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Tactical and shooting variables that determine win or loss in top-Level in water polo

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Abstract

The aims of this study were: 1) determine if there is a difference in the efficacy and velocity of shots between winning and losing teams 2) analyse the relationship between efficacy values according to the particular microsituations (even, power play, transition and penalty) and between winners and losers in disputed games. Seventy-two male games that formed part of the 2008 European Championship and the 2009 World Championship have been analysed. Efficacy coefficients were used to assess all of the microsituations of the game that ended with a shot to obtain efficacy values. The results presented significant differences between winning and losing teams in terms of the coefficients of definition and resolution of shots, and in the coefficient of resolution and detention of shots to goal in both championships. It could be said that the efficacy values that determine the difference between winning and losing teams are those that make reference to the accuracy of the shot. The penalty microsituation of reference is not a determining factor in the winner or loser status of a team. No differences exist in the speed of shot between winning and losing teams within the same championship but they do exist between championships.

Keywords: Match analysis, performance indicators, competitive performance, efficacy of shots.

1. Introduction

The analysis of performance in sport largely refers to the investigation of relevant aspects of the player and/or the achievements of the team in a sporting competition. To this end, various aspects including technical aspects, tactics, patterns of play and efficacy indices should be studied. The prediction of success in team sports is complicated; it is necessary to integrate the individual ability of many sportspeople and tactical strategies of the trainers to obtain high standards of performance (O´Donoghue, 2005). The majority of studies that deal with high standards of performance in water polo are centered on the individual sportsperson in a conditional situation (Feltner and

Taylor, 1997; Horvath et al., 2009; Pavlik et al., 2005; Platanou and Geladas, 2006; Royal et al., 2006; Smith, 1998; Tsekouras et al., 2005), but these studies shed no light on why a team wins. Also, there is a scarcity of scientific publications dealing with aspects of play in male water polo (Argudo et al., 2009; Argudo et al., 2008; Ferragut et al., 2011; Hughes et al., 2006; Lozovina et al., 2003; Lupo et al., 2010a; Lupo et al., 2010b; Smith, 2004).

According to Hughes y Bartlett (2002), a performance indicator is a selection or a combination of action variables that aims to define some or all aspects of a performance. Clearly, to be useful, performance indicators should relate to successful performance or outcome. Performance indications can be considered important performance variables in water polo as it is a sport in which the endpoint of play is very clear as each play finishes with a throw at goal or with action close to the opponent's goal. In recent literature diverse studies use technical and tactical indicators to anlayse performance in water polo (Argudo et al., 2007; Argudo et al., 2008; Hughes et al., 2006; Lupo et al., 2010a; Lupo et al., 2010b; Smith, 2004).

In water polo the team's result is a direct expression of success they have in the action of shooting the ball at the opponent's goal and of the level of efficiency demonstrated by the team in defensive actions against the opposing team. For these reasons, although water polo demands a wide range of physical aptitudes, (McCluskey et al., 2010; Tan et al., 2009), there is no doubt that one of the most decisive actions is the shot (Smith, 1998; Van der Wende, 2005). Knowing how to combine the speed of the ball with precision in the shot is one of the most important factors; these skills have a decisive effect on efficacy (McCluskey et al., 2010). The faster and more precise a shot the more difficult it is for the defense and goalkeeper to intercept the ball. At the same time most studies to date have focused on the biomechanical analysis of penalty throws (Ball, 1996; Davis and Blanksby, 1977; Elliott and Armour, 1988; Feltner and Taylor, 1997; Van der Wende, 2005; Whiting et al., 1985). Nevertheless, few studies have included the study of tactical situations in their analysis of the speed of shot (Davis and Blanksby, 1977; Van der Wende, 2005), and none has analysed the speed of shot in competition and its' relationship with efficacy in game play.

For all the above reasons this study had two objectives. The first was to determine is differences exist between winning and losing teams measurable by efficacy values and speed of shot in each championship and between championships (European Championship and the World Championship). The second objective was to analyse the relation between efficacy values in a microsituations of reference (even, power play, transition and penalty) in teams who won or lost at the end of the game in each championship.

2. Methods

2.1. Participants

The present study was carried out with the 12 male participants selected for the European Championship held in Malaga in 2008 and the 16 participants selected for the 2009 World Championship held in Rome. All the players that competed in both

championships were analysed (European Championship and World Championship). Players were classified into two groups (outside players and center players) based on their principal playing role. Outside players consisted of those in the more generally recognized positional roles of outside shooters and driving players, whereas the center players consisted of players who played in center forward or center back roles. The championship was organised along the lines of a classifying stage, semi-finals and finals. A total of 72 games were analysed.

2.2. Variables and instruments

The analysis of the tactical variables was based on an observational methodology based upon previous research (Anguera, Blanco, Losada and Hernández, 2001). The design was nomothetic and multi-dimensional. The observations were direct observations and not participative. The system of classification used was that defined by Lloret (1994) and Argudo (2000).

The observation of the games was carried out by experts in the field. They were subjected to a training process and the intra and inter-reliability was verified previous to the registration of data (Anguera et al., 2000). To determine reliability the Kappa Index of Chen was applied. Regarding the reliability of the intra-observer, a concordance of greater than 92% was achieved and for the inter-observer it was greater than 87%.

The object variables of the study have been the condition of winner or loser at the end of the game, the microsituations of reference at the end of each attack **(**even, power play**,** transition or penalty), the speed of shot of the registered action and the efficacy values obtained from the coefficients proposed to evaluate each microsituation of the game.

The full description of four microsituations is as follows:

1) The numerical equality (even) microsituation in which all the components of both teams are present in the playing field and can coincide in the pool at the same time according to regulations: six players and a goalkeeper per team and whose main objective is to maintain the possession of the ball so as to obtain a goal (Argudo et al. 2008).

2) The transition with possession microsituation occurs when possession of the ball is recovered and includes the time which elapses between when the tactical playing system is disorganized in the home goal post to the transition into a structuring of the playing tactical playing system in the contrary goal post. The counterattack is a microsituation which is strategically predictable and which occurs after the recovery of the ball possession when players move to occupy as quickly as possible the most favourable tactical-strategic spaces and to create a momentary numerical superiority (Argudo et al, 2007).

3) The power play (numerical inequality) microsituation occurs, as is defined by regulation, when the number of players in each team is asymmetrical. It can be defined depending on the fault committed as: of a short time, of 20 seconds or until the recovery or loss of possession of the ball, or as a definitive expulsion of the player for the remainder of the game with no substitution permitted.

4) A penalty microsituation occurs when a defender commits a major foul within the five meter area that prevents a likely goal. In this case the attacking team is awarded a

penalty shot. An attacking player lines up on the five meter line in front of the opposing goal. No other player may be in front of him or within 2 meters of his position.

For this study a total of 8 coefficients were analysed, adapted from (Argudo et al., 2010). Five coefficients are offensive; the Coefficient of shots definition (CSD), the Coefficient of shots resolution (CSR), the Coefficient of shots accuracy (CSA), the Coefficient of inaccuracy of shots at goal (CISG) and the Coefficient of error in shots at goal (CESG). Also included were three coefficients measuring defensive actions; the Coefficient of shots blocked received (CSBR), the Coefficient of resolution of shots at goal (CRSG) and the Coefficient of detention of shots at goal (CDSG) (Table 1). The Coefficients of definition, resolution and accuracy of shots were better when closer to 1.

Table 1. Coefficients used adapted from Argudo et al., (2010).

Acronym	Name	Formula
CSD	Coefficient of shots definition	Sum of shots scored * 100 / sum of shots performed
CSR	Coefficient of shots resolution	[Sum of shots scored * 100 / sum of shots performed – (sum of shots out + sum of shots blocked + sum of shots post)]
CSA	Coefficient of shots accuracy	[Sum of shots performed - (sum of shots out + sum of shots blocked + sum of shots post)] * 100 / sum of shots performed
CSBT	Coefficient of shots blocked received	Sum of blocked received * 100 / sum of shots performed
CISG	Coefficient of inaccuracy of shots at goal	Shots detain * 100 / total shots
CESG	Coefficient of error of shots at goal	Shots detain * 100 / total shots - (sum of shots out + sum of shots blocked + sum of shots post)
CRSG	Coefficient of resolution of shots at goal	Sum of shots out * 100 / total shots
CDSG	Coefficient of detention of shots at goal	(Sum of shots out + sum of shots blocked + sum of shots post) * 100 / total shots

The speed of the throw

The speed of the shot from the trunk is evaluated in the playing field using radar (StalkerPro Inc., Plano), with a frequency of measure from 100Hz and with a sensitivity of 0,045m.s^{-1}. The radar was placed behind the goal at a distance of 10m. The speed of all shots executed was registered as well as the end result of the action (goal, out, post, blocked or stopped). Throwing velocities were registered from the shots performed

between 2 and 10 meters (away) from the goalpost. It is usually recommended that the shooting velocities registered by radar should be done from a frontal plane. Nevertheless, a recent study has validated the radar versus a photogrammetric method with a high-speed video camera from different zones of the pool (player $\theta = 20^{\circ}$ from the radar gun) with Intraclass correlation coefficient (ICC) of 0.96 and Coefficient of variation (CV) of 3.67% (Ferragut et al., 2010). The maximum velocity corresponds to the maximum velocity registered from the central zone during all the games analysed. The average velocity was obtained from the maximum velocities registered during all of the games from the central zone.

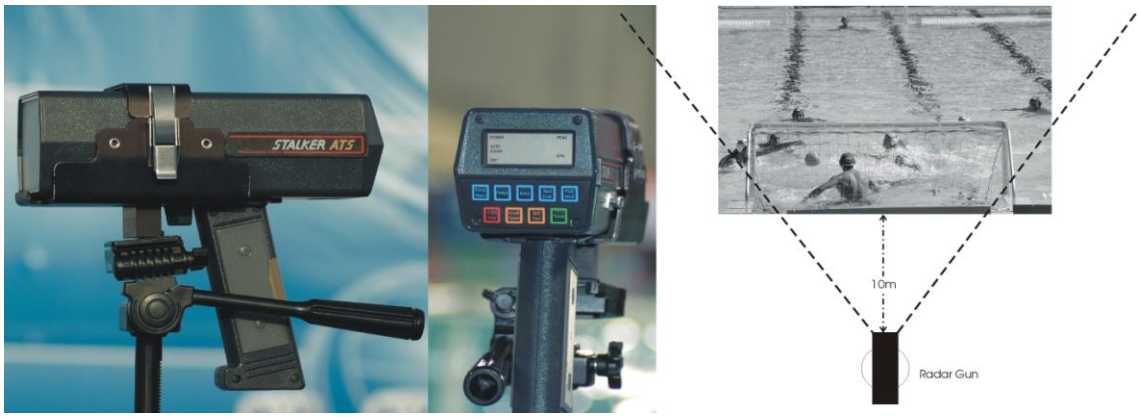

Figure 1. A Schematic representation of the radar position with a model radar gun (StalkerPro Inc., Plano).

2.3. Data analysis

The coefficients of efficiency calculated and expressed in percentages did not comply with standard or homogenous criteria and so non-parametric tests were applied. A non-parametric ANOVA was carried out using the Kruskal-Wallis test to analyse the significant statistical differences that marked the difference between the condition of loser or winner at the end of the game and for game-play situations. Mean and standard deviation scores were calculated for the throwing velocities measured in the study. To compare speeds of throw an ANOVA was used, with a post-hoc according to Tuckey. Homogenity was verified using the statistics of Levenne.

All the statistical treatments mentioned were carried out in accordance with the statistical pack SPSS and accepting that the level of confidence obtained is of 95% with a probability of error of 5% (significance level $p \leq 0.05$).

3. Results

The comparison between the different efficiency values of the winning and losing teams analysed during the World Championship and the European Championships of Water Polo are presented in Table 2.

Table 2. Percentage and typical deviation ($\% \pm sd$) of the efficiency values in the European Championship and in the World Championship. Differences between winners and losers within the same championship (*) for $p \leq 0.05$ and (**) for $p \leq 0.001$. Differences between winners and losers of different championships (†) for $p \leq 0.05$ and (‡) for $p \leq 0.001$.

	European C. Winners	European C. Losers	World C. Winners	World C. Losers
CSD	0.48±0.30**‡	0.36±0.32	0.47±0.27**‡	0.33±0.28
CSR	0.63±0.28**‡	0.49±0.32	0.59±0.28**†	0.46±0.32
CSA	0.74±0.23	0.69±0.23	0.76±0.20**†	0.68±0.23
CSBR	0.09±0.12	0.12±0.14	0.06±0.09**‡	0.11±0.16
CRSG	0.26±0.24*‡	0.32±0.24	0.29±0.19*	0.35±0.25
CDSG	0.37±0.28**‡	0.51±0.32	0.41±0.28*‡	0.53±0.32
CISG	0.06±0.10*‡	0.11±0.15	0.09±0.13	0.10±0.14
CESG	0.46±0.28†	0.53±0.30	0.44±0.24**‡	0.56±0.26

Legend: (CSD) Coefficient of shots of definition; *(CSR)* Coefficient of shots of resolution; *(CSA)* Coefficient of shots of accuracy; *(CSBR)* Coefficient of shots blocked received; *(CRSG)* Coefficient of resolution of shots at goal; *(CDSG)* Coefficient of detention of shots at goal; *(CISG)* Coefficient of inaccuracy of shots at goal; *(CESG)* Coefficient of error of shots at goal.

From the results displayed in Table 2 it is demonstrated that winning teams of the European Championship demonstrate statistical differences compared to the losing teams in 5 of the coefficients measured, one of definition, one of resolution of shots and another of resolution of shots at goal, in that of efficacy of detention of shots at goal and finally in the inaccuracy of shots at goal. For the World Championship the winning teams presented statistical differences in all of the coefficients measured and presented except in the coefficient of inaccuracy of shots at goal.

The results displayed in Table 3 demonstrate that the winning teams in the European Championship present statistical differences compared with the losing teams in four of the eight coefficients within the microsituations of even and counter-attack and in two coefficients in the power play microsituation. For the penalty microsituation no statistical differences have been established in either of the coefficients comparing winning and losing teams.

The results displayed in Table 4 show that the winning teams in the World Championship present statistical differences compared to the losing teams in seven of the eight coefficients in a microsituation of even. Differences also exist in six of the coefficients in a microsituation of counter-attack and in five coefficients in a microsituation of power play. No statistical differences exist for penalty microsituation.

Table 3. Percentage and standard deviation ($\% \pm sd$) of efficiency values in the European Championship organised according to winners and losers in the different microsituations of reference. Differences between winners and losers in the same championship (*) for $p \leq 0.05$ and (**) for $p \leq 0.001$.

	Even		**Power play**		**Transition**		**Penalty**	
	Winner	Loser	Winner	Loser	Winner	Loser	Winner	Loser
CSD	0.25±0.13**	0.14±0.11	0.49±0.26	0.35±0.30	0.56±0.19**	0.40±0.19	0.73±0.46	0.74±0.424
CSR	0.47±0.19**	0.27±0.20	0.57±0.26	0.50±0.35	0.77±0.19**	0.58±0.19	0.79±0.42	0.74±0.424
CSA	0.54±0.16	0.54±0.15	0.83±0.16**	0.68±0.23	0.73±0.19	0.67±0.19	0.93±0.26	100±0.00
CSBR	0.16±0.14	0.18±0.12	0.07±0.11	0.07±0.14	0.09±0.11**	0.18±0.15	---	---
CRSG	0.29±0.14**	0.40±0.15	0.34±0.22	0.33±0.25	0.18±0.17**	0.27±0.11	0.20±0.41	0.26±0.42
CDSG	0.53±0.19**	0.73±0.20	0.43±0.256	0.50±0.35	0.23±0.19**	0.42±0.19	0.21±0.42	0.26±0.42
CISG	0.14±0.12	0.17±0.10	0.04±0.08*	0.17±0.23	0.03±0.06	0.05±0.08	---	---
CESG	0.60±0.18	0.69±0.13	0.46±0.26	0.48±0.31	0.41±0.19**	0.55±0.19	0.27±0.46	0.26±0.42

Legend: (CSD) Coefficient of shots of definition; *(CSR)* Coefficient of shots of resolution; *(CSA)* Coefficient of shots of accuracy; *(CSBR)* Coefficient of shots blocked received; *(CRSG)* Coefficient of resolution of shots at goal; *(CDSG)* Coefficient of detention of shots at goal; *(CISG)* Coefficient of inaccuracy of shots at goal; *(CESG)* Coefficient of error of shots at goal.

Table 4. Percentage and standard deviation ($\% \pm sd$) of the efficiency values in the World Championship organised by winners and losers and in the different microsituations of reference. Differences between winners and losers within the same championship (*) for $p \leq 0.05$ and (**) for $p \leq 0.001$.

	Even		**Power play**		**Transition**		**Penalty**	
	Winner	Loser	Winner	Loser	Winner	Loser	Winner	Loser
CSD	0.24±0.10**	0.17±0.12	0.40±0.17**	0.23±0.22	0.55±0.10**	0.40±0.12	0.76±0.20	0.80±0.24
CSR	0.37±0.13**	0.30±0.16	0.53±0.20**	0.30±0.26	0.70±0.13**	0.61±0.17	0.80±0.22	0.89±0.18
CSA	0.64±0.86**	0.57±0.09	0.72±0.12	0.75±0.20	0.79±0.11**	0.64±0.09	0.96±0.82	0.90±0.18
CSBR	0.11±0.53*	0.13±0.61	0.04±0.06	0.07±0.13	0.08±0.66**	0.15±0.11	---	---
CRSG	0.40±0.08	0.40±0.12	0.32±0.10**	0.50±0.23	0.24±0.11	0.25±0.10	0.20±0.22	0.09±0.14
CDSG	0.62±0.13**	0.70±0.16	0.47±0.20**	0.68±0.27	0.30±0.13*	0.39±0.17	0.20±0.22	0.10±0.18
CISG	0.13±0.70**	0.17±0.61	0.13±0.13	0.11±0.14	0.06±0.06	0.06±0.06	---	---
CESG	0.62±0.93*	0.66±0.14	0.47±0.12**	0.64±0.25	0.38±0.11**	0.55±0.11	0.23±0.21	0.20±0.24

Legend: (CSD) Coefficient of shots of definition; *(CSR)* Coefficient of shots of resolution; *(CSA)* Coefficient of shots of accuracy; *(CSBR)* Coefficient of shots blocked received; *(CRSG)* Coefficient of resolution of shots at goal; *(CDSG)* Coefficient of detention of shots at goal; *(CISG)* Coefficient of inaccuracy of shots at goal; *(CESG)* Coefficient of error of shots at goal.

In Table 5 displays the speed of shot in competitions registered by winning and losing teams in both championships. No statistical differences have been found in the maximum velocities independently of the final condition of winner or loser, and neither was there a difference between championships. However differences were produced in the average velocity of shots between teams participating in the European Championship (winners and losers) and also in the average velocity of shots registered during the World Championship - differences which apply equally to both winners and losers.

Table 5. Values ($\bar{x} \pm sd$) of velocity (v) of throw ($m.s^{-1}$) in winning and losing teams. Significant differences between ($p \leq 0.05$): *Winning selection from the European Championship and †Losing selection from the European Championship

	European C. Winner	European C. Losers	World C. Winner	World C. Losers
Maximum *v*	20.85±7.31	20.92±7.48	20.71±7.08	20.59±7.56
Average *v*	18.13±6.74	18.33±5.77	17.11±7.58*†	17.12±8.04 *†

4. Discussion

The objective of this study was to determine whether differences exist in the coefficients of efficacy and speed of shots between winning and losing teams. Differences have been established in the majority of the coefficients studied in the European Championship and in the World Championship. With respect to the speed of shots registered in each finishing move differences have been found between winning and losing teams in the European Championship and between winning and losing teams in the World Championship.

For the analysis of the European Championship the winning teams were more efficient in their shots (CSD, CRSG and CDSG), and they threw more between the three posts (CSR and CISG). There was no distinction between teams in terms of defensive blocks, data that does not corroborate with data collected in other studies (Argudo et al., 2010; Escalante et al., 2011). An explanation for this may be found in the fact that both studies were carried out in other types of championships (World Championship and Olympic Games) and that the selections that participated were more heterogenous. In the World Championship the only coefficient that did not present statistical differences between winning and losing teams was the coefficient of inaccuracy of shots at goal. This indicates that very few shots ended up outside the three posts and it is independent of the final status of the team. The statistical differences registered for other coefficients studied are in agreement with the data presented by Argudo et al. (2010) in the Barcelona World Championship.

When data is analysed comparing winning and losing teams from different championships differences are found in six of the eight indices studied. In both championships four indices coincide: the Coefficient of Definition and Resolution of shots, the Coefficients of Detention and of Inaccuracy of Shots at Goal. This data confirms that the winning teams present a greater accuracy of shots at goal, they shot less balls out, they shot less at the post and the number of their shots blocked is also lesser. This translates as the fact that in a percentage of the shots of the losing teams the intervention of the goalie is not necessarily required.

With the aim of analysing the results in greater depth and to identify where the greatest differences that affect the final outcome are produced, four microsituations of the game have been analysed. Statistical differences between winning and losing teams in both championships have been found in six of the eight coefficients in the counter-attack microsituation. This confirms the importance of actions in the counter-attack phase for sporting success in a game of water polo. During this phase the losing teams receive the greater number of blocked shots by the defense which implies that a number of the shots realized do not reach the goal. These results indicate that it is necessary to reinforce this phase of the game by working those situations of one on one and with goalie in the Transition with Possession phase during training. The winning teams presented statistical differences in four of the eight coefficients assessed in the even microsituation in the European Championship. In the World Championship this phase of the game differentiates the teams more, as can be seen by the fact that differences were found in seven of the eight coefficients evaluated.

Both microsituations (counter-attack and even) are those in which the greatest differences presented by winning teams compared to losing teams. The results coincide with those obtained by Argudo et al., (2010).

As water polo is a sport in which there are moments of the game in which a team can be down one or various players (microsituation of power play) the results have differed according to the championship. In the European Championship the winning teams were more accurate and precise with their shots. It is worth noting that the winning teams placed the majority of their shots inside the goal, obliging the goalie to be more involved. But a greater number of shots inside the three posts does not translate into an increase in the resolution of shots. This is an especially important aspect for trainers to consider as shots are produced without achieving goals, making it necessary to insist more on the work of targeting shots at goal during training sessions. In the World Championship the differences in the coefficients measured in the power play microsituation between winners and losers are significant. To best interpret these results it must be taken into account that during a World Championship the standard of the selection is more heterogenous than in a European Championship. The above results are in agreement with those presented by Argudo et al., (2010).

In the penalty phase of reference none of the six coefficients present significant differences between winning and losing teams in the championships studied. These results are in line with those presented in the X World Championship (Argudo et al., 2010; Smith, 2004). During this phase of the game inverse behaviour is produced in respect to the coefficients of offensive efficiency analysed. It is the losing teams who present the best results, without these being significant, in the coefficients related to definition, resolution and accuracy of shots. This leads us to point out that penalty situations are very favourable for the achievement of goals, all teams have their specialists and that there is no distinction between winners and losers. From what is demonstrated it is possible to affirm that in the World Championship the coefficient of efficacy sets the winners apart from the losers in the different phases of the game. This affirmation is not however confirmed for the European Championship where the differences between the participating selections are lesser and it is more difficult to identify the frames of reference and coefficients of efficacy that set winners apart from losers.

In regards to the speed of shots registered during competitions they indicate that the speed of shots in general terms is no different for winning or losing teams during the same competition, but it is different between different championships. The average speeds recorded by this study are similar to those presented by other studies of male water polo players at a national level. These values range from 15.0 $m.s^{-1}$ to 19.7 $m.s^{-1}$ (Bloomfield et al., 1990; Davis and Blanksby, 1977; Elliott and Armour, 1988; Van der Wende, 2005; Whiting et al., 1985), and are lower than those speeds reached by the Spanish selection of male water polo (Vila et al., 2009), and similar to those maximum speeds registered during competition. When interpreting the results the heterogenousness of the different samples and the differing methodology used must be kept in mind. In general the ranges of speed exhibited in the literature are similar to those speeds reached by players during competition. Also, players can shot at equal speed during training as during competition. In regards to the speed of shots a deeper

analysis of the teams placed at the upper levels of classification and those at the lower levels of classification is recommendable.

In this study the evaluation of data has been generalised and the possiblity of behavioural changes that could appear as a function of the difference in goal score in the final result has not been contemplated. Neither has it contemplated the possible changes that could appear as a result of the type of games, group (preliminary phase) or eliminatory phase (principle phase) as our intention has been to record, from a general perspective, what has occurred in both competitions.

5. Conclusions

The results of this study make clear that the efficacy values that have the most influence in determining the differences between winning and losing teams are those that are concerned with the accuracy of shots. The winning teams place a greater majority of their shots inside the goal whereas the losing team's shots register a greater majority of shots that are out, hit the post or are blocked. The results suggest that the penalty phase of the game is not a determining factor in the winning or losing status of a team. In relation to the speed of shots in competition there are no differences between winning and losing teams within the same championship.

This study presents measures that could be used as references to design and evaluate competitions for elite water polo teams in a collective way as it can be considered a representative simple of the present day game at high levels in this sport. Also, it offers trainers concrete data to help them analyse themselves and their rivals in the design of tasks for each microsituation of the game.

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