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Relation of Offensive Performance during Exclusions and Final Ranking in Female Handball

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Abstract: The aim of this study was to determine team offensive performance indicators during exclusions related to the final ranking obtained in the tournament. Twenty-nine matches from the 2017 Pan-American Female Championship played by 10 national teams were analyzed using observational methodology. Cramer's V and Fisher's exact test were applied to identify associations between the variables. The Chaid algorithm was used to identify performance variables during inequality situations associated with the final ranking. Results showed that teams ranked 1st to 3rd presented a statistically significant relationship ($p < 0.001$; ASR 5.2) of being in superiority, scoring on 56.8% of their finalizations, while teams ranked 7th to 10 th showed a tendency of ending their attacks in turnovers under inequality situations ($p < 0.00$; ASR 3.1). Playing with an empty net during inferiority situations was a predictor of winners belonging to the medalist teams in 76.2% of the analyzed situations. It can be concluded that during numerical superiority, the best-ranked teams better handled their possessions. The substitution of the goalkeeper for a court player during inferiority was a predictor of belonging to the medalist group. Playing with the goalkeeper in goal (playing 5 against 6) when the match status was balanced or unbalanced, was a predictor of losing teams that did not end up in the medalist groups.

Keywords: numerical inequality; empty net; offensive performance indicators; medalist; Pan-American handball

1. Introduction

The development of team sports gains important income from game analysis, which is used to improve the training quality and tactical aspects of teams during the game [1]. Coaches adapt their training and match interventions taking data from the analysis performed into account [2]. Nevertheless, team sports performance indicators need to be contextualized [3] since the environment of performance, the characteristics of the tournament, the culture of sport, or the level of competition in different countries or regions may offer constraints or limitations to the player's performance [3].

Studies of performance indicators in handball have increased in the last decade [4]. Handball is a complex, multifactorial game, and it is difficult to identify factors that influence player and team performance [5]. The relation of performance to a team's final ranking has been studied in other team sports due to the relevance of knowing how best-ranked teams perform. In handball, Montoya and Anguera [6] determined that medallist teams in the 2008 Olympic Games (OG) finalized their attacks more frequently from the wings than low-ranked teams did. Oliveira et al. [7] stated that the home advantage effect at ASOBAL (the Spanish regular league) during the 2007/2008–2008/2009 seasons was higher (71%) when playing balanced teams (ranked at the same level) than when playing unbalanced teams (54%). The association between the save percentage of goalkeepers and the level of success in championships showed other approaches that researchers have made in this area [8]. Handball performance at the World Championships (WCh), OG, and continental tournaments (i.e., Asian and European) have been studied from different perspectives [1], a study of the variables influencing the final team ranking being one among them.

There are fewer studies on female handball compared to male handball, leading to less new knowledge in this area [9]. In this sense, research about anthropometric aspects [10,11]; injuries assessments [12,13]; the effect of relative age [14]; the position of the player's indicators [15,16]; throwing performance [17]; effects of training tasks upon performance [18–20] and match analysis [21,22] have been developed in recent years. Research about female Pan-American handball tournaments started to be recently carried out.

One of the game situations less studied in handball is the numerical inequality situation caused by exclusions, although exclusions and their consequences have been studied as a performance indicator in other team sports. Numerical inequality as a consequence of temporal or total exclusions of players and team performance during those game periods is a field of research in team sports. Temporal or total exclusion of a player occurs in handball under the circumstances described in Rules 8 and 16 of the International Handball Federation (IHF) Rules of the Game [23]. The 2017 Female Pan-American Handball Championship (2017 FPHCh) was the first tournament played in the Americas under the last change of the rules (applied for the first time at Rio 2016 OG). One of the main changes is expressed in Rule 4.1, which states that the goalkeeper can be substituted for a court player (if identified as one, wearing the same clothing as their teammates) at any time, as long as the requirements for substitutions, in general, are respected.

Thus, studying the situational context of the numerical relationship of players and the impact on the final result of a handball match may be relevant for both trainers and academics [24]. In this respect, some studies found a relationship between the number of fouls, exclusions, or red cards and the winning or losing of a game. However, not many studies have focused on analyzing the moments of the game where one of the two teams has a numerical inferiority of players [7]. In this sense, a recent study by Krahenbühl et al. [25] analyzed the effect of playing with an empty net during inferiority at the OG. Results of this study showed that 65% of the total attacks where the goalkeeper was changed for a field player were done in a numerical inferiority context, and 85 out of 98 of the total actions were registered in this numerical inequality context. Moreover, there was no statistical relationship between attack efficiency and changing (or not) the goalkeeper, nor between scoring a goal or not after a counterattack when playing with an empty net.

Assuming that this relationship between players could be relevant for training and game situations, it is important to study the relationship between performance during exclusions and the final ranking of teams in an elite female tournament. Therefore, the aims of the present study were (a) to determine team offensive performance indicators during exclusions in relation to the final classification achieved at the 2017 FPHCh, and (b) to analyze how teams from different ranking positions perform during offensive numerical inequality situations.

2. Methods

2.1. Sample

The sample consisted of 29 matches from the 2017 Pan-American Female Championship played by 10 national teams. In each game, all offensive sequences of the match carried out while at least one of the teams was under exclusion penalty were observed and registered. No offensive sequence was registered when both teams had the same number of court players (i.e., 6 × 6, 5 × 5, or 4 × 4). The offensive sequence has been defined according to aspects mentioned by Antúnez et al. [26]. Determined from the moment that one team regains or obtains possession of the ball (most of the times immediately after an exclusion is sanctioned) until either (a) the ball is lost because the opposite team regains possession, or (b) the team in possession of the ball gets to make a valid throwing, and immediately after must restart the game via a sideline or corner launch. No offensive sequence was studied once the 2-min suspension time ended.

2.2. Instrument

Observational methodology procedures used in sports research [27] were followed to register the actions. A mixed ad hoc instrument, modified from [28], consisted of a field format with category systems duly validated by five experts (all coaches with national team experience as well as 10 years experience as coaches at the club level). Criteria and their respective categories included exhaustiveness and mutual exclusivity into the category system. A total of 49 categorical cores and their corresponding register codes were generated (Table 1) and grouped into 7 criteria (team, game time, type of asymmetry, match status, game phase, offensive system, and finalization).

Table 1. Observational instrument.

Criterion	Category	Categorial Core
Team	BRA, ARG, PAR, URU, USA, PUR, CHI, DOM, COL, GUA.	In order of final ranking, from 1st to 10th: BRA: Brasil; ARG: Argentina; PAR: Paraguay; URU: Uruguay; USA: United States of America; PUR: Puerto Rico; CHI: Chile; DOM: Dominican Republic, COL: Colombia; GUA: Guatemala
Game Time	T1	Minute 0 a 9:59
	T2	Minute 10:00 a 25:59
	T3	Minute 26:00 a 30:00
	T4	Minute 30:01 a 39:59
	T5	Minute 40:00 a 54:59
	T6	Minute 55:00 a 60:00
	T7	First period of extra time
	T8	Second period of extra time
Match Status	≥5, 4, 3, 2 y 1	Observed team leads by 5 (or more), 4, 3, 2, or 1 goal
	0	Teams are tied at the moment the action is registered
	≤5, −4, −3,−2, −1	Observed team is behind in 5 (or more), 4, 3, 2 or 1 goal
Type of Asymmetry	6 × 5, 5 × 4, 6 × 4	Each of 3 types of numerical Superiority of 1 or 2 players.
	5 × 6, 4 × 5, 4 × 6	Each of 3 types of numerical Inferiority of 1 or 2 players.
	EN	Numerical equality with Empty Net
Game Phase	FB	Fast break attack (1st wave)
	CA	Counterattack (2nd and 3rd wave)
	PA	Positional attack
	7M	7M Throw

Table 1. *Cont.*

Criterion	Category	Categorial Core
Offensive System	3:3	3:3 with 1 pivot and 2 wings
	3:3 (2)	3:3 with 2 pivots and 1 wing
	2:4	2 back players, 2 wings, 2 pivots
	3:2	3 back players and 2 wings
	3:1:1	3 back players, 1 wing, 1 pivot
	NS	No System (counterattacks and 7M throws)
Finalization	G	Goal
	P	Throw on post
	S	Goalkeeper saves
	Out	Throw not goal (not post, not goalkeeper save)
	B	Blocked shot by a defense player
	GE	Goal and exclusion (in the same action)
	I	Defense player intercepts a pass
	BP	Error in passing the ball (not getting it past the defender)
	RTE	Regulatory or Technical error (attacking foul, double dribbling, steps, error while changing players, other sanctions)

2.3. Procedures

The research team reviewed the videos and collected data using the software Lince 1.2.1 [29]. Intra- and inter-observer reliability concordance was verified using Cohen's Kappa coefficient [30], registering values rated as very good ($K \geq 0.89$). The final position of the teams in the tournament (1 to 10) and final condition (winner, loser, draw) was directly inserted onto the registration sheet, being part of the studied variables. None of the matches ended in a draw.

For the study, 3 Ranking Groups were formed using the following criteria. Group I (GI): teams ranked 1st to 3rd; Group II (GII): teams ranked 4th to 6th; Group III (GIII): teams ranked 7th to 10th. Game time was grouped into two groups, based on previous studies which found critical moments of the game where exclusions occurred [24,31], i.e., critical moments (game time 2, 4, 5) and non-critical moments (game time 1, 3, 6). Match status was grouped into three groups: 2 goals (all actions registered when the difference in the score was 2 goals or less); 3–4 goals (all actions registered when the difference in the score was of 3 or 4 goals up or behind); 5 or more goals (when the difference in the score was 5 goals or more). The asymmetry was grouped into two types of asymmetry. Superiority (all actions registered when the numerical inequality was 6 against 5, 5 against 4, or 6 against 4), and inferiority (all actions registered when the goalkeeper was in goal and the numerical inequality was 5 against 6, 4 against 5, or 4 against 6 and playing with an empty net). Moreover, when analyzing only numerical inferiority, actions were grouped into 'with the goalkeeper in goal' (all actions registered when the goalkeeper was in goal and the numerical inequality was 5 against 6, 4 against 5, or 4 against 6) and empty net (all actions registered during inferiority and the observed team play with empty net). Finalizations were grouped into three groups: goal (goal and "goal and exclusion"); no goal (throw on post, goalkeeper save, blocked shots, throwing out the goal), and turnover (all finalizations not involving throwing).

Ethics principles established in the Helsinki Declaration [32] were followed. Neither examination nor informed consent was necessary since the study involved observing persons in a public environment. People and teams had no expectations (matches were streamed via television and the internet), and the researchers did not interfere with the teams studied.

2.4. Statistical Analysis

Deviation in normality was determined using the Kolmogorov-Smirnoff test. Crosstab commands were used to study the relationships (Pearson's chi-square test) between the groups concerning final ranking (medalist and other 2 groups) and the type of numerical inequality and contextual indicators (final condition, finalization, type of play, system of play). Fisher's exact test (f) with the Monte Carlo method was applied when the Expected Frequency Distribution was lower than 5, or the count of cases in one cell was lower or equal to 5 [33]. To estimate effect sizes (ES), Cramer's V test was used. Adjusted Standardised Residual (ASR; critical value = 1.96 and $p = 0.05$) was used to determine which cross-section was responsible for the independence of the variables. Secondly, to identify the variables that best explain the teams' performance, an exhaustive CHAID (Chi-squared automatic interaction detection) classification tree analysis was used to determine the differences between the performance of the 3 groups of teams (medalist, best in their continent, last positioned) according to the temporal and contextual indicators. The SPSS v.25 for Mac software (IBM, Corp., Armonk, NY, United States) was used to perform the statistical analysis. Data were presented as frequencies and percentages. The confidence interval was set at 95%. A statistically significant relation was found when $p < 0.05$.

3. Results

3.1. Results during Numerical Inequality Context as a Consequence of Exclusions

During the 29 games of the tournament, 211 exclusions were sanctioned (an average of 7.3 exclusions per game), and a total of 812 actions were registered. Table 2 presents the frequency distribution of offensive situations under numerical inequality situations. A statistically significant relationship ($p < 0.01$) was found between final classification and type of asymmetry (superiority and inferiority), game outcome, finalization, partial difference in the score, phase of the game, and offensive system. GI and GII teams presented a statistically significant relationship ($p < 0.01$; ASR 5.0 and 2.6) when playing in superiority and GIII playing in inferiority ($p < 0.01$; ASR 7.1). A statically significant relationship ($p < 0.01$, ASR 3.0) was found between GIII teams and ending attacks in turnovers. GI teams tended to use 1st, 2nd, and 3rd wave counterattacks ($p < 0.01$; ASR 3.5 and 2. 2).

Table 2. Frequency distribution of offensive situations under inequality during the tournament.

	1st–3rd *n* = 236	4th–6th *n* = 270	7th–10th *n* = 306	s.t.	*p*	ES	ESp
Asymmetry				53.561	<0.001	0.26	<0.001
Superiority	163(69.1)	167(61.9)	121(39.5)				
ASR	5.0	2.6	−7.1				
Inferiority	73 (30.9)	103(38.1)	185(60.5)				
ASR	−5.0	−2.6	7.1				
Game outcome				202.504	<0.001	0.50	<0.001
Winner	204(86.4)	136(50.4)	76 (24.8)				
ASR	12.8	−0.3	−11.7				
Loser	32 (13.6)	134(49.6)	230(75.2)				
ASR	−12.8	0.3	11.7				
Finalization				36.038	<0.001	0.21(14)	<0.001
Goal	134(56.8)	113(41.9)	99 (32.4)				
ASR	5.2	−0.3	−4.6				
No goal	65 (27.5)	81 (30.0)	110(35.9)				
ASR	−1.6	−0.7	2.1				
Turnover	37 (15.7)	76 (28.1)	97 (31.7)				
ASR	−4.2	1.1	3.0				

Table 2. *Cont.*

	1st–3rd *n* = 236	4th–6th *n* = 270	7th–10th *n* = 306	s.t.	*p*	ES	ESp
Match status				36.392	<0.001	0.15	<0.001
2 goals	73 (30.9)	108(40.0)	62 (20.3)				
ASR	0.4	4.4	−4.7				
3–4 goals	25 (10.6)	43 (15.9)	36 (11.8)				
ASR	−1.2	1.9	−0.7				
5 or more goals	138(58.5)	119(44.1)	208(68.0)				
ASR	0.4	−5.4	4.8				
Game phase				36.591	<0.001	0.15	<0.001
Positional Attack	141(60.0)	185(68.5)	249(81.4)				
ASR	−4.4	−1.1	5.1				
1st wave	36 (15.3)	21 (7.8)	21 (6.9)				
ASR	3.5	−1.3	−2.1				
2nd and 3rd wave	28 (11.9)	25 (9.3)	16 (5.2)				
ASR	2.2	0.5	−2.6				
7 m	30 (12.8)	39 (14.4)	20 (6.5)				
ASR	1.0	2.2	−3.1				
Offensive system				38.057	<0.001	0.15	<0.001
3:3 1_Pivot	141(59.7)	139 (51.5)	171 (56.1)				
ASR	1.5	−1.7	0.2				
3:3 2 Pivots	3 (1.3)	13 (4.8)	11 (3.6)				
ASR	−2.1	1.7	0.3				
3:2 No Pivots	52 (22.0)	63 (23.3)	93 (30.5)				
ASR	−1.5	−1.1	2.5				
No system	39 (16.5)	41 (15.2)	19 (6.2)				
ASR	2.4	1.8	−4.0				
1 Pivot no wing	1 (0.4)	14 (5.2)	11 (3.6)				
ASR	−2.9	2.3	0.5				
Game time grouped				9.516	0.095	0.11	0.095
Periods 2,4,5	152 (64.4)	207 (76.7)	210 (70.1)				
Periods 1,3,6	84 (35.6)	63 (23.3)	96 (29.9)				

Data presented as absolute frequencies (percentage). n: absolute frequencies of actions registered for each ranking group; s.t.: statistical test value for the Pearson Chi-Square Test or Fisher's Exact Test as applicable; *p*: *p*-value; ES: effect size (Cramer's V for asymmetric tables and Contingency coefficient for symmetric tables); ESp: *p*-value for Cramer's V; ASR: adjusted standardized residual, calculated only for those variables that presented a statistically significant relationship ($p < 0.05$).

3.2. Results during Superiority Situations

Table 3 presents frequency distribution during superiority situations. A statistically significant relationship was found between final classification and game outcome, finalization, match status, game time grouped ($p < 0.01$), and game phase ($p < 0.05$). GI national teams tended not to end in turnovers ($p < 0.01$; ASR −2.8). The attack efficacy (AE) decreased from GI to GIII (63.2%, 49.1%, and 41.3%), while turnovers increased from GI to GIII. GI teams tended to use direct counterattacks ($p < 0.01$; ASR 2.2), while GIII teams showed a tendency to use positional attacks ($p < 0.01$; ASR 3.4). GI national teams presented a statically significant relationship of using power plays in non-critical moments of the game ($p < 0.01$; ASR 2.6).

Table 3. Frequency distribution of offensive situations under superiority during the tournament.

	1st–3rd $n = 163$	4th–6th $n = 167$	7th–10th $n = 121$	s.t.	p	ES	ESp
Game outcome				68.234	<0.001	0.39	<0.001
Winner	139(85.3)	98(58.7)	46(38.0)				
ASR	7.4	−1.4	−6.6				
Loser	24 (14.7)	69(41.3)	75(62.0)				
ASR	−7.4	1.4	6.6				
Finalization				15.496	<0.005	0.13	<0.01
Goal	103(63.2)	82(49.1)	50(41.3)				
ASR	3.5	−1.0	−2.8				
No goal	39 (23.9)	47(28.1)	41(33.9)				
ASR	−1.5	0.0	1.6				
Turnover	21 (12.9)	38(22.8)	30(24.8)				
ASR	−2.8	1.2	1.6				
Match Status				20.578	<0.001	0.15	<0.001
2 goals	50 (30.7)	66(39.5)	24(19.8)				
ASR	−0.1	3.0	−3.1				
3–4 goals	15 (9.2)	29(17.4)	17(14.0)				
ASR	−2.0	1.8	0.2				
5 or more goals	98 (60.1)	72(43.1)	80(66.1)				
ASR	1.5	−4.0	2.8				
Game phase				15.060	<0.05	0.13	<0.05
Positional Attack	79 (48.8)	87(52.1)	83(68.6)				
ASR	−2.1	−1.1	3.4				
1st wave	27 (16.7)	18(10.8)	10 (8.3)				
ASR	2.2	−0.7	−1.6				
2nd and 3rd wave	26 (16.0)	25(15.0)	11 (9.1)				
ASR	1.0	0.6	−1.7				
7 m	30 (18.5)	37(22.2)	17(14.0)				
ASR	−0.1	1.5	−1.5				
Offensive system				11.619	0.081	0.11	0.081
1_Pivot	96 (58.9)	88(52.7)	75(62.0)				
3:3_2 Pivots	3 (1.8)	9 (5.4)	10 (8.3)				
3:2 No Pivots	29 (17.8)	31(18.6)	20(16.5)				
No system	35 (21.5)	39(23.4)	16(13.2)				
1Pivot_No wing	0 (0)	0 (0)	0 (0)				
Time period grouped				6.763	<0.05	0.12	<0.05
Periods 2,4,5	104(63.8)	126(75.4)	91(75.2)				
ASR	−2.6	1.5	1.1				
Periods 1,3,6	59 (36.2)	41 (24.6)	30(24.8)				
ASR	2.6	−1.5	−1.1				

Data presented as absolute frequencies (percentage)n: absolute frequencies of actions registered for each ranking group; s.t.: statistical test value for the Pearson Chi-Square Test or Fisher's Exact Test as applicable; ES: Effect size (Cramer's V for asymmetric tables and Contingency coefficient for symmetric tables); Esp: p-value for Cramer's V; ASR: Adjusted standardized residual, calculated only for those variables that presented a statistically significant relationship ($p < 0.05$).

3.3. Results during Inferiority Situations

Frequency distribution in an inferiority context can be seen in Table 4. A statistically significant relationship ($p < 0.01$) was found between final classification and game outcome, offensive system, and inferiority disposition, with match status and game time grouped ($p < 0.05$). Teams grouped in GII showed a statistically significant relationship with suffering exclusions when the difference in the score was of 2 or fewer goals ($p < 0.01$; ASR 2.6; ASR 3.3), presenting a tendency of using a 3:2 offensive system with 1 pivot ($p < 0.01$; ASR

3.0). GI presented better AE and throwing efficacy (TE) than the other two groups. When analyzing the strategic use of the new rule, a statistically significant relationship ($p < 0.01$) was found between final classification and playing or not with an empty goal ($p < 0.001$; ES 0.41). In total, 84.2% of the attacks were played with the goalkeeper on the court and 15.8% with an empty net. GI teams decided to change the goalkeeper for a court player most often ($p < 0.01$; ASR 7.7). In this respect, it is important to mention that only the teams ranked 1st and 2nd (Brazil and Argentina) opted to play with an empty net.

Table 4. Frequency distribution of offensive situations under inferiority during the tournament.

	1st–3rd $n = 73$	**4th–6th** $n = 103$	**7th–10th** $n = 185$	**s.t.**	**ES**	p	**ESp**
Game outcome				119.306	0.55	<0.001	<0.001
Winner	65 (89.0)	38 (36.9)	30 (16.2)				
ASR	10.4	0.0	−8.3				
Loser	8 (11.0)	65 (63.1)	155 (83.8)				
ASR	−10.4	0.0	8.3				
Finalization				8.390	0.11	0.078	0.078
Goal	31 (42.5)	31 (30.1)	49 (26.5)				
No goal	26 (35.6)	34 (33.0)	69 (37.3)				
Turnover	16 (21.9)	38 (36.9)	67 (36.2)				
Offensive system				20.098	0.18	<0.01	<0.01
3:3 1_Pivot	45 (61.6)	51 (49.5)	96 (52.2)				
ASR	1.6	−0.9	−0.5				
3:3 2 Pivots	0 (0.0)	4 (3.9)	1 (0.5)				
ASR	−1.1	2.6	−1.4				
3:2 No Pivots	23 (31.5)	32 (31.1)	73 (39.7)				
ASR	−0.8	−1.1	1.7				
No system	4 (5.5)	2 (1.9)	3 (1.6)				
ASR	1.8	−0.4	−1.1				
1 Pivot No wing	1 (1.4)	14 (13.6)	11 (6.0)				
ASR	−2.2	3.0	−0.9				
Partial difference				17.152	0.15	<0.05	<0.05
2 goals	23 (31.5)	42 (40.8)	38 (20.5)				
ASR	0.6	3.3	−3.4				
3–4 goals	10 (13.7)	14 (13.6)	19 (10.3)				
ASR	0.5	0.6	−1.0				
5 or more goals	40 (54.8)	47 (45.6)	128 (69.2)				
ASR	−0.9	−3.4	3.8				
Game phase				10.042	0.12	0.084	0.084
Positional Attack	62 (84.9)	98 (95.1)	166 (89.7)				
Direct counterattack	9 (12.3)	3 (2.9)	11 (5.9)				
2nd and 3rd wave	2 (2.7)	0 (0.0)	5 (2.7)				
7 m	0 (0.0)	2 (1.9)	3 (1.6)				
Time period grouped				6.675	0.14	<0.05	<0.05
Periods 2,4,5	48 (65.8)	81 (78.6)	119 (64.3)				
ASR	−0.6	2.6	−1.8				
Periods 1,3,6	25 (34.2)	22 (21.4)	66 (35.7)				
ASR	0.6	−2.6	1.8				

Table 4. *Cont.*

	1st–3rd *n* = 73	4th–6th *n* = 103	7th–10th *n* = 185	s.t.	ES	*p*	ESp
Inferiority disposition				60.307	0.41	<0.001	<0.001
With goalkeeper	40 (54.8)	97 (94.2)	167 (90.3)				
ASR	−7.7	3.3	3.2				
Empty net	33 (45.2)	6 (5.8)	18 (9.7)				
ASR	7.7	−3.3	−3.2				

Data presented as absolute frequencies (percentage). n: absolute frequencies of actions registered for each ranking group; s.t.: statistical test value for the Pearson Chi-Square Test or Fisher's Exact Test as applicable; ES: Effect size (Cramer's V for asymmetric tables and Contingency coefficient for symmetric tables); Esp: *p*-value for Cramer's V; ASR: adjusted standardized residual, calculated only for those variables that presented a statistically significant relationship ($p < 0.05$).

Figure 1 presents a decision tree using the exhaustive CHAID algorithm to predict offensive performance during exclusions related to the final ranking. The dependent variable was Ranking (GI, GII, and GIII). Independent variables were the game outcome, critical periods of the game, offensive system, asymmetries grouped, partial difference in the score, phase of the game, and finalizations. The model obtained explained 58.3% of the variance (estimated risk of 0.42; SD 0.02), estimating 78.0% for GI, 67.6% for GIII, and 30.4% for GII. Node 1 predicts winners belonging to GI at 49.0%, while Node 2 predicts losers belonging to GIII at 58.1%. Node 4 shows that playing with an empty net during inferiority situations predicts winners belonging to GI. Node 5 shows that playing under numerical inequality (superiority or inferiority) when the difference in the score is of more than 5 goals predicts being ranked in GIII. In contrast, node 9 shows that in a context of 4 goals (for or against), playing at inferiority with an empty net, and having superiority situations (that is to say that rivals suffered exclusions), is a predictor of belonging to GII. Node 10 notes that in the context of a difference in the score, playing in inferiority situations with the goalkeeper in goal is a predictor of losers belonging to GIII.

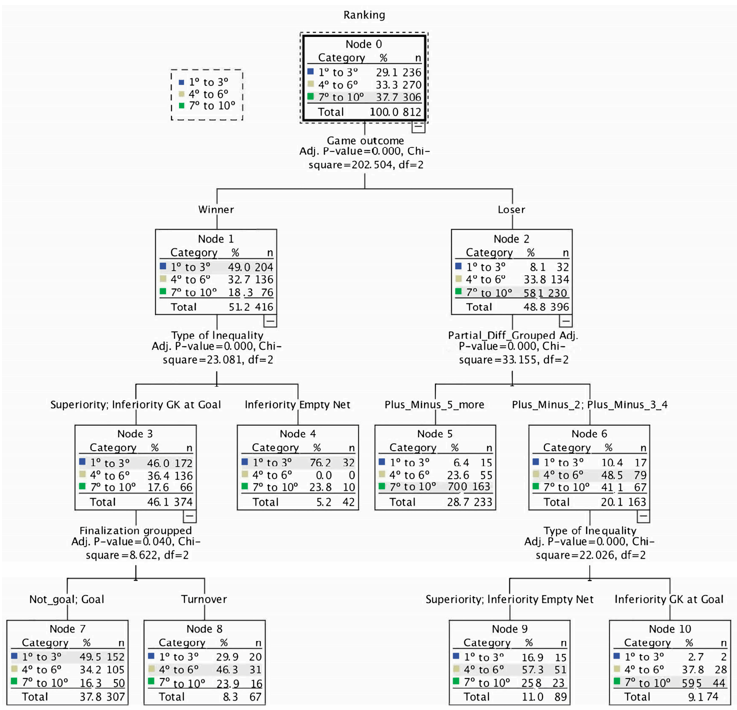

Figure 1. Decision tree using the exhaustive CHAID algorithm to predict the offensive performance during exclusions according to the final ranking.

4. Discussion

4.1. General

A total of 812 actions were registered during the 211 sanctioned exclusions during the tournament (an average of 7.3 exclusions per game). Almost a quarter of the total game time (around 15 min) was played under numerical inequality situations. These results are similar to the 7.9 exclusions per game at the female OG [34] and the 7.6 exclusions per game found at the 2015 female Pan-American Games (PPGG) [31]. They are similar to results found at the male elite international level, where almost 30.0% of the game time is played under exclusions [34]. Two reasons may explain this fact. One could be that female handball defense is "less aggressive" than male defense. The other could be that, based on the fact that referees at male and female championships are not always the same, the criterion used might be different.

4.2. Exclusion as Indicator

A total of 56.8% of the total actions occurred during superiority, and 43.2% during inferiority. The main reason for this appeared to be regulatory. Rules 2 and 13 in Rules of the Game state that when a 2 min or a disqualification is sanctioned, referees must call for a timeout, and the opposing team that receives the exclusion may restart the game with a free throw [23]. This means that the team restarting the game (the one that benefited from the exclusion of its opponent) will register the first finalization of the period of asymmetry. Therefore, since the number of actions in inferiority increased from GI to GIII, it can be said that the number of exclusions also increased from the group of top-ranked teams compared to the group at the bottom, coinciding with the performance of winning and losing women teams at the 2004 to 2016 OG [35] and 2007 to 2017 female WCh [22]. Exclusions and dismissals are associated with psychological players' crises in the competition context [36]. Indeed, players tend to behave in a way that does not lead to an exclusion in equal games [36,37]. Since GIII teams registered a tendency to lose, it can be argued that the reason those teams received more exclusions may be due to being disadvantaged during the games. This is sustained (in comparison to GI) by registering more finalizations when the difference in the score was 5 or more goals (an unequal game context).

4.3. Context of Superiority

AE is one of the performance indicators used to compare and explain performance in handball. The studied teams ranked 1 to 8 in the all-male OG, WCh, and European Championships between 2004 and 2010 presented an AE mean of 50.9% per game for the entire match [1]. Since attacking in superiority can be linked to having the possible advantage of overcoming the opposition, having found that teams of GI at the 2017 FPHCh had an AE of 63.2% can be considered similar to the elite international level. To win in a handball game, teams should create situations where the possibility of scoring is facilitated. A temporal numerical advantage in the number of players is undoubtedly an advantage. Should a team want to win a game, it may also perform better than the opponent in those temporal moments. The CHAID study showed that ranging between 1st to 7th (GI and GII) is predicted when winners play under superiority conditions; therefore, winners in those groups may have a better AE (better performance) than losers. This coincides with studies in this context concerning a numerical advantage of players at the Serbia 2013 women's WCh [28] and the Toronto 2015 Female Handball PPGG [31]. However, it is notable that the AE during superiority in the present study had a statistically significant relationship with the final ranking, not coinciding with results in Serbia 2013 [28]. The characteristics of the players [5], the improvement in TE through the impact of programs focused on the enhancement of strength [38], game time handling [39], and the tactical intention of throwing from the 6-m line [40] are the possible aspects that determine winners more effective performance during temporal superiority situations. Nevertheless, future research might target the specific reasons for the increased efficacy observed in the winning teams. Gruic et al. [41] found the impact of turnovers as a predictor of performance in male handball. Following this line, it was found that teams of GIII doubled the percentage of turnovers of GI teams. Technical-regulatory errors in the attack may be caused by deficiencies in the players' abilities (especially of the back-court players who are in charge of organizing the game in all phases, and also those most in contact with the ball) or by the high-quality either of defensive players or defensive systems. During the context of superiority in offensive situations, the skills of players of the attacking team should be more relevant than the opposition. Therefore it is possible to state that GIII teams (the lowest quality of the tournament, reflected in their final score differences in all games) made many mistakes during their attacks while having superiority, mainly because their players may not be good enough to handle possessions ending with a throw. The fact that GIII teams have less experienced players (or at least some who haven't participated in youth and junior WCh) may also explain the performance in this context since expert players are better at predicting and anticipating responses during game situations.

4.4. Context of Inferiority

The offensive performance of teams that suffered an exclusion tends to be negatively influenced, creating difficulties in scoring goals and impacting their AE [24]. Despite the fact that results in the present research have not presented a statistically significant relationship between AE and final ranking, the differences in the AE were very important, with GI teams performing similarly to the top 6 teams ranked in the Serbia 2013 WCh [28]. It is relevant to mention that GII and III teams ended in turnover 36.9% and 36.2% of their attacks (while GI teams presented 21.9% of turnovers), concurring with the performance of losing teams during the 2007 to 2017 female WCh [22]. Match status is a game context introduced into performance analysis as another important situational variable. Results from the 2017 FPHCh suggest that playing in a context of inferiority and keeping the goalkeeper in goal when the match status was balanced or moderate was a predictor of losing teams ending in GII or GIII. It appears that strategic behavior was affected by match status, leading the teams to not take risks when match status was moderate or balanced. Since 2016, the opportunity has existed to equalize (or even reduce) the numerical inequality suffered after exclusions, through playing with an empty net and with all players wearing the same clothing as their teammates. In this respect, Brazil and Argentina made an important change in Pan-America since they played almost 50% of their inferiorities with an empty net, in contrast to results at the PPGG 2015, where in none of the attacks was the goalkeeper substituted [31]. This important percentage of use of the rule by Brazil is sustained by Brazilian elite coaches who stated that during exclusions they mainly use a court player substituted for the goalkeeper to play in numerical equality [42]. Since a statistically significant relationship was found between using or not using this strategic rule change and final ranking, this tactical decision taken by national coaches may have influenced the final position of Brazil and Argentina at the top of the ranking. The fact that less than a fifth of the total offensive actions registered were played with an empty net differs from results presented at 8 games in the knockout phase of the male 2016 OG, where 85 out of 98 finalizations during an inferiority context were played with an empty net [25]. The reason for this difference is stated by coaches, who stated that the male teams had used the rule more than the female [42]. However, the significant difference in the attack efficacy of medalist teams and those ranked in the last 4 found in this study (42.5% and 26.5%, respectively) do not coincide with results from the best 8 male teams at Rio 2016 [25]. The decision to use this strategy verifies the importance stated by coaches to maintaining numerical equality in court players (even taking the risk of leaving the empty net), showing interest in the offensive game structure and the development of individual and collective actions [43].

5. Conclusions

In conclusion, during the 2017 FPHCh, finalizations under a superiority context predicted GI team inclusion. Indeed, GI teams tended to score in most of their finalizations and used 1st wave counterattacks with statistically significant frequency. Substituting the goalkeeper for a court player in an inferiority context (playing 6 against 6 with an empty net) was a predictor of belonging to GI, while playing with the goalkeeper in goal (playing 5 against 6) when the match status was balanced or moderate, predicted the loser teams ending up in GII or GIII. This information is likely to be used by coaches as they plan specific tasks accounting for indicators presented here, especially when training to play with an empty net during inferiority situations, as teams tend to have a better AE when using this strategy.

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