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Tactical and shooting variables that determine the difference between win or loss in top-level female water polo: analysis by phases of the game

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Abstract

The basic aim of this research study is to analyze the efficacy values and speed of shot of two championships female water polo, comparing winning and losing indicators classified according to different playing situations (even, power play, transition and penalty). Fifty female games that formed part of the 2008 European Championship and the 2009 World Championship have been analyzed. The results showed significant differences between winning and losing teams in the coefficients of accuracy of shots in the European Championship, and in the coefficient of definition, resolution of shots and the resolution, detention and error of shots at goal in the World Championship. The maximal speed achieved was 17.31 m.s^{-1} in the European Championship. 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 even microsituation is the most important determining factor in the winner or loser status of a team. No differences were found 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, throwing velocity in game, efficacy of shots.

1. Introduction

Trainers of team sports are demanding studies from researchers that will help them better understand the progress of the game during a competition. The information provided by such studies can help trainers decide how to plan training sessions (Hughes and Barlett, 2002; O'Donoghue, 2005). In recent years the trend in the investigation on team sports is towards trying to back up the qualitative analysis of the game with quantative measures of performance indicators of individual and collective actions (Meletakos, Vagenas and Bayios, 2011; Mac Donald, 1985). A performance indicator is

a selection or a combination of action variables that aims to define some or all aspects of a performance Hughes and Bartlett (2002). Clearly, to be useful, performance indicators should relate to successful performance or outcome.

Every sport requires performance indicators specific to its' specific discipline to objectify and quantify the performance of both the team and the players (Meletakos, Vagenas and Bayios, 2011; Enomoto *et al.*, 2003; Costa *et al.*, 2010). Performance indicators 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 shot at goal or with action close to the opponent's goal. Recently diverse studies use technical and tactical indicators to analyze performance in water polo (Argudo *et al.*, 2007; Argudo *et al.*, 2008; Argudo *et al.*, 2010; Hughes *et al.*, 2006; Lupo *et al.*, 2010a; Lupo *et al.*, 2010b; Smith, 2004; Vila *et al.*, 2011). None of these studies except the study published by Vila *et al.*, 2011,take into account the various changes in water polo regulations adopted by the sport governing body late in FINA 2005 (International Swimming Federation),

Knowing how to combine ball velocity and accuracy 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 is, 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 shots (Ball, 1996; Davis and Blanksby, 1977; Elliott and Armour, 1988; Feltner and Taylor, 1997; Van der Wende, 2005; Whiting *et al.*, 1985). Nevertheless, some studies have included the study of tactical situations with water polo players in their analysis of the speed of shot (Davis and Blanksby, 1977; Van der Wende, 2005). Moreover, there is a relative scarcity of studies on the technical and tactical aspects of women's water polo (Argudo *et al.*, 2007, Lupo *et al.*, 2009, 2010b). No study has analyzed the speed of shot in competition and its relationship to efficacy in game play.

Thus, the present study aims to analyze the efficacy values and speed of shot of the teams that participate in two championships (European Championship and the World Championship) female water polo, comparing winning and losing indicators classified according to different playing situations (even, power play, counter-attack and penalty). The second objective is to determine if 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).

2. Methods

2.1. Participants

The participating national teams in the 2008 Malaga European Championship were, 1) Spain, 2) Russia, 3) Netherlands, 4) Germany, 5) Italy, 6) Hungary, 7) Greece, 8) France. And in the 2009 Roma World Championship were, 1) Spain, 2) Russia, 3) Netherlands, 4) Germany, 5) Italy, 6) Hungary, 7) Greece, 8) Australia, 9) New Zealand, 10) Brazil, 11) Canada, 12) USA, 13) South Africa, 14) China, 15) Kazakhstan 16) Uzbekistan. The championship was organized along the lines of a classifying stage,

semi-finals and finals. A total of 50 games were analyzed. All games that ended in a draw were analyzed.

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.

2.2. Variables and instruments

An observational design as per the proposals Anguera, Blanco, Losada and Hernández (2001) was used. The design was precise, nomothetic and multi-dimensional. The observations were direct 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 Cohen 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 were: the condition of winner or loser at the end of the game; the microsituation of reference at the end of each attack (from a position of even, power play, transition or penalty); the speed of shot of the registered action; the efficacy values obtained from the coefficients proposed to evaluate each micro-situation of the game.

The full description of the 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 the most favourable tactical-strategic spaces as quickly as possible 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 s 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 analyzed, adapted from (Argudo *et al.*, 2010):

Five coefficients are offensive:

> Coefficient of shots definition (CSD) = Sum of shots scored * 100 / sum of shots performed.
>
> Coefficient of shots resolution (CSR) = [Sum of shots scored * 100 / sum of shots performed – (sum of shots out + sum of shots blocked + sum of shots post)]
>
> Coefficient of shots accuracy (CSA) = [Sum of shots performed - (sum of shots out + sum of shots blocked + sum of shots post)] * 100 / sum of shots performed
>
> Coefficient of inaccuracy of shots at goal (CISG) = Shots detain * 100 / total shots
>
> Coefficient of error in shots at goal (CESG) = Shots detain * 100 / total shots - (sum of shots out + sum of shots blocked + sum of shots post)

Also included were three coefficients measuring defensive actions:

> Coefficient of shots blocked received (CSBR) = Sum of blocked received * 100 / sum of shots performed
>
> Coefficient of resolution of shots at goal (CRSG) = Sum of shots out * 100 / total shots
>
> Coefficient of detention of shots at goal (CDSG) = (Sum of shots out + sum of shots blocked + sum of shots post) * 100 / total shots

2.2.1. The speed of the shot

The speed of the shot from the trunk was 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 (Ferragut *et al.*, 2010). The speed of all shots executed was registered as well as the end result of the action (goal, out, post, blocked or stopped). It is usually recommended that the shoting velocities registered by radar should be done from a frontal plane. 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 (Ferragut *et al.*, 2011).

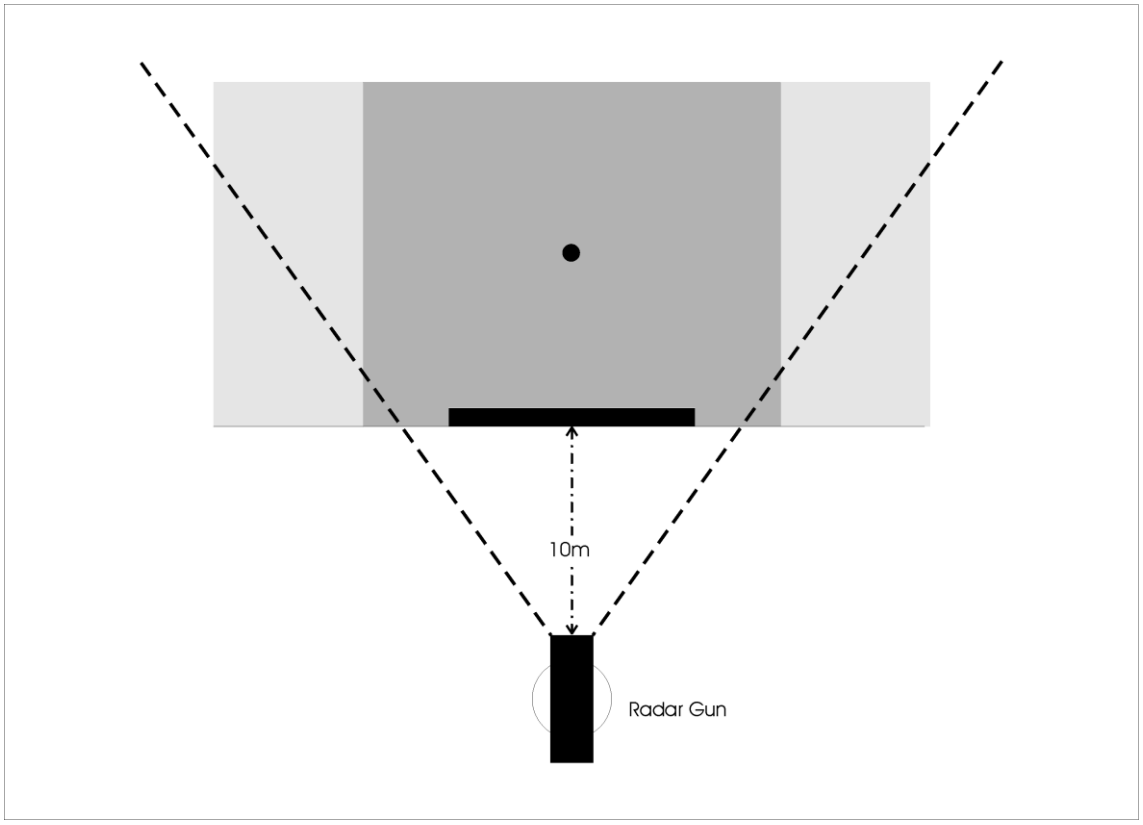

Figure 1. A schematic representation of a radar gun.

2.3. Data analysis

The coefficients of efficacy 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 and winner at the end of the game and for game-play situations. Mean and standard deviation scores were calculated for the shooting velocities measured in the study. To compare speeds of shot an ANOVA was used. Homogeneity was verified using the statistics of Levene.

All the statistical treatments mentioned were carried out with the statistical package 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 efficacy values of the winning and losing teams analyzed during the World Championship and the European Championships of Water Polo are presented in Table 1.

Table 1. Percentage of the efficacy 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 $p \leq 0.05$.

	European C. Winners	European C. Losers	World C. Winners	World C. Losers
CSD	0.45	$0.36^{\dagger}$	0.47^{**}	$0.36^{\dagger}$
CSR	0.56	$0.50^{\dagger}$	0.62^{**}	0.21
CSA	0.77^{*}	0.68	0.73	$0.68^{\dagger}$
CSBR	0.05	0.08	0.07	0.08
CRSG	0.33	0.32	0.25^{*}	0.33
CDSG	0.44	$0.49^{\dagger}$	0.38^{**}	0.49
CISG	0.08	0.13	0.09	0.12
CESG	0.47	0.50	0.44^{**}	0.52

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 1 can be inferred that winning teams of the World Championship demonstrate statistical differences when compared with the losing teams in five of the coefficients measured - one of definition, one of resolution of shots, another of resolution of shots at goal and also one of efficacy of detention of shots at goal and finally, in the error of shots at goal. Between both championships statistical differences were found in the coefficients related to definition, resolution and accuracy of shots.

Table 2. Percentage of efficacy values in the **European Championship** organized according by 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	0.24^{**}	0.12	0.58^{*}	0.41	0.41	0.26	0.58^{*}	0.94
CSR	0.43^{*}	0.23	0.74	0.62	0.50	0.42	0.58^{*}	0.94
CSA	0.59^{*}	0.51	0.79	0.69	0.80	0.68	0.96	100
CSBR	0.10	0.16	0.08	0.08	0.02	0.05	---	---
CRSG	0.34	0.38	0.38	0.28	0.39	0.42	0.38^{*}	0.05
CDSG	0.57^{*}	0.76	0.26	0.38	0.50	0.58	0.42^{*}	0.05
CISG	0.18	0.21	0.04	0.06	0.07	0.19	---	---
CESG	0.57	0.66	0.37^{*}	0.53	0.51	0.54	0.66^{*}	0.05

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.

The results displayed in Table 2 can be inferred that the winning teams in the European Championship present statistical differences compared with the losing teams in four of the eight coefficients within the even microsituation, and in two coefficients in the microsituations of power play or penalty. For the counter-attack microsituation no statistical differences have been established in either of the coefficients comparing

winning and losing teams. In the penalty phase differences exist in five of the six coefficients, but it is worth noting that the number of penalties awarded during the whole championship was 22.

Table 3. Percentage of the efficacy values in the **World Championship** organized by winners and losers and in the different microsituations. 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	0.31**	0.20	0.56*	0.42	0.38*	0.22	0.75	0.66
CSR	0.47*	0.36	0.75	0.67	0.50*	0.30	0.85	0.71
CSA	0.63*	0.5	0.75	0.64	0.72	0.71	0.88	0.93
CSBR	0.07*	0.11	0.12	0.13	0.07	0.04	---	---
CRSG	0.40	0.35	0.17	0.22	0.34*	0.49	0.13	0.27
CDSG	0.52*	0.63	0.24	0.33	0.49*	0.69	0.15	0.29
CISG	0.15	0.19	0.05	0.08	0.10	0.13	---	---
CESG	0.54	0.60	0.38*	0.50	0.52	0.64	0.21	0.30

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.

The results displayed in Table 3 show that the winning teams in the World Championship present statistical differences compared to the losing teams in five of the eight coefficients in a situation of even, in four of the coefficients in a situation of counter-attack and in two coefficients in a situation of power play. No statistical differences exist in a penalty situation.

Table 4. Values ($\bar{x} \pm sd$) of velocity (v) of shot ($m.s^{-1}$) in winning and losing teams. Significant differences between ($p \leq 0.000$): * Losing selection from the losers of European Championship and †Losing selection from the winner of European Championship.

	European C. Winner	European C. Losers	World C. Winner	World C. Losers
Maximum *v*	17.31±10.87	16.32±15.49	15.68±8.00†	14.96±11.71†
Average *v*	15.7±4.42	15.36±3.52	13.68±6.01†*	13.49±6.74†*

Table 4 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 found when comparing championships. However, there were differences in the average shot velocity between teams participating in the European and in the World Championship.

4. Discussion

The results show significant differences between the coefficients of efficacy and average speed of shots between winning and losing teams. Differences have been

established in the majority of the coefficients studied in the World Championship. The results highlight the importance of the efficiency of shots. With respect to the speed of shots registered (in central zone) 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. There was no difference noted between the winners and losers playing in the same championship.

Between the winning and losing teams playing in the European Championship there were no differences found in the coefficients studied except for the in the coefficient of accuracy of shots. The contrast with the lack of differences in indexes found in the present study is probably a result of the similar standard of performance achieved by the women's teams in the European Championship. In the analysis of the World Championship it was demonstrated that the winning teams were more efficient in their shots (CSD, CSA, CSBR and CDSG), and they threw more between the three posts (CSR). In both championships the importance of the efficacy of shots stands out, a finding that is in agreement with results expressed by author s of other studies (Escalante *et al.*, 2011; Lupo *et al.*, 2010a; Enomoto *et al.*, 2003). This same pattern is confirmed by the results presented in the comparison between championships and it serves to highlight the importance of the fact that winning teams place a greater number of shots between the three bars. The lack of differences in the women's game could be attributable to various factors such as the shorter tradition of female water polo, lesser professionalism and fewer competitive demands. Consequently there less specialization in the collective game (Escalante et al, 2011).

With the aim of analyzing 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 analyzed. Statistical differences between winning and losing teams in both championships have been found, in the microsituation of even numbers. The winning teams place their shots better than losing teams, and score more goals. This does not, however, occur in the other three microsituations (power play, counter-attack and penalty). Winner teams are able to target the shot better than looser ones, so winners get higher numbers of goals. This situation does not occur in the other three phases. As well, in the World Championship the winning teams' shots were blocked less often. The differences found in this phase of the game coincide with the results presented by Lupo *et al.* (2010a) and those of Argudo *et al.* (2009 and 2010) except in the coefficient related to blocking of shots. The microsituation in which the greatest difference exists between winning and losing teams, and which is of the greatest relevance, is the even numbers microsituation.

As water polo is a sport in which there are moments of the game in which a team can be down to one or various players less (microsituation of **transition)** the results have differed according to the championship. In the European Championship the **transition** microsituation did not show to be of relevant influence to a match. This is in agreement with that expressed by Lupo *et al.* (2010a). In the World Championship the differences in the coefficients measured in the **transition** 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 heterogeneous than in a European Championship. The above results are in agreement with those presented

by Argudo *et al.* (2010). 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 counter-attack phase during training.

The penalty situations are very favorable for the achievement of goals. Changes to the regulations seem to suggest that the penalty phase could take on a more important role in the victory of a team. The resulting increased opportunities for penalty shots suggests that the task might now be a more quantitatively important and decisive aspect of the game, and carry with it with a lower chance of success. In the **penalty** microsituation five of the six coefficients present significant differences between winning and losing teams in the European Championship. During this phase of the game inverse behavior is produced in respect to the coefficients of offensive efficacy analyzed. 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. Whether differences exist or not between winning and losing teams, the penalty microsituation does not influence the final score. The number of goals that can be achieved during this phase of the game does not influence the condition of winner or loser. These results are in line with those reported by other studies (Argudo *et al.,* 2009; Smith, 2004).

During the **power play** microsituation, differences are registered in two of the eight coefficients. The winning teams take more shots at goal but do not score more goals. The power play actions are not shown to have a relevant influence on the match, a result that coincides with that presented by Lupo *et al.*, (2010a). As this is a phase of the game in which the superior teams gains advantage it is important that trainers work to gain a better shot position in both attacking shots and blocking shots defensively. These results do not support those presented by Argudo *et al.* (2007) in which this phase of the game presented differences between winning and losing teams. The comparison of results, however, should be undertaken with caution as they are the analysis of competitions in which the regulations are different from current regulations.

Regarding the speed of shots registered in both competitions, there were no differences between winning and losing teams in the same competition, but between championships. The average speeds recorded by this study are similar to those presented by other studies of female water polo players at a national level. These values range from 14.7 $m.s^{-1}$ to 15.5 $m.s^{-1}$ (Elliott and Armour, 1988; Alcaraz et al, 2011; Platonou, 2011), and lower to those maximum speeds registered during competition. When interpreting the results the heterogeneousness 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. 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.

Given that the aim of this study was to generally analyzed the performance of elite water polo teams, neither behavioral changes due to differences in score, nor the type of game (preliminary or principle phase) were contemplated.

5. Conclusions

As this study shows, in female water polo there are few differences between winning and losing teams, and these differences are even less notable in European teams. This implies that it is necessary to continue carrying out more specific tactical work in the different phases of play. Special attention should be paid to the efficacy of every shot at goal so as to achieve the highest number of shots that end up within the goal area. It is also necessary to place more emphasis on the work of blocking the thrown ball in all of the phases of the game. The microsituations of transition and penalty present differing results in the analysis of their importance to the game depending on the championship analyzed. In relation to the speed of shots in competition there are no differences between winning and losing teams within the same championship.

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