Match Statistics as Predictors of Team's Performance in Elite competitive Handball

Estadística del partido como predictor del rendimiento de equipo en el balonmano de élite

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Abstract

The aim of the present study was to identify performance indicators able to predict victory in a handball match. A documental research was carried out based on data from 80 matches from the Men's Handball World Championship, held in Qatar in 2015. Data was obtained from the International Handball Federation website. Reliability was determined through intra and inter-observer agreement. Our results show that the combination of attack, defense, and goalkeeper indicators adequately predicted winning a match. Specifically, the multivariate logistic regression analysis showed that shots saved by other team's goalkeeper, technical fouls, steals, and own goalkeeper's saves were adequate predictors of team performance. We also analysed the cut-off points of key performance indicators that significantly predict the victory of a match. The study of objective performance indicators and their relationship with team outcome can be useful to trainers as a tool to assess different match features.

Key words: handball; match statistics; prediction; performance indicators.

Resumen

El objetivo del presente estudio es identificar los indicadores de rendimiento que permiten predecir la victoria en un partido de balonmano. Se llevó a cabo un estudio documental basado en los datos de los 80 partidos del Campeonato Mundial de Balonmano Masculino, celebrado en Qatar en 2015. Los datos fueron recogidos por la Federación Internacional de Balonmano. Se calculó la fiabilidad intra e inter observador. Los resultados muestran que la combinación de indicadores de ataque, defensa y portero predijo adecuadamente ganar un partido. Específicamente, el análisis de regresión logística multivariante mostró que los lanzamientos parados por el portero del otro equipo, las faltas técnicas, los robos y las paradas del propio portero, eran predictores adecuados del rendimiento del equipo. Se establecieron puntos de corte a partir de los cuales aumenta significativamente la probabilidad de ganar el partido. El estudio de los indicadores de desempeño y su relación con los resultados del equipo puede ser una buena herramienta para evaluar diferentes características del juego.

Palabras clave: balonmano; estadísticas de partido; predicción; indicadores de rendimiento.

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Introduction

Match statistics are a powerful tool for assessing both individual and team performance in sports. The media, trainers, and spectators all demand clear and summarised information about the events that occur in competitive events. Performance indicators are defined by O'Donoghue (2010) as "those variables that are demonstrated to be valid measures of important aspects of performance and which possess the metric properties of having an objective measurement procedure, a known scale of measurement and a valid means of interpretation". Moreover, they can be especially useful as part of match analysis by providing an objective and unbiased record of team activity (Higham, Hopkins, and Anson, 2014; Hughes and Bartlett, 2002).

This, in turn, can help those interested to assess and monitor performance. Moreover, the identification of performance indicators can help predict the final result (O'Shaughnessy, 2006). To be meaningful and useful, match indicators should be related to successful performance outcomes and must provide accurate information about the actions that should be encouraged during play (Daza, 2010).

The analysis of performance indicators in sports has direct practical implications. As Higham et al. (2014) note, reference values can assist in understanding variability in team performance, can aid coaches in establishing quantifiable objectives for training and performance, and can help when evaluating the efficacy of training interventions and tactical changes. Knowledge of performance indicators can also be used to create performance profiles to predict team behaviours and performance outcomes (Wagner, Finkenzeller, Würth, and von Duvillard, 2014).

In team sports, the primary outcome measure of group performance is usually the final result: that is, winning or losing (Hughes and Bartlett, 2002; O'Shaughnessy, 2006; Oliveira, Gómez, and Sampaio, 2012). However, as noted by several authors (Ferrari, Dos Santos, and Vaz, 2014; Gómez, Lago-Peñas, Viaño, and González-Garcia, 2014; Teles and Volossovith, 2015; Vaz, van Rooyen, and Sampaio, 2010), team performance indicators should consider not only the final result but also the number of points scored. Indeed, recent studies have analysed match statistics in several sports settings (Georgiana and Aurelia, 2014; Liu, Gómez, Lago-Peñas, and Sampaio, 2015; Lupo, Condello, Capranica, and Tessitore, 2014; Sampaio, Ibáñez, and Lorenzo, 2013). Volossovitch (2013) the lack of studies considering the dynamics of the game versus the studies addressed from a static perspective, where the time in which the game actions occur is not taken into account.

Despite the interest in identifying features that could be useful to assess performance in team sports, few studies have focused on handball. The game dynamics in handball arise from a series of phases that are organised and based on ball possession, and performance indicators may be able to reflect the internal structure of this possession in different game sequences. It is important to note that in handball, setting up a goal is the result of direct and indirect actions, as well as the use of free spaces and passes, but note that different objectives must be met during different game phases (Gruić, Vuleta, and Milanović, 2006). These game phases: a) attack, characterised by a team attempting to score a goal; b) defense, which aims to recover possession and prevent the opposing team from scoring a goal; and c) goalkeeper, where a player tries to prevent a goal within the goal area. These dimensions are combined to achieve match success, and take place in different areas of the field.

Today, technology allows for the collection of reliable indicators of handball matches in the main national leagues and international championships, thus enabling researchers to carry out accurate analyses of performance (Blanco, Ibáñez, Antúnez, and Hernández-Mendo, 2015). To this end, several studies have assessed performance statistics in handball (Foretić, Rogulj, and Trinić, 2010; Georgiana and Aurelia, 2014; Gruić et al., 2006; Meletakos, Vagenas, and Bayios, 2011). Given the specific features of handball, match indicators should include defense, attack, and the role of the goalkeeper, as conducted by Skarbalius, Pukénas, and Vidūnaité (2013). As pointed out by these authors, detailed quantitative analyses of performance indicators in handball setting can enhance performance through the improvement of performer feedback.

Nor is there any consensus regarding the definition of performance indicators that predict team performance in handball. Some researchers have highlighted the efficacy of fastbreak, pivot actions, and first line players in team success (Bilge, 2012), while others have shown negative correlations between goal attempts and goals scored in shots from six- and nine-metre (Foretić et al., 2010; Meletakos et al., 2011). Other studies have shown that, in isolation, goalkeeper actions are insufficient to increase the probability of winning a match, and that shot efficacy should be considered. Moreover, several studies have indicated that defensive actions and fastbreaks are relevant to the overall team performance (Antúnez, García, Sáez, Valle, and García, 2013; Sáez, Romero, and Feu, 2009; Vuleta, Sporiš, Purgar, Herceg, and Milanović, 2012) and, therefore, to the probability of winning a match. However, the heterogeneous nature of these data means that it is unclear which performance indicators should be monitored, and their identification is a relevant matter.

The aim of the present study was to identify key performance indicators able to predict the final scores on the basis of statistics from matches in the Men's Handball World Championship in Qatar 2015. The specific aims of the study were: a) to identify a prediction model of group performance based on objective attack, defense, and goalkeeper indicators, and b) to analyze the optimum values of key performance indicators.

Methods

Data collection

Data were collected from the 24th Men's Handball World Championship held in Qatar in 2015. The data referred to the official match team statistics comprising numerical and objective indicators routinely recorded in Handball World Championships. The competition brought together 24 national teams from the five continental confederations, which had passed the respective qualifying stages. Matches that ended in a draw or went into extra time were excluded, therefore 80 matches were considered for the analyses.

Measures

Team performance was analysed based on the three dimensions defined in the introduction in Table 1: a) result, outcome of the final score of the game b) attack, referring to attempts to score, c) defense, referring to attempts to recover the ball, and d) goalkeeper, focused on saving opponents' shots on goal. Several indicators related to these three dimensions were considered, given the importance of their combined action. For the attack phase, the indicators recorded were: shots (shots saved by other team's

goalkeeper, shots missed, shots hitting the post), assists, 7 metre shots, technical fouls and balls lost. Indicators for the defense phase were interceptions, blocks, and punishments (warnings, suspensions and expulsion). For goalkeeper, the indicator was the number of shots saved by the goalkeeper.

Table 1. Definition of performance indicators

Dimension	Indicator	Description
Result	Win	The team wins the game.
	Lose	The team loses the game.
	Tie	The team ties the game.
Attack	Goal	The ball completely crosses the goal line of the opponent in a regulatory action.
	Shot saved	Shots fired stopped by the goalkeeper.
	Shot missed	Shots fired outside the goal.
	Shot post	Shots fired on the a goal post.
	Shot blocking	Shots blocked by a defender.
	Assists	Pass received by a player who leaves it ready to finish with launch and scores a goal.
	7m penalty shots	Action shot from 7m.
	Turnover and technical faults	Turnover and rule violation (steps, double, feet, area, more than three seconds with the ball adapted, offensive foul...)
	Induce yellow card	Player action causes the sanction of warning the opposing player.
	Induce 2 minute suspension	Player action causes the penalty two minutes from opposing player.
	Induce red card	Player action causes the red card penalty opposing player.
Defense	Goal against	The ball beyond the line fully own goal, the referees point goal.
	Steals	A defender recovers the ball to the opponent
	Blocked shots	A defender hits a blocking the path of the ball thrown on goal.
	Yellow cards	Referees teach a card player yellow colour
	2 minute	Referees penalized with two minutes, the team stays temporarily with one player less.
	Red card	Referees teach a card player red colour, the team stays temporarily with one player less.
	7m penalty against	Action shot from 7m against
Goalkeeper	Saves goalkeeper	The goalkeeper intercepts the trajectory of the ball thrown by a player avoiding the goal.

In order to analyze reliability of data obtained from the official match statistics, an observational analysis was carried out by two independent experts. Observers were selected based on their academic and research background in observational methodology in sport sciences. Observation criteria were previously defined by the experts in order to code data from one match of the sample. According to specialized literature (González-García, Casáis, Viaño, and Gómez, 2016; Lames and McGarry, 2007), both observers were subjected to stable conditions in which the measurements were taken. Intra- and interobserver reliability was assessed based on a total of 127 actions, that were analyzed and coded in LINCE (v.1.1) (Gabin, Camerino, Anguera, and Castañer, 2012). All official indicators shown in Table 1 were assessed and an intraclass correlation was calculated. Results showed perfect agreement between the official statistics and both raters (ICC=1.000, p < .0001).

Data analysis

The analyses in the present study were performed with PASW Statistics for Windows, Version 18.0 (SPSS, Inc, Chicago, IL, USA). Firstly, a descriptive analysis in term of means, standard deviation, and minima and maxima of match statistics was conducted. Mean comparisons were carried out with the Student's t test and the Mann-Whitney U test, depending on the normality or non-normality of variables. Parametric and non-parametric correlations were applied (Pearson and Spearman) to assess the possible relationship between the quantitative indicators included in the match statistics. The possible differences in the abovementioned performance indicators between different rounds of the competition were conducted by means of analysis of variance (ANOVA) and the non-parametric Kruskal–Wallis test.

Secondly, multivariate logistic regression analyses were applied. Since the Kruskal-Wallis non-parametric test showed statistically significant differences in shots hitting the post according to the round of competition ($X^2_{(6)} = 14.08$, p <.05), only those teams that were selected for the second round (n = 16) were included in the analysis. The dichotomous dependent variable was the match result (winning or losing). The independent variables included in the multivariate logistic regression analyses were the ones that were important in the group performance and therefore showed statistically significant differences between won and lost matches. Finally, odds ratio and 95% confidence intervals were obtained in order to define the likelihood of winning the match according to the specific values of the variables identified as predictors in the previous logistic regression analysis.

Results

Descriptive analysis of attack, defense and goalkeeper indicators

The results of the descriptive analysis of the attack, defense, and goalkeeper indicators are shown in Table 2. The number of goals in the matches analysed ranged from 13 to 42. Winning teams scored a mean of 30.23 goals (SD = 4.31) and losing teams a mean of 24.36 goals (SD = 4.42).

As expected, the mean comparison between the scores obtained in these indicators showed that there were statistically significant differences between the number of goals scored by winning or losing teams. Statistically significant differences were also identified in the following variables: unsuccessful goal attempts (specifically, there were significant differences in shots saved by other team's goalkeeper, shots missed,

shots hitting the post, and shots blocked), goals from 7m penalty shots, assists and technical fouls. Regarding the defensive indicators, statistically significant differences were found in the variables steal and block. Finally, goalkeepers on winning teams made more saves than goalkeepers on losing teams.

Table 2. Descriptive analysis of attack, defense and goalkeeper indicators

	Matches lost				Matches won				
	Min	Max	M	SD	Min	Max	M	SD	Mean comparisons
Goals	13	38	24.36	4.42	23	42	30.23	4.31	$t_{(154)} = -8.40^{***}$
Unsuccessful goal attemps	12	35	22.71	5.41	8	33	17.12	4.82	$U = 1348.50^{***}$
Shots saved by opposing goalkeeper	7	24	13.31	3.60	4	18	10.44	3.12	$U = 1758.00^{***}$
Shots missed	0	8	3.24	1.84	0	7	2.42	1.75	$U = 2242.00^{*}$
Shots hitting post	0	7	2.62	1.73	0	6	1.94	1.41	$U = 2400.50^{*}$
Shots blocked	0	10	3.29	2.34	0	8	2.09	1.71	$U = 2087.00^{*}$
7m Penalty Shots	0	7	3.28	1.72	1	10	4.28	1.82	$U = 2140.00^{*}$
Assists	1	25	11.77	4.50	6	28	16.17	4.37	$t_{(153.88)} = -6.19^{***}$
Technical fouls	7	24	13.60	4.40	5	26	12.10	3.78	$U = 2469.50^{*}$
Steals	0	12	4.06	2.27	0	10	4.64	2.20	$U = 2438.50^{*}$
Blocks	0	8	2.21	1.75	0	10	3.33	2.27	$U = 2122.50^{*}$
Yellow Cards	1	4	2.99	0.85	1	4	2.96	0.69	$U = 2910.00, p = .605$
2 Minute Suspensions	1	12	5.13	2.15	1	9	4.88	1.90	$U = 2881.50, p = .564$
Red cards	0	3	0.19	0.51	0	1	0.08	0.27	$U = 2802.00, p = .125$
Saves by goalkeeper	4	18	10.37	3.23	3	24	13.09	3.91	$U = 1851.50^{***}$

Note. * $p < .05$, ** $p < .001$, *** $p < .0001$.

Variables related to the number of goals

A correlation analysis was conducted to identify indicators that were directly related to the number of goals scored, and therefore to the group performance.

A statistically significant correlation between the number of goals and unsuccessful goal attempts was obtained ($r = -.449$, $p < .0001$), since a lower number of unsuccessful goal attempts was related to a higher number of goals. Specifically, the following no-goal indicators presented statistically significant correlations with the final score: shots saved ($r = -.373$, $p < .0001$), and shots blocked ($r = -.358$, $p < .0001$). Significant correlations

were obtained with other performance indicators: 7 m penalty shots (r =.226, p <.05), assists (r =.635, p <.0001), and technical fouls (r = -.282, p <.0001). Regarding defense variables, the number of goals was only significantly correlated with the variable block (r =.246, p <.05). Finally, as expected the number of goalkeeper saves was positively correlated with the final score (r =.266, p <.05).

Predictive analysis of group performance

A multiple logistic regression analysis was carried out to predict team performance. The 16 teams that qualified for the corresponding round of the Championship (last sixteen) were considered in the present analysis.

First a multiple logistic regression analysis was performed to identify those attack variables that predicted winning the match. The number of goals was excluded from the analysis since it is a direct indicator of team performance and it would therefore have distorted the results. A model including shots saved and technical fouls showed the best fit to predict winning the match.

After identifying the attack variables that predict team performance, a second multiple logistic regression analysis was applied in order to identify the model that, considering attack, defense, and goalkeeper variables, was the best for predicting winning the match. The attack variables identified as adequate predictors, as well as defense and goalkeeper variables, were included in the model as independent variables. Specifically, only the defense and goalkeeper variables that showed statistically significant differences when comparing won and lost matches (Table 2) were included in the analysis.

Multiple logistic regression analysis revealed that the model that showed the best fit for the prediction of winning the match was the one that included the following variables: shots saved by the other team's goalkeeper, technical fouls, steals, and saves by the goalkeeper (Nagelkerke R square = .422).

Odds ratio were calculated to analyse the probability of winning the match according to the frequency of the variables identified as predictors in the earlier regression analysis. These indicators were recoded into categorical variables according to their mean values. Specifically, the odds ratio showed that the teams that made fewer than 12 shots saved by the other team's goalkeeper or technical fouls were more likely to win the match. Similarly, when the goalkeeper made 12 or more saves, his team was twice as likely to win the match. Finally, when at least five steals were made, the likelihood of winning the match increased slightly. With seven steals – which corresponds to the mean value plus the standard deviation – the chances of winning the match increased markedly odds ratio (OR = 2.041). Similarly, teams that made fewer than ten technical fouls were twice as likely to win the match (OR = 2.063).

Table 3. Odds ratio of the predictive variables of the team's performance in semi-finals and final

	Cut-off point	OR (95% CI)
Shots saved by the other team's goalkeeper	< 12	2.06 (.52 – 8.17)
Technical fouls	< 12	2.70 (.66 – 11.09)
Steals	≥ 5	1.61 (.41 – 6.24)
Saves by goalkeeper	≥ 12	2.04 (.52 – 7.99)

Note. CI, confidence interval; OR, odds ratio.

Finally, a descriptive analysis was carried out of the mean number of shots saved by the other team's goalkeeper, technical fouls, steals, and saves by the goalkeeper during the semi-finals and final. Only the team that won the Championship – France – showed optimum values for these variables (Table 3).

Discussion

Our results provide empirical support for the use of match statistics to explain and predict results in top-level competitive handball, corroborating the reports of other authors in other team sports (Vaz, Mouchet, Carreras, and Morente, 2011). The use of data from the official statistics allow us to contextualize the events in a handball match and to identify the indicators that have a significant influence on the final result. As several authors note (Gómez, Battaglia, Lorenzo, Lorenzo, Jiménez, and Sampaio, 2015; Gómez, Lorenzo, Ibáñez, and Sampaio, 2013; Liu et al., 2015; Sampaio et al., 2013), it is important to take the box score of the match as a global indicator of group performance. The present study is the first to include attack, defense, and goalkeeper variables together as indicators of team performance.

The correlation analysis showed that goals, shots and assists are associated with match result. Several variables related to the attack phase showed statistically significant differences between winning and losing teams. Specifically, the number of goals, and unsuccessful goal attempts (shots saved, shots missed, and shots blocked), all of which showed statistically significant differences between winning and losing teams. Consequently, it seems that unsuccessful goal attempts and 7m penalty shots are variables that affect the match result, as stated in previous research (Vuleta et al., 2012). The effect of spatial position and time of plays on team performance have been widely studied (Celes, Vojvodic, and Skender, 2012; Foretić et al., 2010; Gutiérrez and Ruiz, 2013; Meletakos et al., 2011). However, other authors suggest that the number of shots per game could be an adequate indicator of team performance (Bilge, 2012). In this line, the present study shows that the number of throws is a significant variable in overall team performance.

Several variables – shots saved by the other team's goalkeeper, shots blocked, and technical fouls – were inversely correlated with the number of goals, which could be explained by the fact that these actions involve the end of possession, and therefore lead to possession for the other team. On the other hand, the number of 7m penalty shots and goal assists were moderately and strongly associated – respectively – to the number of goals, since these are actions that lead to good goal-scoring opportunities.

In line with the multivariate analysis carried out by Gruić et al. (2006), our results revealed that winning teams make more assist passes and fewer technical fouls than losing teams. Our data show that assist passes represent a significant variable for winning the match; this is a variable strongly linked to goal-scoring (since it involves a player making a pass to a team-mate in an ideal position to shoot). Also, a technical foul, a variable that leads to a loss of possession, causes a clear fastbreak opportunity for the opposing side, and has been shown to be a relevant variable in team performance (Meletakos et al., 2011).

Shot efficiency as a predictor of the result was previously studied by Foretić et al. (2010) and Oliveira et al. (2012), who found that the winning teams in the Spanish Professional Handball League (2007-09) scored more goals from 6m, 7m, and 9m than

losing teams. Similarly Srhoj, Rogulj, Padovan, and Katić (2001) analysed the 1999 Men's Handball World Championship and presented empirical evidence that the final result depended not on the number of throws, but on their quality. According to this line, Yamada, Aida, Fujimoto, and Nakagawa (2014), show that female handball teams have a greater efficiency in the launch in organized attack and counterattack, 6m and with contact with the opponent.

Regarding the defense phase, our results corroborate those obtained by other authors (Gruić et al., 2006; Ohnjec, Vuleta, Milanović, and Gruić, 2008; Sáez et al., 2009; Srhoj et al., 2001), who found that teams that are more efficient in defense perform fast transitions and increase goal efficacy (Gruić et al., 2006).

The number of saves made by the goalkeeper is a significant variable when comparing winning and losing teams, being the winning teams those who show a higher frequency of saves. This indicator has shown to be a good variable to predict the final result of the match (Pascual, Lago, and Casáis, 2010; Sáez et al., 2009). Saves made by the goalkeeper facilitate the development of counter-attack actions by the other members of the team. There is evidence that the efficacy in the completion of these actions is higher than those of the positional attack phase (Antúnez et al., 2013; Cälin, 2010; Sáez et al., 2009; Rogulj, Srhoj, and Srhoj, 2004). Therefore, the goalkeeper has a decisive role in the final result of the match (Antúnez et al., 2013; Ohnjec et al., 2008). However, the final performance does not only rely on the goalkeeper, but on the combination of an adequate offensive effectiveness (Pascual et al., 2010).

The prediction of performance has been approached from different angles, but none of them have simultaneously considered the attack, defense, and goalkeeper indicators. In the present study, the multivariate logistic regression analysis showed that the variables shots saved by the other goalkeeper, technical fouls, steals, and goalkeeper's saves were adequate predictors of team performance. Previous studies of the 2003 Men's and Women's World's Championship (Gruić et al., 2006; Ohnjec et al., 2008) found attacking variables to be good predictors of final outcome (efficiency of shots from specific positions, 7 m goals, technical fouls committed, and goal assists). Moreover, Vuleta et al. (2012) also identified a group of standard prediction variables: goals from 9 m, unsuccessful shots from 9m, goals from 6m, wing shots, unsuccessful shots from 6m, goals from fastbreaks, shots from fastbreaks, goals from 7m, unsuccessful shots from 7m, and successful and unsuccessful assists. Our results provide empirical support for the notion that the combination of attack, defense, and goalkeeper indicators adequately predict victory. In this line, there is an increasing interest in assessing comprehensive performance indicators also at an individual level in the handball setting (Kim et al., 2014) and the relevance of anticipation in the improvement of performance in handball (Balint and Curitianu, 2012). We also assessed the optimum values of shots saved by the other team's goalkeeper, technical fouls, steals, and goalkeeper's saves. The interpretation of these team performance indicators is related to the construction of fastbreaks. In this regard, the increase in the speed of play is related to a higher effectiveness of fastbreak shots than of positional attack shots (González, 2012). Therefore, avoiding actions that lead to opponents' fastbreaks, orienting defensive actions towards steals and improving the effectiveness of goalkeepers' saves should be the aims of handball planning and training in order to increase the chances of success.

The present study focuses on team performance based on official statistics. Further research should include individual indicators of specific skills that can contribute to the overall team performance (Michalsik, Madsen, and Aagaard, 2015; Volossovitch, Dumangane, and Rosati, 2009). The collection of data on both individual and team performance could lead to an integrative model for explaining team success. Moreover, the inclusion of spatial structure in the team execution analysis could provide a comprehensive approach to team success.

Conclusions

The present study examines official statistics from an international handball championship and assesses their relation to team performance. The number of goals scored and winning the match were taken as primary outcomes, and attack, defense, and goalkeeper indicators were included in the analysis.

The analyses of differences between winning and losing teams showed that several indicators are correlated with the number of goals scored and, therefore, with team success. However, only some of these indicators really predict victory. The predictive analysis revealed that the variables shots saved by the opposing goalkeeper, technical fouls, steals, and goalkeeper's saves are the key indicators of team performance.

The study of objective performance indicators and their relationship with team outcome can be useful to trainers for assessing various features of handball play. Physical preparation and players' technique can be monitored with these indicators in mind.

The use of statistic indicators can be a useful resource to coaches, since they offer valuable and objective information to assess the match. Therefore, performance indicators could be used to control and assess the competition. Specifically, ofensive, defensive and goalkeeper threshold indicators can be a guide to players and coaches to assess the match, as to be generalized to training sessions. Further research should be addressed to analyze the cut-off points established in the present study in other competitions and categories, in order to establish a specific model to assess both the team and players across different match phases.

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Acknowledgements