a way for the defense to deal with the attack's predominance, the results of this study highlighted the occurrence of goalkeeper saves in throwing actions and defensive violations in actions without throws. The goalkeeper's saves stand out as a possibility for defenders to recover the ball and have a positive momentum (Mortimer & Burt, 2014). This fact can be confirmed with the results of a study with high-level handball, which demonstrates that the winning teams' goalkeepers had a better performance (Hansen et al., 2017). For this, one of the possible strategies for defense is that the players hinder the attacker's throws by trying to anticipate or previously occupy space, so the goalkeepers could save in an easy way (Saavedra et al., 2017). This strategy can also cause offensive violations and attack errors, which are other ways to recover the ball possession without an opponent's throw.

On the other hand, it can be observed that defensive violation occurs frequently. The use of defensive violations can be attributed to the defender's needs for reorganization and positioning (Silva, 2008). However, it can also be attributed to the player's effort to recover the ball possession and/or the game intensity increase, corroborating analysis of defensive actions in high-level handball (Gryko et al., 2018). Despite the risk of providing a numerical superiority situation to the opponent (Gryko et al., 2018), the high occurrence of defensive violations can be related to the game rules, which do not limit the number of fouls to be made (International Handball Federation, 2017).

Conclusion

This study seeks to identify the handball tendencies and compare them for males and females. It was noted that the self-organization of handball does not differ due to gender. It could be observed a tendency for throws to be taken with the conversion in goal. To overcome these actions, the goalkeeper's saving seems to be an important action, mainly when coordinated with the defenders' attempt to recover the ball or cause an attack error. Another identified tendency was the occurrence of defensive violations, which stand out as a strategy used by defenders to stop the attack.

The comprehension of the handball's self-organization can predict what the game demands from the players and helps to stipulate criteria to the organization and evaluation of their actions. With a better evaluation of the situations, this study results can help coaches to direct their feedback for the players in training sessions and matches, as well as plan and apply activities according to the investigated parameters. Lastly, it can also contribute to the construction of the teams' game models.

Practical applications

The results found in this study can contribute to the identification of the main attractors of handball matches, as well as the main fluctuations of this system. This information can help coaches devise specific training strategies to increase fluctuations in their favor and maximize their team's actions. Such possibilities are intended to increase effectiveness in the offensive and defensive phases of the game.

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