

<https://doi.org/10.5232/ricyde2020.06205>

Offensive performance under numerical inequality during exclusions in female handball Rendimiento ofensivo en situaciones de desigualdad numérica durante las exclusiones en balonmano femenino

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Abstract

The aims of this study were: i) to describe the situations of numerical inequality due to exclusions during the Female Handball at Panamerican Games Tournament 2015; ii) to analyse the efficacy to relate these situations with the final performance and results. All matches played by teams ranked 1 to 4 in the tournament were analysed using the observational methodology. An ad hoc tool was created in order to develop the observation. A total of 14 matches were analysed in which 461 situations of numerical inequality occurred. Differences among different categories were analysed using chi-square test. Statistical significance was considered when $p < 0.05$. The main number of actions was concentrated during the second part of the matches ($p < 0.05$). Results showed the winners being more efficient than losers in the majority of the variables studied ($p < 0.05$). Winner teams scored a higher percentage of goals and showed a lower percentage of throws out than loser teams. Winner teams showed a more efficient performance in their attack efficacy (number of goals scored in relation to the number of attacks) while playing in inferiority. It was concluded that winner teams convert more goals than loser teams and they are more efficient during actions under numerical inequality.

Key words: female handball; numerical inequality; exclusions; efficacy; offensive performance.

Resumen

Los objetivos de este estudio fueron: 1) describir las situaciones de desigualdad numérica como consecuencia de exclusiones durante el torneo de balonmano femenino en los Juegos Panamericanos 2015; 2) analizar la eficacia para relacionarla con el resultado final de los partidos. Todos los partidos jugados por los equipos clasificados del puesto 1 al 4 en el torneo fueron analizados, utilizando la metodología observacional. Se construyó un instrumento ad hoc para realizar la observación. Un total de 14 partidos fueron analizados, en los cuales ocurrieron 461 acciones de desigualdad numérica. Las diferencias estadísticas entre las categorías analizadas fueron comprobadas usando el test de chi-cuadrado. Diferencia estadísticamente significativa fue considerada cuando $p < 0.05$. La mayor cantidad de acciones se concentró durante la segunda parte de los partidos ($p < 0.05$). Los resultados mostraron a los ganadores siendo más eficaces que los perdedores en la mayoría de las variables estudiadas ($p < 0.05$). Los equipos ganadores convierten el mayor porcentaje del total goles convertidos y mostraron un porcentaje menor de lanzamientos fuera. Los ganadores mostraron un mejor rendimiento en su eficacia de ataque (números de goles en relación al número de ataques/posesiones) cuando juegan en inferioridad. Se concluyó que los equipos ganadores convierten más goles que los perdedores en estas situaciones y que son más eficaces durante las acciones de desigualdad numérica.

Palabras clave: balonmano femenino; desigualdad numérica; exclusiones; eficacia; rendimiento ofensivo.

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Introduction

The study and understanding of the situational variables describing team sport performance is likely to be an important income for coaches to plan trainings and prepare competitions (Marcelino, Sampaio, & Mesquita, 2012; Ruano, Serna, Lupo, & Sampaio, 2016). Hughes & Bartlett (2002) mentioned that performance indicators, obtained from the selection or combination of action variables, can be used by coaches either to compare with opponents or own past performances, or even in isolation. And they suggest that it must be taken into account that analysing data without contextualising them may mislead to false interpretation. An example of contextualising was given by Robertson, Back, & Bartlett (2015) when including the opposition in their method of preparing matches.

The success of an offensive action during a match of handball depend on, among others, the ability of teams and individuals to adjust their behaviours to the changes that occur over time in the offensive context of the handball game (Volossovitch, 2005). In order to develop a reliable interpretation of the efficacy of the attack, some patterns such as centres or a line, the speed of shootings, the time of the preparation of the attack, could be considered. Besides, the scoring efficiency has been studied previously to determinate which player's actions are that most influence in handball games. Thus, the highest effectiveness of the shots for the winner teams was obtained in short distance shots (7-meter throws and 6-meter centre) and wing shots (Srhoj, Rogulj, Padovan, & Katic, 2001; Vuleta, Milanovic & Sertic, 2003). Besides, the five variables that could have a high influence in the final results of the match were: number of shots, number of shots saved by the goalkeepers, number of blocks, side shot throwing efficiency and number of failed passes (Volossovitch & Gonçalves, 2003). The attack efficiency at the men Olympic Games 2004 differed in a significantly way from the 2006 European championship and 2007 world championship, while throwing efficiency was similar in those tournaments (Bilge, 2012).

Manifestation of those performance indicators could be observed whether in training sessions (Andersen, Fimland, Cumming, Vraalsen, & Saeterbakken, 2018; Hartz, Sindorf, Lopes, Batista, & Moreno, 2018; Mazurek et al., 2018) or official competitions (Cardinale, Whiteley, Hosny, & Popovic, 2017; Hansen et al., 2017). One of the main goals for a national handball team is to compete at the Olympic Games. The International Handball Federation -IHF- leaves to each Continental Federation's decision the criteria to qualify to them. For those American teams, Pan-American Games (PPGG) represents a good opportunity. Considering the importance of the tournament, it is relevant to state that PPGG is the last stage where the best 8 teams of the Americas compete for only one spot to the Olympic Games, that the IHF gives to the continental federation. At the 2015 Toronto Games, in case Brazil would have reached the first place, the team that would finished second would have obtain the direct qualification to Rio 2016. The team that obtained the Bronze medal got the opportunity to fight for another spot in Rio at a tournament together with 3 Europeans national teams. Given the importance of the tournament, it is the last milestone of a 4-year planning made by each National Handball Federation. Therefore, this tournament is the highest expression of level in the Americas. Performance indicators in these handball important competitions have been previously studied (Bilge, 2012). Numerical inequality, as a consequence of exclusions, is one of the context in which performance

is analysed (Milanovic, Vuleta, & Ohnjec, 2018; Saavedra, Thornorgeirsson, Chang, Kristjansdottir, & Garcia-Hermoso, 2018).

Temporal exclusions of players who generate actions against the rules through technical faults or unsportsmanlike attitude is a predicted sanction in the International Handball Federation regulation (IHF, 2010). Rule 8 describes the situations in which a player may be excluded. The duration of an exclusion is two minutes and consists in a suspension for the player who has committed the conduct to be punished for. The team is not allowed to replace the player sanctioned, therefore, during this time the team has less players, according to the number of players sanctioned with exclusion. When the opponent keeps all its players on the court, this inferiority of numbers of field players in one team versus the other team is a disadvantage for that team while the superiority generated to the opponent is an advantage, in case the opponent has not any player excluded. Even though it could be considered as an advantage or disadvantage, what is important for coaches and researchers is the magnitude of this numerical inequality and its consequences in the final result (Prieto, Gómez, & Sampaio, 2015). It is necessary to mention that the 2015 Handball Tournament at the Pan-American Games was held under the 2010 IHF Rules of the Game (IHF, 2010). According to rule 4.8, it was not allowed changing the goalkeeper for a field player wearing a field player clothing. This rule has changed from August 2016 onwards.

Therefore, exclusions of players in a handball match have an important influence in the tactical aspect of the game, due to the possibility of playing in numerical equality when having players excluded (taking the risk of playing with “empty net”). In addition, these numerical situations in the relation of the number of players per team are studied in different team sports which have similar rule’s criteria in terms of penalising with the exclusions of players for certain period of time. Some studies take the exclusion itself as a performance indicator in handball (Debanne, 2018; Lago-Peñas, Gómez, Viaño, González-García, & Fernández-Villarino, 2013). Indeed, some studies may relate red cards (one of the possibilities of having an exclusion during a handball match) and the possibility of winning or losing (Saavedra et al., 2018). It is possible to find studies in football (Liu, Gómez, Lago-Peñas, & Sampaio, 2015), futsal, ice hockey (Widmeyer & McGuire, 1997) and water polo (Escalante, Saavedra, Mansilla, & Tella, 2011; Escalante et al., 2012; García-Martín, Argudo Iturriaga, & Alonso Roque, 2015; Gómez, Serna, Lupo, & Sampaio, 2014; Lupo, Condello, Capranica, & Tessitor, 2013; Lupo, Condello, & Tessitor, 2012; Platanou, 2004; Ruano et al., 2016) where performance of teams during the period of time of exclusions is studied. These kinds of situations are relatively frequent during a handball match completing a 20% of the total game time (Gutierrez, Fernández, & Borrás, 2010). However, it is known that the pressure generated to the team with superiority may generate a lower performance in these situations (Schucker, Hagemann, & Strauss, 2013), being a possible reason to explain the unexpected result of actions under numerical superiority found in previous research (Prieto et al., 2015).

This fact generates a change in the tactical schema for both teams and can influence in the result at short term, giving advantage for the teams in numerical superiority (Prieto et al., 2015) or at long term, increasing the likelihood to be the winner or loser team (Trejo & Planas, 2018). Also, the new generated game situations could affect technical and tactical aspects that have influence in the result. The performance of the Spanish male national handball team was studied from a tactical point of view during the European championships 2012 and 2014 (Sierra-Guzmán, Sierra-Guzmán, Sánchez

Sánchez, & Sánchez Sánchez, 2015). In other sense, (Gutierrez et al., 2010) reported that during the matches played in the Male World Championship 2003 and the Male European Championships 2002 and 2004 the losing teams presented worse efficient performance at throwing efficacy and attacking efficacy during numerical inferiority. Studies in other team sports are focused in identifying a relationship between the result of a match and the variable time. Those moments where performance has more influence in the final outcome of a match were named critic (Bar-Eli & Tractinsky, 2000). Sampaio, Lorenzo, & Ribero (2006) found that those moments appeared in the second half of a basketball match. Oliveira, Gomez, & Sampaio (2012) found out that in handball, winners were more efficient in the last minutes of each half.

The literature has reported not too many studies focused on this issue. From the same point of view, being in inferiority is important for coaches and researchers in order to study the team performance during these temporal situations. Up to our best knowledge, there are no studies regarding this issue in elite female handball. For this reason the aim of the present study was to describe the situations of numerical inequality due to exclusions during a female handball international tournament and to analyse the efficacy to relate these situations with the final performance in the different periods of the match.

Methods

Sample

The study was conducted on a sample of 14 matches from 2015 Women's Pan-American Handball Championship in Toronto. Those games were the total ones played by the national teams that finished the tournament in the four first places. A total of 107 exclusions occurred during those matches.

The number of finalization actions was 464 and three of them were discarded because of the low quality of the recorded video. Therefore, the number of valid actions was 461. These actions were registered when the result of them was shot on target (divided as goal or no goal) or no shot (i.e. losing possession of the ball). A total of 325 actions ended on shot on target and 136 in no shot. Actions in which there was numerical equality (i.e. 5x5 and 4x4) in both teams were not included in the analysis.

Since public videos were used to extract the actions, it was not necessary the informed consent of the participants.

Instrument

Observational methodology was used. Then, the observational instrument combined the field format with the system of categories. The final condition of the match (winner, loser or draw) was directly inserted in the registration sheet, being part of the variables studied. "Tournament phase" was a fixed criterion, categorizing the phases in "group phase", "play offs" and "medal". The selected categories for each criterion contained exhaustiveness and mutual exclusivity at the system of categories. A total of 49 categorical cores and their correspondent register code were generated (Table 1).

Table 1. Criteria and categories of the observational instrument

Criteria	Categories	Categorical core
Team	BRA, ARG, URU, MEX, RIV	Teams to be analysed. BRA: Brazil; ARG: Argentina; URU: Uruguay; MEX: México. It is considered as “Rival” (RIV) any other team of the tournament
	T1	Interval 0 to 9:59
Game time	T2	Interval 10:00 to 25:59
	T3	Interval 26:00 to 30:00
	T4	Interval 30:01 to 39:59
	T5	Interval 40:00 to 54:59
	T6	Interval 55:00 to 60:00
Asymmetry	6x5, 5x4, 6x4	Superiority of 1 or 2 players
	5x6, 4x5, 4x6	Inferiority of 1 or 2 players
	Pe	Inferiority of any kind but with a field player using a bib.
Attack result	G	Goal
	F	Throw not on goal
	A	Goalkeeper get the throw
	P	Throw on post
	B	Defensive Block
	GE	Goal and exclusion in the same action
	E	Attacking player generates an exclusion
	I	Defensive interception of the ball
	MP	Bad Pass by attacking player
	ETR	Technical or regulatory mistake

The observational instrument was uploaded to the software Lince 1.1, whose validation in the field of physical education and sports science was performed by Gabin, Camerino, Anguera, & Castañer (2012). Videos were watched by the research team and data collected. The unity of observation is considered as the period of time in which the team get the ball possession until a collectable action (result) is produced. In the present study it was referred only to the situations that take place during an exclusion that generates a numerical inequality.

Procedures

A theoretical framework and the authority criteria sustained the validity of the construct. These last one was covered with the response of 5 Pan-American elite coaches to a specific survey. The level of agreement in the totality of the items included in the questionnaire was higher than 90%. The reliability of the instrument was confirmed undertaking tests of quality control and concordance at inter-observers and intra-observers. Kappa coefficient values at those items showed 0.85 and 0.93 respectively.

The definition of attack and throwing efficacy proposed by Gutierrez et al. (2010) and Trejo & Planas (2018) was taken as a reference, having then the following definitions:

Throwing Efficacy (TE) = [(number of goals x 100) / Number of throws];

Attack Efficacy (AE) = [number of goals / (number of throws + turnovers)].

The results of attacks ending in interception (I), bad pass by attacking player (MP) and technical or regulatory mistake (ETR) were considered “no shot (turnovers)”.

Statistical analysis

Statistical analyses were performed using IBM SPSS v.20.0 (SPSS, Chicago, IL, USA). Frequencies were obtained for the different variables. Differences among different categories were analysed using Chi-square test for contingency tables. Period and consequence or type of inequality and consequence were the variables included in the chi-square analysis to know differences in periods during the matches or among type of inequalities. When a general difference was observed, a chi-square test was performed in the specific category. Statistical significance was considered when $p < 0.05$.

Results

During the 14 matches analysed, 107 exclusions occurred, which represents an average of 7.6 exclusions per match and then an average of around 15 minutes per match in situations during which numerical inequality actions appeared. A total of 461 situations of numerical inequality were analysed in the tournament (55.7% in superiority and 44.3% in inferiority). Ten of these situations finished with exclusion and the rest were registered as shot on target (divided in two categories: goal or no goal) and no shot. Figure 1 shows the distribution of the situations of numerical inequality divided by situations in superiority (which includes all actions of asymmetry registered as 6x5, 5x4 or 6x4) and inferiority (which includes all actions of asymmetry registered as 5x6, 4x5, 4x6 or Pe) during the match and its consequences. A remarkable result is that no action from category “Pe” was registered, meaning that no team changed its goalkeeper for a field player. The majority of the situations of numerical inequality finished in shot and the most of them in goal, with the highest percentage during the T5 as well. The statistical analysis did not show statistical differences between the number of situations in numerical inequality among the different game times. The analysis by numerical inequality showed that in T2 there the goals converted in superiority are more than those converted in inferiority even when the T2 actions represents similar percentages respect to the total actions during the match (21.8% and 22.5% respectively). During the last part of the game (T6) the teams in inferiority converted more goals than those in superiority.

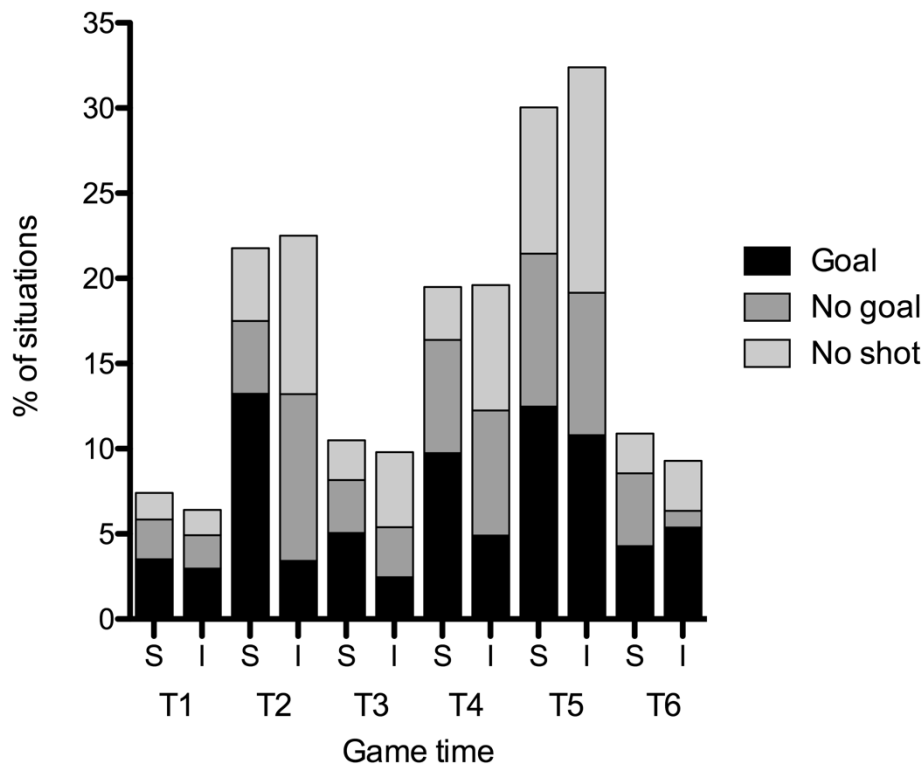


Figure 1. Percentage of situations in numerical inequality by game time and its consequences.

T1 to T6: Game time splitted in 6 periods; S: Superiority; I: Inferiority.

The figure 2 shows the distribution of the situations related to the type of finalization and in function of the final result of the match (win or lose). Winner teams converted more goals (57.3% of the total of finalizations, which are 39.5% in superiority and 17.8% in inferiority) than the loser teams (42.7%) of the total of finalizations, which are 27.6% in superiority and 15.1% in inferiority), showing a statistically significant difference ($p < 0.05$, $V = 0.16$). Also, winner teams had a statistically significant lower percentage of throws out (34.0%, which are 22.0% in superiority and 12.0% in inferiority) in comparison to loser teams (66.0%, which are 40.0% in superiority and 26.0% in inferiority) during the situations of numerical inequality. In the rest of finalizations (goalkeeper saves or turnovers) no statistically differences between winner and loser teams were observed, nevertheless the loser teams presented the lowest percentage of goalkeeper saves (48.9%) and winner teams the lowest percentage of turnovers (42.6%).

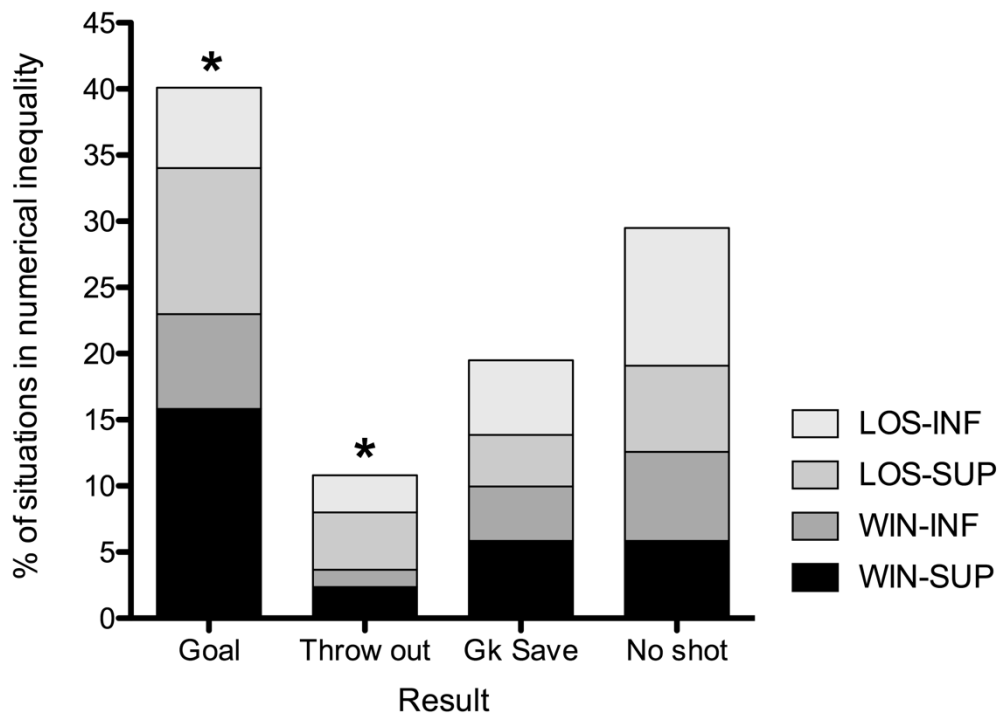


Figure 2. Percentage of situations under numerical inequality divided by team and numerical inequality condition.

*Gk Save: Goalkeeper save; WIN: Winner team; LOS: Loser team; SUP: Superiority; INF: Inferiority. * Statistically significant differences between winner and loser teams ($p < 0,05$).*

Regarding the efficacy during the situations of numerical inequality (Table 2), the winner teams had a higher throwing efficacy and a higher attack efficacy in comparison with loser teams in superiority ($\Delta TE: 8.5\%$; $\Delta AE: 10.9\%$) and inferiority as well ($\Delta TE: 15.1\%$; $\Delta AE: 13.1\%$). The winner teams presented a statistically significant ($p < 0.05$) higher percentage in the attack efficacy while playing in inferiority in comparison with the loser teams (37.9% and 24.8%, respectively).

Table 2. Efficacy in situations under numerical inequality.

	Superiority		Inferiority	
	Winner	Loser	Winner	Loser
Throwing Efficacy (%)	65.8 (56.4-74.0)	57.3 (46.8-67.2)	56.9 (43.8-69.1)	41.8 (30.5-54.0)
Attack Efficacy (%)	54.5 (45.9-62.8)	43.6 (34.8-52.8)	37.9 (28.3-48.6)	24.8 (17.6-33.6) *

Data are presented as CI95%; * Statistically significant differences respect to winner teams ($p < 0,05$)

Discussion

The aim of the present study was to describe the situations of numerical inequality due to exclusions during a female handball international tournament and to analyse the efficacy to relate these situations with the final performance. The outcomes of the present study show that these numerical inequality situations are principally located during the second part of the matches. Besides winner teams convert significantly more goals and show a lower percentage of throws out during these inequality situations.

In the PPGG 2015 approximately a quarter of the total playing time was played in an unequal numerical situation. This result is in line with previous studies made in Spanish handball league where 20% of the time teams played under numerical inequality situations (Gutierrez et al., 2010) and during the period 1982-2014 in European, World and Olympic finals matches where exclusions lasted 30% of the total game time (Pueo & Espina-Agullo, 2017). In the present study, the last five minutes of the second half (T6) presented a low number of situations under numerical inequality, meaning low number of exclusions as well. The majority of the exclusions were concentrated during the second part of the match, especially in the range from 40:00 to 54:59 minutes. This is consistent with previous studies in other team sports (Bar-eli, Tenenbaum, & Elbaz, 1990; Bar-Eli & Tractinsky, 2000; García-Martín et al., 2015), where the second part of the match was the most crucial. Sampaio et al. (2006) found that those moments appeared in the second half of a basketball match. These results are in agreement with studies made in handball where the number of exclusions increased in the second half of a match (Prieto et al., 2015; Pueo & Espina-Agullo, 2017). Application of rules (IHF, 2010) as well as psychological player's crisis could explain these findings (Bar-Eli & Tractinsky, 2000). The scale of sanction may cause on players' behaviour an increase of the expected and fair actions (Bar-eli et al., 1990). Thus, the players could tend to behave in a way that allow them to stay in court in order to maintain the equality in the number of players (Bar-eli et al., 1990).

Previous studies in another team sports, some of them including handball, reported that the goals scored in the first half had higher impact on the final score goal difference (Gómez et al., 2014; Lago-Peñas et al., 2013; Prieto, Gómez, & Sampaio, 2016) however in the present study it was found out that the last period of a handball match could be the most productive in terms of goals, going in line with previous research in handball (Oliveira et al., 2012) were winners were more efficient in the last minutes of each half.

Results in the present study show that winners scored more goals than losers while being in superiority. This coincides with previous researches in other team sports where winners' performance indicators are better than losers. In water polo winners shot more time than losers when they have an extra man (Escalante et al., 2011); goals achieved by the winner teams in water polo were considerably more as compared to the ones of the loser team (Platanou, 2004) and a statistic significant difference between winners and losers was found in all the coefficient of performance in teams with an extra man (Argudo, Ruiz, & Abaldes, 2010). In ice hockey, winners have better performance than losers while being in power play (5x4 and 5x3) even pulling the goalie out (Beaudoin & Swartz, 2010). Gutierrez et al., (2010) in their study of European and World Handball Championship between 2002 and 2004 found out that during inferiority situations losers present worst performance than winners. In handball, since the aim of the game for a team is to score more goals than the opponent, winners ends scoring more than losers. It

is then important to find out when, how and why winners score the most. Results of the research shows that winners scored more than losers during the periods of games that exclusions are sanctioned by referees. Therefore, winners are more effective than losers during those periods of the game, specially during superiority situations. They have the capacity to take more advantage of these situations in comparison to losers. This coincides with performances of teams at the Male Olympic Games 2008-2012 where winners perform better than losers while being in superiority (Pueo & Espina-Agullo, 2017). The characteristics of the players (Wagner et al., 2014); the improvement in shot efficacy and efficiency (Wagner & Müller, 2008; Aguilar-Martínez et al., 2012); the handle of the game time (Gomes, Volossovitch & Ferreira, 2014) and the tactical intention of throwing from the 6-meter line (Sierra-Guzman et al., 2015) can be considered the reasons why winners are more effective in superiority situations. Nevertheless, future studies should be focussed on the causes of increased efficacy observed in winner teams.

Throws out of target (shots that ended at posts or out of the target) showed a statistical significant relation among numerical inequalities. Losers playing under numerical superiority presented higher number of these actions during the games analysed. Shot efficiency relates goals with the total number of throws that a team makes (Gutierrez et al., 2010; Trejo & Planas, 2018). Shots out of target have then an impact in the shot efficiency. Losers team had more shots stopped by goalkeepers (Karastergios, Skandalis, Zapartidis, & Hatzimanouil, 2017) having a significant impact in their shot efficiency; losers in the present study showed that throwing out of target had a negative impact in their shot efficacy.

The efficacy was evaluated in the present study through AE and TE. Similarly to previous researches in handball, loser teams presented an AE and a TE less efficient than winner teams (Gutierrez et al., 2010). Generally, an AE below 50.0% is considered as low efficacy. Although both superiority (44.5%) and inferiority (24.8%) situations presented an AE low in losers female handball teams at the 2015 PPGG, the performance in situations of unequal numerical of inferiority was especially affected. This goes in line with the study of the Handball World Championship played in 2013 where results showed that efficacy during these numerical inequality situations could have a high influence on the likelihood to be the winner or loser team (Trejo & Planas, 2018).

Some limitations of this study are worth noting. Recordings did not allow seeing some actions, having to have them discarded. Only the best 4 teams of the tournament were analysed, having no data of the rest of the teams participating. Finally, actions taken by the defensive teams were not taken into account. Contextualising the studies (taking into account the difference in the score, the level of the opponent, the phase of the tournament, the type of defence, the offensive system used) should give more accurate information for coaches to prepare their players. Anyway, due to the lack of high quality studies, especially in female handball, more studies should be developed in order to confirm these results.

Conclusions

It can be concluded that the main number of numerical inequalities in an international female handball tournament occurs during the second part of the game, that may be related with the applications of the sanction's scale of progression applied by referees.

Winner teams scored a higher percentage of goals and showed a lower percentage of throws out than loser teams. Winner teams showed a more efficient performance in their attack efficacy (number of goals scored in relation to the number of attacks) while playing in inferiority. Thus, coaches and technician in handball should take into account these findings to developed different strategies that allow them to achieve better goal scores in inequality situations. These strategies may go, for example, in order to prepare their teams how to perform in the different moments of the line-time of a match taking into account the exclusions impact between the first and second half of the match. It can also go in the way of taking into account which level of efficacy during exclusions their teams may achieve pursuing in reducing the possibility of losing a match (for example training in order to score more than 2 out of 10 attacks during inferiority may move teams away of being losers).

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