ANALYSIS OF DISCRIMINATORY GAME VARIABLES BETWEEN WINNERS AND LOSERS IN WOMEN'S HANDBALL WORLD CHAMPIONSHIPS FROM 2007 TO 2017

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Abstract:

The aim of this study was to identify game variables that discriminated winning from losing teams and to understand how these variables contributed to victory by observing goal differences in matches of the women's handball world championships. The sample comprised 471 WCh's games played between 2007 and 2017. The games were grouped into three clusters: balanced games – difference of 1-8 goals; unbalanced games – difference of 9-20 goals; and very unbalanced games – difference of > 20 goals. Generally, the performance of winning teams was significantly higher (in most variables), or lower in the case of the number of technical faults (p<.05). In the balanced games, there was a greater contribution of defensive variables (stolen balls, blocked throws, and goalkeeper's efficiency indicators) in relation to attack variables (attack efficiency and throw efficiency indicators). For victory, the number of technical faults reduce the chances of winning. Games with the unbalanced and very unbalanced goal differences seem to follow the same tendency; however, in the very unbalanced games, there were more assists, yellow cards and 2-min suspensions. We concluded that the decisive variables for victory in the balanced games showed a greater weight, with a special emphasis on stolen balls followed by offensive variables (throw efficiency indicators, attack efficiency, and technical faults). There was an equal tendency for the games with unbalanced and very unbalanced outcomes.

Key words: *team handball, game analysis, static approach, tactics, team sports*

Introduction

The search for excellence in handball requires from coaches and technical committees to seek means and tools for a competitive performance analysis to identify the variables needed for success. Between 1995 and 2001, important changes in the rules of handball were discussed and implemented, such as the "passive play rule", related to a lack of objectivity in the attack, and "quick restart of the game after the goal conceded" (Karcher & Buchheit, 2014; Seco, 2015). Essentially, because of such modifications and subsequent changes (such as the latest rule of the seventh player switched with the goalkeeper), the game has become faster, more dynamic and complex, with many changes in the intensity of players' actions. In this sense, a lack of information from game performance analyses on the variables that differentiate between the winning and losing teams makes it difficult to plan training and competitions aiming to improve performance in high-level competitions; also, there is a lack of data that can serve as a reference for teams, coaches, and players in development (Karcher & Buchheit, 2014; Prieto, Gómez, & Sampaio, 2015).

Handball is a team sport characterized by intermittent physical efforts, played in a common space, where play is unfolding under laws of within-team cooperation and oppositional relationships between players of two teams. The context of individual and team actions developed in the game has a great unpredictability, randomness, and variability (Menezes, 2012). Players behave in accordance with offensive (maintenance of ball possession, advance to the opponent's goal, and score) and defensive principles (recover ball possession, hinder the opponent's progression, and protect own target) (Bayer, 1994; Estriga & Moreira, 2014).

The technical-tactical analysis of handball games unfolds usually in two categories called (1) dynamic analysis oriented to the process of games, and (2) game-oriented static analysis (Prieto, et al., 2015; Volossovitch, 2013, 2017). The dynamic analysis records technical-tactical actions in a chronological order, providing a more complete and expanded view of tactical options as considers the context of actions, and is more complex methodologically (Pfeiffer & Perl, 2006; Volossovitch, 2013; Prieto, et al., 2015). On the other hand, the static analysis comes to studies of description and comparison of cumulative game variables of individual and team actions, as well as the study of game patterns of winners and losers in competitions using multivariate approaches, without considering the context of action occurrence (Volossovitch, 2013, 2017; Prieto, et al., 2015).

Studies describing and comparing game variables in high-level competitions have attributed the greatest prediction power for victory to the efficiency of different types of throws (Bilge, 2012; Gruic, Vuleta, & Milanovic, 2006; Lagos, Gómez, Viaño, González-Garcia, & Fernández, 2013; Meletakos, Vagenas, & Byaios, 2011; Ohnjec, Vuleta, Milanović, & Gruić, 2008; Srhoj, Rogulj, Padovan, & Katic, 2001; Vuleta, Milanovic, & Sertic, 2003; Vuleta, Sporis, & Milanovic, 2015), and the counter-attack efficiency (Gruic, et al., 2006; Rogulj, Vuleta, Milanovic, Cavala, & Foretic, 2011; Oliveira & Gomez, 2012; Teles & Volossovitch, 2015; Srhoj, et al., 2001;) in the offensive phase. However, diffuse results observed predominantly in men's handball can possibly be attributed to the analysis of games with different confrontation quality characteristics (univariate approach).

On the other hand, there seems to be little interest in the analysis of defensive variables, highlighting the efficiency of the goalkeeper (Gruic, et al., 2006; Lagos, et al., 2013; Volossovitch & Gonçalves, 2003), ball retrieving and blocked throws (Lagos, et al., 2013). In addition, there seems to be a consensus on the importance of the general efficiency of the goalkeeper (Daza; Andrés & Tarragó, 2017: Saavedra, Porgeirsson, Kristjánsdóttir, Chang, & Halldórsson, 2017;Volossovitch & Gonçalves, 2003) and stolen balls (Daza, et al., 2017), important elements to the beginning of the transition to attack.

Additionally, in game patterns analyses, the available evidence shows that counter-attack efficiency (Rogulj, Srhoj, & Srhoj, 2004; Volossovitch & Gonçalves, 2003), fast attacks lasting less than 25 seconds (Volossovitch & Gonçalves, 2003), technical faults (Daza, et al., 2017; Saavedra, et al., 2017), the efficiency of 9-meter throws (Volossovitch & Gonçalves, 2003), general throw efficiency, number of attacks (Saavedra, et al., 2017), and number of throws defended by the opposing team (Daza, et al., 2017) are relevant performance indicators of the winning teams' play in attack. However, despite representative samples (80-324 games), such studies were performed only with men and did not consider the characteristics of confrontations, as evidenced by the difference in the goals scored observed in game results (Daza, et al., 2017; Rogulj, et al., 2004; Saavedra, et al., 2017; Volossovitch & Gonçalves, 2003).

Furthermore, to our knowledge, there is a lack of information and studies about analysis of play patterns of winners and losers in high-level women's handball, suggesting the need for a greater focus on it (Volossovitch, 2013) and for considering the characteristics of confrontations. Therefore, the identification of performance indicators and behaviors that contribute to the success of a team is one of the latent issues in the tactical analysis of handball. In this sense, game analysis can offer a greater capacity for sports preparation for a future competitive scenario. Thus, the aim of this research was to analyze game variables that discriminated the winning teams from losing teams, and how these variables contributed to victory considering the characteristics of confrontations by observing goal differences in matches of women's handball world championships.

Methods

This study is a *post-facto* quasi-experimental study (Tenenbaum & Driscoll, 2005) based on the official data of matches, provided by the International Handball Federation (IHF), accomplished in women's handball world championships from 2007 to 2017.

Sample

Altogether, 489 women handball world championships' matches were played between 2007 and 2017, corresponding to 39.4% of all matches played in all elite handball world championships (1,242 matches). Eighteen games that resulted in a tie were excluded from the sample. Therefore, the final study sample consisted of 471 games (37.9% of the total). In Table 1, the number of official matches played in each competition and the characteristics of age, body mass, and height of the athletes are presented.

Procedures

Data were obtained from an online source of the International Handball Federation (IHF) (www.ihf.info). Game variables and results are available for download in the IHF website's competitions archive. The game statistics of the teams participating in the women's handball world championships from 2007 to 2017 were extracted and tabulated in a spreadsheet (Microsoft Excel®) (Table 2).

Table 1. Number of adult women's handball matches and general characteristics of the athletes in the 2007 to 2017 world championships

Year	Host (Champion)	Matches	Mass (kg)	Height (cm)	Age (years)
2007	France (Russia)	36	67.84±7.80	174.71±7.02	24.97±4.64
2009	China (Russia)	110	68.45±7.90	174.63±7.17	24.57±4.04
2011	Brazil (Norway)	88	68.68±7.72	175.35±6.43	25.70±4.12
2013	Serbia (Brazil)	84	69.17±7.51	174.84±6.49	25.73±4.36
2015	Denmark (Norway)	88	69.23±8.55	175.35±6.97	26.04±4.39
2017	Germany (France)	83	70.04±2.24	175.78±2.04	25.66±1.62
Total (mean±standard deviation)		489	68.90±0.75	175.11±0.45	25.44±0.55

Note. The data are available at the IHF website www.ihf.info from the year 2007 to the year 2017.

Table 2. Variables proposed by the IHF and their meaning

Game variable	Meaning
Throw efficiency (TE)	Percentage ratio between the number of goals scored and the number of throws taken.
Attack efficiency (AE)	Percentage ratio between the number of goals scored and the number of attacks.
Efficiency of 6-m throws (E6T)	Percentage ratio between the number of goals scored and the number of throws executed from the line of 6 meters.
Efficiency of wing throws (EWT)	Percentage ratio between the number of goals scored and the number of throws from wings' positions.
Efficiency of 9-m throws (E9T)	Percentage ratio between the number of goals scored and the number of throws taken from and farther from the line of 9 meters (long range shots).
Efficiency of 7-m throws (E7T)	Percentage ratio between the number of goals scored and the number of throws taken from the line of 7 meters.
Fastbreak efficiency (FE)	Percentage ratio between the number of goals scored and the number of fastbreaks executed by each team.
Breakthrough efficiency (BE)	Percentage ratio between the number of goals scored and the number of breakthroughs performed by each team.
Assists (ASS)	Absolute frequency of assists by a team, which consist in pass the shooter receives to throw on goal and score, i.e. a pass directly contributing to a field goal scored.
Technical faults (TF)	Absolute frequency/number of technical errors made by a team.
Steals (ST)	Absolute frequency/number of stolen ballls by a team.
Blocked throws (BT)	Absolute frequency/number of the opponent's throws blocked by a team.
Yellow cards (YC)	Yellow cards awarded by the referee for each team.
2-minute punishments (P2)	Punishments of 2 minutes (suspensions) conferred by the refereeing for each team.
Goalkeeper efficiency (GE)	Percentage ratio between the number of goalkeeper's saves and the number of throws.
Efficiency of 6-m goalkeeper's defenses (E6G)	Percentage ratio between the number of the goalkeeper's saves of 6-m line throws and the number of throws made from 6 meters.
Efficiency of wings goalkeeper's defenses (EWG)	Percentage ratio between the number of the goalkeepers' saves of wing throws and the number of wing throws.
Efficiency of 9 meters goalkeeper's defenses (E9G)	Percentage ratio between the number of the goalkeeper's saves of 9-m line throws and the number of throws made from and farther from the 9-meter line.
Efficiency of 7-m goalkeeper's defenses (E7G)	Percentage ratio between the number of the goalkeeper's saves of the 7-m throws and the number of throws made from 7 meters.
Efficiency of fastbreaks goalkeeper's defenses (EFG)	Percentage ratio between the number of the goalkeeper's saves of throws from fastbreaks and the number of fastbreak throws.
Efficiency of breakthroughs goalkeeper's defenses (EBG)	Percentage ratio between the number of the goalkeeper's saves of the throws from breakthroughs and the number of throws made from breakthroughs.

In each game, the winning and the losing teams were identified. Then, the matches were classified according to the difference in the number of goals into balanced games (1-8 goals), unbalanced games (9-20 goals), and very unbalanced games (> 20 goals).

Statistical analysis

The descriptive statistics are presented in terms of means and standard deviations (mean±SD) (Tables 1 and 3). Then, a cluster analysis was performed using k-means to define the cut-off point of goal differences between the matches by computing the partition coefficient (R^2). A priori, three clusters were defined (balanced games, unbalanced games, very unbalanced games) (Prieto, Gómez, Volossovitch, & Sampaio, 2016). Previously, the assumptions of normality (Shapiro-Wilk test) and homoscedasticity (Bartlett test) were tested. When any of the assumptions was violated, a logarithmic transformation was performed, and the normality and homoscedasticity tests were performed again. To test the differences in game statistics between the winning and losing teams within each cluster, an analysis of variance (one-way ANOVA) was performed for the variables that respected such assumptions, and the nonparametric Mann-Whitney test for those that did not respect such assumptions.

Before the use of discrimination methods, the method of selecting the "stepwise" variables was used by observing the lowest measurement value of the Akaike Information Criterion (AIC) (Mingotti, 2013; Massuça, Fragoso, & Teles, 2013). Then, to identify the variables that discriminated winning from losing teams in groupings, a Fischer linear discriminant analysis was performed using the cross-validation method. The discriminant value for the structural coefficient (SC) was ≥ |0.30| (Lorenzo, Gómez, Ortega, Ibáñez, & Sampaio, 2010). Finally, logistic regression models were fitted to estimate the probability of victory and the relative importance of each explanatory variable within each cluster. To verify the quality of the adjusted models, the residual deviance of the model was calculated. The significance level was α=.05. For the tests, the statistical software "R" ("R" Foundation for Statistical Computing), version 3.3.0, was used.

Results

The studied variables are described in terms of means and standard deviations for each cluster (Table 3). In the balanced games, there were significant differences in most variables in favor of the winning teams (TE, AE, E6T, EWT, E9T, E7T, BE, ASS, ST, BT, P2, GE, E6G, EWG, EBG, E7G), except for FE, YC, E9G, and in only one variable in favor of the losing teams (technical faults, TF). In the unbalanced games, there were again significant differences in favor of the winning teams (TE, AE,

*Table 3. Descriptive analysis of game variables studied in terms of mean and standard deviation (mean±SD) (*Indicates significant diferences for p<.05)*

INDEX	Balanced games (CLUSTER 1; 1-8 goals, n=264)			Unbalanced games (CLUSTER 2; 9-20 goals, n=146)			Very unbalanced games (CLUSTER 3, >20 goals, n=61)		
	Winner	Loser	Statistic; p – value	Winner	Loser	Statistic; p – value	Winner	Loser	Statistic; p – value
TE	59.0±7.0	50.9±7.2	F=168.8; p<.001*	65.4±6.4	42.3±7.6	U=198.5; p<.001*	70.7±10.5	31.1±9.2	U=61; p<.001*
AE	47.6±6.0	40.9±6.6	U=15128; p<.001*	53.7±6.3	31.8±6.8	U=277; p<.001*	61.9±6.8	21.6±8.6	U=44.5; p<.001*
E6T	64.9±18.3	57.4±20.4	U=26842; p<.001*	67.5±16.5	50.5±20.1	U=5401.5; p<.001*	74.9±15.7	45.3±20.1	F=81.6; p<.001*
EWT	61.4±22.0	52.1±24.5	U=25553; p<.001*	63.4±20.9	40.5±26.5	U=5203; p<.001*	65.7±20.5	32.2±22.5	U=491; p<.001*
E9T	39.8±14.8	33.6±14.2	U=25450; p<.001*	45.6±20.1	26.2±11.1	U=3876.5; p<.001*	49.8±22.6	16.2±9.9	U=333; p<.001 *
E7T	72.6±25.9	67.3±27.3	U=30727; p=.017*	73.9±25.4	65.5±31.4	U=9277; p=.049*	76.5±26.7	51.5±39.0	U=1169.5; p<.001*
FE	75.1±23.2	71.7±26.4	U=32800; p=.235	77.6±12.4	55.7±37.6	U=7474.5; p<.001*	78.4±9.6	37.9±40.2	U=834; p<.001*
BE	74.6±31.5	65.4±35.1	U=29666; p=.002*	73.5±32.9	63.6±39.5	U=9361.5; p = 0.06	76.3±30.2	53.9±41.4	U=1332; p<.001*
ASS	13.0±4.6	10.7±4.3	U=24986; p<.001*	17.2±5.5	8.5±4.0	U=1924; p<.001*	23.5±7.3	5.4±3.4	U=30.5; p<.001*
TF	14.9±4.5	15.8±4.5	U=38406; p=.041*	14.6±4.5	20.7±6.1	U=16943; p<.001*	12.7± 5.0	27.8±7.6*	U=3557.5; p<.001*
ST	4.3±2.5	3.8±2.4	U=31199; p=.035*	6.4±3.7	3.6±2.6	U=5596.5; p<.001*	7.9±3.9	3.1±2.0	U=409; p<.001*
BT	3.3±2.5	2.1±1.9	U=25074; p<.001*	4.0±2.7	1.3±1.3	U=3761; p<.001*	6.7±3.5	0.5±0.8	U=67; p<.001*
YC	2.9±0.7	2.8±0.8	U=34675; p=.916	2.7±0.7	2.6±0.9	U=10128; p =.415	2.5±0.7	2.6±0.5	U=2006; p=0.377
P2	3.9±1.8	3.6±1.8	U=31207; p=.035*	3.3±2.0	3.5 ±1.9	U=11276; p =.3869	1.7±1.5	3.5±1.8	U=2866.5; p<.001*
GE	35.3±8.0	27.7±7.3	F=126.40; p<.001*	43.3±9.5	22.5±6.5	U=558; p <.001*	53.6±10.4	18.3±5.3	F=552.4; p<.001*
E6G	33.0±20.0	26.42±16.9	U=27598; p<.001*	38.5±20.2	23.8±15.5	U=5967; p<.001*	40.3±21.5	18.7±13.2	U=694; p<.001*
EWG	39.1±25.5	29.6±21.4	U=27387; p<.001*	47.9±29.8	26.0±21.3	U=5964; p<.001*	58.1±26.1	23.7±19.1	U=521; p<.001*
E7G	24.5±24.3	17.3±21.1	U=28771; p<.001*	24.7±28.1	15.6±20.4	U=8802; p =.008*	25.5±33.6	11.7±19.1	U=1526; p=0.06
E9G	46.1±19.0	39.6±19.2	U=27578; p=.667	55.7±16.7	31.9±21.4	U=3775; p<.001*	70.1±16.1	26.9±24.9	U=308; p<.001*
EFG	18.6±22.7	15.8±18.9	U=33421; p=.393	19.1±25.9	15.0±10.51	U=11642; p=.161	29.0±38.9	14.1±7.9	U=2058; p=0.306
EBG	20.1±27.1	12.5±20.4	U=29755; p<.001*	16.8±27.3	12.5±21.3	U=10218; p =.475	16.9±27.6	9.1±14.6	U=1717.5; p=0.392

Note. F - Test Statistics (Fisher); U - Test Statistics (Mann - Whitney).

E6T, EWT, E9T, E7T, FE, BE, ASS, ST, BT, GE, E6G, EWG, E9G, E7G), and only one in favor of the losing teams (TF). Significant differences were not obtained only for BE, YC, P2, EFG, and EBG. For the very unbalanced games, no significant differences were obtained for YC, E7G, EFG, and EBG, whereas in all the other quantified variables significant differences were determined either in favor of the winning teams (TE, AE, E6T, EWT, E9T, E7T, FE, BE, ASS, ST, BT, P2, GE, E6G, EWG and E9G), or the losing teams (TF).

The number of three clusters was previously determined in order to minimize the sum of squares of residuals and to increase the value of R^2 (85.7%), which indicated a greater heterogeneity among the groups, resulting in a larger sum of squares between the groups and, consequently, a greater homogeneity of the games allocated in each cluster. Table 4 shows the number of games classified in each cluster by the k-means method. After the application of the variable selection method (*stepwise*), the explanatory variables TE, EWT, AE, TF, ST, BT, YC, and GE (AIC=-1,111.2) were maintained in the cluster 1 (balanced games), the variables TE, AE, TF, ST, BT, P2, and GE (AIC=-983.09) were maintained in cluster 2 (unbalanced games), and the variables AE, ASS, TF, ST, BT, YC, P2, and GE (AIC=-512.93) were maintained in cluster 3 (very unbalanced games) for the construction of the models.

According to the established criterion (SC≥|.30|), only the variable ST had a greater importance for the balanced games in relation to the others. For the unbalanced games, the variables ST, BT, GE, TE, and AE showed, in the descending order, a greater importance for the discrimination of winners. For the very unbalanced games, there was a greater importance for the variables YC, P2, GE, BT, AE, ASS, and ST according to the values obtained for the CE, resulting in a greater contribution, in that order, to the score of the discriminant function of winners. It is interesting to note that the ST variable was common to all the discriminant analyses performed. The structural coefficients obtained in the discriminant analyses and the proportion of correct classifications (%) observed with the use of cross validation are shown in Table 4.

After the calculation of the residual deviance and the associated probability, we found that the logistic regression models obtained were adequate ($p>.05$), and the number of degrees of freedom (df) was greater than the deviance value (Table 5). For the interpretation of the obtained models, it was necessary to calculate the exponential value of the obtained coefficients (Odds Ratio - OR) for each model, as presented in Table 5.

In this sense, the increase by 1% in the TE and AE increased the odds - ratio of winning in balanced games by 16.37% and 18.44%, respectively, regarding the attack actions (considering the other variables unchanged). For the variables related to defense, each increase of one unit raise the odds ratio of winning in ST by 35.87% and in BT by 26.46%. Additionally, considering the other constant variables, the 1% increase in GE increased the chance of a team to win by 25.81%. On the other hand, by keeping the remaining variables (TE, AE, ST, BT, and GE) unchanged, the increment of one TF unit decreased the OR of winning by 6.66% in the balanced games. Table 5 shows the OR for each component variable of the logistic regression models obtained for the balanced games.

In the unbalanced games, a 1% increase in AE increased the odds of winning by 7.0%, considering that the value of the other variables remained

Table 4. Structural coefficients (SC) of the linear discriminant analysis of the official variables in balanced, unbalanced and very unbalanced games after the application of the variable selection methods by clusters. (Discriminant value of the SC≥|.30| in balanced games[a], unbalanced games[*] and very unbalanced games[†])

CLUSTER 1 (1-8 goals) Balanced games		CLUSTER 2 (9-20 goals) Unbalanced games		CLUSTER 3 (>20 goals) Very unbalanced games	
VARIABLES	**SC**	**VARIABLES**	**SC**	**VARIABLES**	**SC**
TE	-.13	TE	-.33*	AE	-.64†
AE	-.17	AE	-.31*	ASS	-.55†
EWT	-.01	TF	.19	TF	.19
TF	.07	ST	-.55*	ST	-.53†
ST	-.30a	BT	-.49*	BT	-.67†
BT	-.21	P2	-.16	YC	-2.75†
YC	-.24	GE	-.42*	P2	1.12†
GE	-.22	-	-	GE	-.71†
Correct Classifications	86.0%	**Correct Classifications**	99.3%	**Correct Classifications**	99.2%
Sample (%)	264 (56.05%)	**Sample (%)**	146 (30.99%)	**Sample (%)**	61 (12.95%)

Note. TE - Throws efficiency; AE - Attack Efficiency; EWT - Efficiency of wing throws; TF - Technical Faults; ASS - Assists; ST - Steals; BS - Blocked shots; YC - Yellow cards; P2 - 2-minutes punishments; GE - Goalkeeper efficiency.

Table 5. Odd ratios (OR) of predictive variables and residual deviance (RD) of the logistic regression models

CLUSTER	VARIABLES	OR (95% CI)	SE	DR (DF, p-value)
Balanced games (1-8 gols)	Intercept	$4.17_*10^{-11}(4.21_*10^{-13}- 4.13_*10^{-9})$	2.345	346.31 (522, p=.99)
	TE	1.163 (1.066–1.27)	.044	
	AE	1.184 (1.057–1.327)	.058	
	TF	.933 (.836–1.042)	.056	
	ST	1.358 (1.196–1.542)	.064	
	BT	1.264 (1.110–1.441)	.067	
	GE	1.258 (1.200–1.316)	.023	
Unbalanced games (9-20 gols)	Intercept	.003 (.001-.011)	.572	58.26 (288, p=.99)
	AE	1.070 (1.050-1.090)	.009	
	ST	1.058 (1.014-1.104)	.021	
	GE	1.033 (1.019-1.046)	.006	
Very unbalanced games (>20 gols)	Intercept	.010 (.002-.047)	.766	16.24 (119, p=.99)
	AE	1.049 (1.024-1.076)	.012	
	GE	1.026 (1.004-1.048)	.011	

Note. TE - Throws efficiency; AE - Attack Efficiency; TF - Technical Faults; ST - Steals; BS - Blocked shots; GE - Goalkeeper efficiency; CI - Confidence interval; DF - Degrees of freedom; SE - Standard Error.

constant. In these games, the increase in one unit of ST resulted in an increase in the OR of winning by 5.8% in the unbalanced games. For the goalkeeper, a 1% increase in GE meant an increase by 3.3% in the winning ratio. Finally, for the very unbalanced games, the 1% increase in AE indicated a 5.0% increase in the odds ratio, maintenance the value of the GE variable constant. On the other hand, by upkeep the AE variable unchanged, the 1% increase in GE increased the odds of winning by 2.65%. Table 5 shows the odds of winning for each component variable of the logistic regression models obtained for the unbalanced and very unbalanced games.

Discussion and conclusions

This study identified game variables that discriminate the winning from the losing teams and how these variables contribute to victory in high-level women's handball, considering the characteristics of confrontations (goal differences in all matches) at the 2007-2017 world championships according to the data made available by the IHF. In summary, to our knowledge, this is the first study on high-level women's handball using a highly representative sample and a multivariate approach. This shows that, in the balanced games, there is a greater contribution of the defensive variables stolen balls, blocked throws and goalkeeper's efficiency, when compared to the offensive variables of attack efficiency and throw efficiency, to predicting victory in balanced matches, with a particular emphasis on steals. On the other hand, by observing the offensive variables, the number of technical faults reduce the chances of winning.

In general, comparisons of the established means revealed that the performance of winning teams was significantly higher in most variables, whereas it was lower in case of the number of technical faults in each cluster (Table 3), except for the variables YC (all clusters), P2 (unbalanced games), BE (unbalanced games), FE (balanced games), EFG (all clusters), EBG (unbalanced and very unbalanced games), E7C (very unbalanced games), and E9C (balanced games), which did not present significant differences between the winning and losing teams. Possibly, the separation of games into clusters and their homogeneity may explain broader differences between winners and losers (Table 3) found in the present study in relation to previous studies that highlighted differences in the efficiency of throws (Bilge, 2012; Gruic, et al., 2006; Lagos, et al., 2013; Meletakos, et al., 2011; Ohnjec, et al., 2008; Oliveira & Gomez, 2012; Rogulj, et al., 2011; Srhoj, et al., 2001; Teles & Volossovitch, 2015; Vuleta, et al., 2003, 2015). The classification of games resulted in three groups of games with homogeneous characteristics (R^2=85.7%), which may have led to a broader significance of differences than in previous studies, showing progressively greater differences among the means of variables from cluster 1 to cluster 3 (see Table 3).

When comparing our findings with studies with the same purpose and approach to men's handball, the results differ. Saavedra et al. (2017) studied men's handball at the Olympic Games from 2004 to 2016 using a linear discriminant analysis (83% of correct rankings), and found that throw efficiency, blocked throws or throws defended by the goalkeeper, technical faults and number of attacks differed (in descending order) winning from losing teams. These results diverge completely from our findings on the balanced games, where the variable stolen balls was the only significant SC variable, resembling in part with the component variables of discriminant models in the unbalanced and very unbalanced games (Table 4), except for the importance given to steals (defensive phase) in our study according to all discriminant analyses performed and compared to a greater weight given to throw efficiency (offensive phase), as observed by Saavedra et al. (2017). Possibly, the differences obtained in our study may be attributed, in part, to the characteristics of the confrontations considered in this study, differently from the procedures adopted by Saavedra et al. (2017).

Daza et al. (2017) identified variables related to victory prediction from the official statistics of the 2015 men's world championship using a multiple logistic regression model. The authors found that the variables number of technical faults (less than 10), throws saved by the opponent's goalkeeper (less than 12 throws), goalkeeper efficiency (greater than or equal to 12 throws) and stolen balls (greater than five) increase, in that order, the odds of winning. Although these results refer to men, excepting for the opponent's goalkeeper efficiency, all the other predictor variables of the logistic regression model corroborate the defensive variables as identified in our study for the balanced games and, in part, for the unbalanced games and very unbalanced games (Table 5).

However, the odds ratio for winning in this study is translated by the largest contribution of stolen balls, blocked throws and goalkeeper efficiency, thus differing from findings of Daza et al. (2017). Comparing our findings with those of Saavedra et al. (2017) and Dazaet al. (2017), we can see that there is agreement on the importance of the defensive variables ST, BT and GE for both men and women being indicators of a greater importance for the discrimination between winning and losing teams. Perhaps, these findings should be associated with strength or mental vigor gained or added to success in stealing the ball, blocking or defending a throw, which alters interpersonal perception and ultimately influences individual physical and mental performance, reflecting itself in outcomes of games (Moesch & Aplitzsch, 2012; Mortimer & Edward, 2014). Thus, the team that has regained ball possession has a chance to attack again without the opponent having scored a goal (Mortimer & Edward, 2014).

Based on the results of our research, we can feasibly highlight the importance of the goalkeeper given the identification of GE as a component variable of all victory predicting models; the goalkeeper is a key element of defensive performance. Although GE is a component of the model for the balanced games and does not have a significant CE in the analyses, a progressive increase in the contribution of this variable to the final score is observed with the increase in goal difference. In addition, the success of expert goalkeepers in defense actions seems to be located at the delay in starting the movement to obtain more information about the ball's trajectory, executing intervention actions in a shorter time (faster) when compared to less experienced ones (Schorer, 2005). Such findings reinforce the importance of maximum strength and explosive strength training (Aagaard, Simonsen, Andersen, Magnusson, & Dyhre-Poulsen, 2002) and the ability to anticipate actions by identifying signals offered by attackers on the side and height of a throw to decrease uncertainty (Guttiérrez-Davila, Rojas, Ortega, Campos, & Párraga, 2011; Rojas, Gutiérrez-Davila, Ortega, Campos, & Párraga, 2012).

There is a parallel between the game variables identified in the discriminant analyses and the principles of game in team sports (Bayer, 1994; Estriga & Moreira, 2014). In the balanced games, the defensive principles of retrieving ball possession, hampering opponent's progression and protecting the goal are observed to a certain extent in the identified variables ST, BT, and GE. Antagonistically, offensive principles of maintaining ball possession, progression to goal and goal scoring are partially observed in the discriminant variables AE, TE, and TF. However, the variables identified for the balanced matches do not seem to clearly highlight both the defensive principle of hindering the opponent's progression (e.g., number of faults and punishments) and the offensive principle of goal progression (e.g., duration and number of attacks ending in throws and assists). In the unbalanced and very unbalanced games, the representation of the variables identified on the principles of the game is again verified, however, in the very unbalanced games, the principles of progression to the goal (offensive) and hindering the opponent's progression to the target (defensive) are verified from a greater number of assists and defensive faults resulting in YC, respectively.

After the analysis of a game, coaches often have difficulties in interpreting and integrating the obtained information in the planning of training. In this sense, coaches need to have a clear and desired game model, and they must develop steps and strategies to achieve it (Freitas, 2012). The variables identified seem to offer a clear general idea of the winning team's game model, with a greater weight on defensive behaviors, manifesting in the pressure on the opponents with the aim to regain possession of the ball, as well as in protecting the goal out of which, when successful, opportunities arise for quick transition and scoring quick goals (counterattacks). If opponents have managed to deny such transitions, possession of the ball must be preserved in order to seek situations with numerical and spatial advantages for throws from positioned attacks; no loss of possession due to technical faults is wanted.

Additionally, the elaboration of the game model is based on the choice of training tasks using teaching approaches that emphasize the demands related to complex interactions between teammates and opponents (Menezes, 2012). Therefore, it is important to emphasize game situations and teaching through games because they allow the delimitation of a tactical problem (with possibilities of restricting the space, number and functions of the players, and game rules), and require tasks based on the game for the improvement of the technical control of handball skills (simple situations contextualized), thus expanding players' understanding of the context and their ability to make decisions (Estriga & Moreira, 2014; Menezes, Marques, & Nunomura, 2017). Small-sided games with constraints on the invariant characteristics of the formal game (ball, goal, number of players, space of games, technical-tactical rules) also integrate the development of desired technical-tactical behaviors transferable to the formal game (Davids, Araújo, Correia, & Vilar, 2013). However, the development of tasks should seek the desired skills of players aligned with the performance in competition, and should be adequate to learning, consolidation and improvement phases (Freitas, 2012).

It is also worth noting that, in the training planning process, factors such as experience in participating in competitions, use of time-out, home team advantage, and quality of opposition are extremely important for the outcome of games (Prieto, et al. 2016; Teles & Volossovitch, 2015). In order to achieve an expert performance, practice time, participation in competitions and number of top-level games are the main forms used to characterize and analyze the development and process of sporting excellence (Deakin, Côté, & Harvey, 2009; Ericsson, Krampe, & Tesch-Romer, 1993; Ericsson & Charness, 1994).

For studies with a result-oriented approach based on the summary of accumulated information, it is also highlighted that, for some balanced games, it seems not possible to establish a direct relationship between the quantified actions and the results observed at the end of the games. In addition, it should be remembered that, although the system of cumulative game observation variables used by the IHF has been used in several studies, to our knowledge, this system lacks previous validation. In addition, despite a great importance of defense and counterattack to the outcome of the game, the adopted variable system does not report the number of interruptions (faults) caused by defensive actions, or the success of defensive sequences in avoiding a favorable condition during a counterattack, when a team performed a defensive return (Karcher & Buchheit, 2014).

We recommend for future studies with the focus on women's handball noting the use of *time-out*, considering the quality of opposition in confrontations, and studying of sequences of technical-tactical actions carried out in balanced matches using techniques that allow approaches to dynamics. In addition, attention should be paid to how the information obtained in game reviews can guide coaches and technical committees in organizing and elaborating exercises and training sessions, directing problem solving to the preparation of games according to the characteristics of confrontations.

In summary, among the variables identified by the discriminant methods, a greater weight was verified for the defensive variables stolen balls, blocked throws and goalkeeper general efficiency, with a special emphasis on stolen balls, followed by the offensive variables throw efficiency, attack efficiency and technical faults in balanced games. The games with the unbalanced and very unbalanced scores seem to follow the same tendency as the variables identified for balanced games. However, for the very unbalanced games, the principles of progressing to the target (number of assists) and hindering the progression to the own target (yellow cards and 2-minute suspensions) are more commonly verified. The variables identified seem to provide a "general idea of the game model" based on the success of defensive behaviors in favoring and taking advantage of counterattacks or positional attacks with the fewest number of technical faults possible in high-level female handball, but other ideas on the game can be unfolded from the information obtained.

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