Water Polo Shooting Performance: Differences Between World Championship Winning, Drawing and Losing Teams

by
Sofia Canossa[1], José Arturo Abraldes[1,2], Luísa Estriga[1], Ricardo J Fernandes[1,3],
Júlio Garganta[1]

Shooting performance of globally ranked winning, drawing and losing water polo teams was compared, and technical and tactical success indicators were identified. In total, 886 shots from a world championship final round were videotaped and teams were clustered for a performance evaluation (considering differences between game outcomes). Shooting speeds were assessed by a radar, with higher values observed at further distances from the goal than in the central area close to the goal ($p \leq 0.00$, ES: 2.54). Shots tended to be more frequent from the central corridor, with $\leq 50\%$ and $>75\%$ relative shot efficacy attained from field areas 3 and 6; winning teams obtained better results. Furthermore, winners had greater success than losers when shooting from field area 2 ($p \leq 0.04$, ES: 1.13) and towards the goal zone 2 ($p < 0.03$, ES: 1.10). They also attained better efficacy regarding shots towards goal zone 1, had better efficacy on the part of centre-forwards ($p \leq 0.05$, ES: 0.85-1.27), and were more effective regarding shots without a frontal defensive block. In addition, contingency analysis highlighted shots performed from field area 6, without a defensive block, toward the bottom left goal corner, and through man-up play as success indicators (all for $p \leq 0.005$). We concluded that world-level winning teams homogeneously distributed their shot opportunities at the second offensive line with balanced efficacy, creating variability and uncertainty in their opponents' defensive action. Elite level players must be capable of interpreting game situations with intelligence and proper decision making. This information may be useful for improving teams performance.

Key words: *match analysis, performance indicators, expert teams, success.*

Introduction

Establishing variables that best distinguish winning from losing teams has been a challenging task (Hughes and Bartlett, 2002; Liu et al, 2015). Performance analysis has proposed some critical game success factors, aiming to contribute to team improvement (Goméz et al., 2016; Lames and McGarry, 2007; Lupo et al., 2014). In this regard, water polo is not an exception and, following a deeper performance analysis, some key game success factors have been identified (Lupo et al., 2012b; Takagi et al., 2005; Vila et al., 2011). Of these, shooting action is

one of the most important, as it allows for assessing efficacy ratios as a predictor of team success (Graham and Mayberry, 2014; Hraste et al., 2014; Melchiorry et al., 2015; Özkol et al., 2013).

The main variables of game analysis have been agreed upon, but researchers are still pursuing the best experimental and data evaluation procedures for this analysis, such as inferential statistics (e.g. ANOVA, multivariate ANOVA, Kruskal-Wallis, chi-squared tests, correlations, Fisher's test; Hraste et al., 2014; Lupo

[1] - *Center of Research, Education, Innovation and Intervention in Sport, Faculty of Sport, University of Porto, Portugal.*

[2] - *Department of Physical Activity and Sport, Faculty of Sports Sciences, University of Murcia, Spain.*

[3] - *Porto Biomechanics Laboratory, University of Porto, Portugal.*

et al., 2016; Tucher et al., 2014) and discriminant analysis (e.g. structural coefficients; Escalante et al., 2013). System modelling has also been applied, involving linear regression, the Markov chain model, cluster analysis and network analysis (Gómez et al., 2016; Passos et al., 2011; Pfeiffer et al., 2010; Saavedra et al., 2014). Furthermore, in an attempt to obtain deeper information about game tactical efficiency, an efficiency rating model was recently proposed (Graham and Mayberry, 2014).

World-class water polo championships are played between national teams at different competitive levels, which can lead to a relevant difference in performance indicators shown by the lower world ranking teams (Lupo et al., 2012b). As competition rounds evolve, games become more demanding and teams get closer to their final outcome, with winning and losing top teams scoring goals in a similar way (Graham and Mayberry, 2014). However, final matches are usually decided by a single goal difference, constraining team differentiation through classical performance analysis due to a lack of statistical significance (Lames and McGarry, 2007). Thus, alternative methods are required to obtain qualitative information from the game interaction process (Gómez et al., 2016; Pfeiffer et al., 2010), although there is no consensus at present with regard to game analysis methodology based on dynamic principles (Lames and McGarry, 2007).

The current study aimed to assess performance-related differences between winning, drawing and losing elite water polo teams, particularly regarding game variables related to successful shooting. It was hypothesised that, in addition to the already identified man-up play, goalkeeper performance and scored goals, other performance indicators could be relevant when distinguishing between winners and losers (such as shooting without a direct and frontal defensive block).

Methods

Participants

The top eight ranked national teams participating in the final 15th FINA world championship were evaluated regarding the total shots carried out (n = 886) during 1254 offensive sequences of 20 water polo matches (from the elimination round of sixteen or quarter-finals until

the final game). Teams were pooled into winners (three medallists), drawing (fourth and fifth places) and losing groups (sixth, seventh and eighth places), ensuring the absence of significant differences between game outcomes. Since matches were played in advanced championship rounds, the majority of the observed team contests were close games, i.e., they ended with only a one- or two-goal difference in score. Two matches were unbalanced (with six goal differences), and those teams were accordingly clustered into the winner or the loser group. The goal distribution was the same across the observed groups and margins of victory were checked (Saavedra et al., 2014).

The placement of a radar device behind the goal and a video camera in the public upper benches to record all championship matches was authorised by the organising committee. However, informed consent was not obtained from individual players and teams as the event was in the public domain, with matches being broadcast by television and team information (including players' personal data) posted on official websites. This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Faculty of Sport of the University of Porto ethics committee.

Measures

Shooting speeds were assessed by a radar (StalkerPro Inc., Plano; Alcaraz et al., 2011) and games were videotaped with a digital video camera (Sony, Handycam HDR-PJ530). Technical and tactical variables were previously selected based on the literature (Escalante et al., 2013; Hughes et al., 2006; Lupo et al., 2010). The evaluated shooting-related variables are described in Table 1.

Design and Procedures

Data collection was conducted by three experts during the 15th FINA world championship, with the radar gun positioned behind the goal to detect shot speeds, as previously described (Ferragut et al., 2015). Simultaneously, a digital video camera was positioned in the public upper benches, with the line projection on the middle of the pool and midfield. The games were videotaped by framing all players on the image (Lupo et al., 2012b). Afterwards, the variables were visualised and noted using broadcast images (Televisión

Española S.A.) and replays were used to visualise shots in the sagittal, anterior and posterior planes, confirming the shooting direction, goal zone and the presence of frontal and direct defensive block. Official tournament scores and organising committee statistics were used to check data, and the intra and inter-observer reliability was tested (Kappa index values of >0.93 and >0.85, respectively). A field of play and goal target schematisation was used for shot location and goal zone identification (Figure 1). Then, game variables and shot/goal percentages were calculated, and the offensive ratios were computed (Vila et al., 2011).

Statistical Analysis

Descriptive statistics (such as mean and standard deviations, variable frequencies, and minimum and maximum values) were assessed and checked for data normality with the Kolmogorov-Smirnov test. Margins of victory were checked, defining close, unbalanced and very unbalanced games as differences of fewer than four goals, between five and ten goals and more than twelve goals, respectively (Saavedra et al., 2014). The chi-squared, Mann-Whitney and Kruskal-Wallis tests were used to determine variable frequencies, shooting occurrences and differences between game outcomes. The above-mentioned statistical procedures were conducted using the Statistical Package for the Social Sciences (SPSS v. 22.0; SPSS Inc., USA) and the significance level was set at $p < 0.05$. Complementarily, contingency analysis was performed using JMP® (statistical discovery software from SAS®), with contingency tables, test reports and analysis of means for goal proportions being obtained with 95% confidence intervals. Cohen's d was calculated for effect size (ES) with interpretation as follows (Cohen, 1992): trivial (0-0.19), small (0.20-0.49), medium (0.50-0.79) or large effect (>0.80).

Results

All results are presented in Table 2, with the exception of failed shot subcategories, named invalidated by foul/time and stayed in the water (as described in Table 1), due their marginal occurrence. It was observed that shooting speeds were similar between groups but, when considering all sample shots, field area 6 displayed lower values than area 8 (mean ± SD - 15.3 ± 2.3, min-max - 3.5-22.4 m·s⁻¹ vs. 20.3 ± 1.9, 13.1-24.8 m·s⁻¹, $p \le 0.000$, ES: 2.54), as well as field areas near the goal (areas 1, 6 and 5) compared to those from further distances (areas 7, 8 and 9) ($p \le 0.001$, ES: 0.94-2.54). This also occurred regarding the second offensive line areas compared to those near the midfield, particularly area 4 vs. areas 9 and 8 ($p \le 0.001$, ES: 0.81 and 1.29, respectively), and area 3 vs. area 8 ($p \le 0.000$, ES: 0.75). Furthermore, both losing and winning teams tended to shoot more without a defensive block than with a block, with drawing teams presenting the opposite behaviour. Finally, winners showed better efficacy in shooting without a frontal defensive block than the other groups (≥ 10%), whereas drawing teams presented the lowest efficacy scores.

All teams tended to shoot more often from the central corridor (winning: 41.8 ± 9.2, 24.1-53.9%; drawing: 51.9 ± 7.9, 41.8-62.5%; losing: 49.2 ± 10.5, 25.0-63.4%), with losers showing a higher shooting frequency in field area 3 than their counterparts (Figure 2). This latter fact did not lead to a dissimilar field area 3 goal distribution and relative shot efficacy between groups (winning: 50.0 ± 28.1, 0-75.0%; drawing: 37.5 ± 11.9, 16.7-52.6%; losing: 38.0 ± 14.4, 12.5-66.7%). Conversely, the groups showed a lower tendency for shooting from area 6, resulting in relative shot efficacy ≥ 76% (winning: 76.2 ± 22.9, 50-100%; drawing: 55.6 ± 50.6, 0-100%; losing: 62.5 ± 41.6, 0-100%). Moreover, winners scored a higher number of goals from field area 2 than losers (21.0 ± 9.8, 11.0-44.0% vs. 13.0 ± 9.7, 0-31.0%, $p \le 0.037$, ES: 1.13).

Shot frequency by playing positions revealed that groups consensually elected the central corridor, with the centre-back position being preferred by winning and drawing teams (24.0 ± 7.2, 13.0-34.8% and 29.5 ± 7.8, 20.8-44.0%, respectively), while the centre-forward position was selected by the losing group (23.9 ± 7.8, 12.9-37.0%). In addition, >40% of the total shot occurrences were obtained when adding the second most frequent shot position (right-driver, centre-forward and centre-back for the winning, drawing and losing teams, respectively). The best shot efficacy was attained by centre-forward and left-winger positions in winning (55.0 ± 25.6, 25-100% and 48.9 ± 27.1, 0-100%), centre-back and left-winger in drawing (33.8 ± 15.7, 16.7-60.0% and

32.1 ± 26.6, 0-75%) and right-driver and centre-forward in losing teams (41.7 ± 33.4, 0-100% and 38.7 ± 18.8, 0-66.7%). The centre-forward efficacy (55%) of winning teams was higher than in drawing and losing teams (p = 0.05; ES: 0.85-1.27), whose results were <40%.

Table 1

Game technical and tactical variables (and subcategories) considered
for observation and analysis of water polo successful shot.

Variables	Description
Offensive sequences (n)	**Offensive plays per game (since ball recovery until ball loss).**
Sequence partial result (n)	**Aborted (offensive play was interrupted without shot occurrence) or with shot action. Shots invalidated by foul were also considered.**
Shot occurrence (n)	Shots per game.
- speed (m·s⁻¹)	Shot speed per attempt.
- type (n)	Drive, bounce, lob and back-shots.
- field origin (n)	Shot location by field of play and corridors: left (areas 1, 2 and 7), central (areas 6, 3 and 8) and right (areas 4, 5 and 9).
- player individual tactical resources (n)	Spontaneous shot (without simulation or feint), feint and arising from 1x1 struggle or direct confrontation in drive in motion (except center-forward action).
- player position (n)	Play position at the shot moment.
- direct opposition (n)	Frontal opposition presence (or not) by defensive block, regardless the shot outcome.
- partial result (n)	Failed shots (when the ball hits the goal post, crossbar, went out of the field, stay in the water without touching any goal part, was stopped by a defensive block, was invalidated by a foul or offensive time expired) or defended by a goalkeeper.
- final outcome (n)	Goal or unsuccessful shot.
- goal-zones (n)	Where the ball entered or was thrown to.
Game tactical situations (n)	Shot attempts coming from man-up plays or other tactics.
man-up plays (n)	Shots and their outcome as to the offensive tactical situation of player's numerical advantage due defensive player exclusion by 20 seconds.
- other tactics (n)	Shot attempts coming from even tactics, fast break or penalty.
Penalty shots (n)	Attempts and their outcome.
Absolute efficacy (%)	Ratio between the number of total goals and offensive sequences: (goals x100) / offensive sequences.
Relative efficacy (%)	Ratio between goals and total shots in that given situation: (goals x100) / shots.
Team productivity (%)	Ratio between the number of total shots performed and offensive sequences: (shots x 100) / offensive sequences.
Shot accuracy (%)	Ratio between the number of total shots that reached the goal face or goalmouth (excluding crossbar and goal posts) and total shots: (total shots to goal mouth x100) / total shots.

*Note. n = number of cases observed per variable*
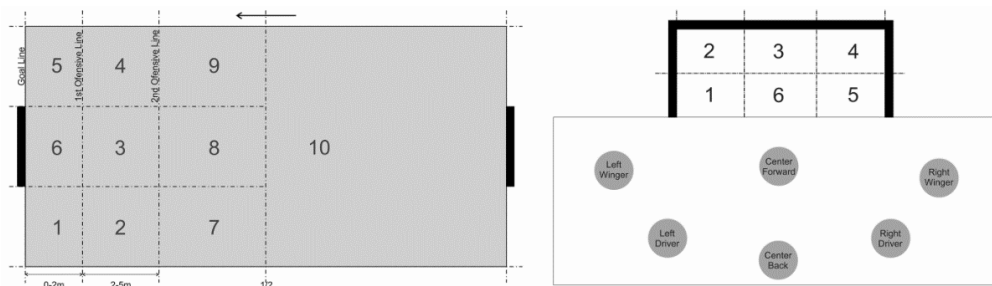
Figure 1

Offensive water polo field-areas, goal-zones and shooter play positions (left and right panels; adapted from Hughes et al., 2006; Hraste et al., 2010; Lupo et al., 2014; Passos et al., 2011).

Table 2

Mean and standard deviation, minimum and maximum offensive sequences per game and respective partial results per groups. Shot speed and type, players individual tactical resources, shot opposition and shots outcome and their subcategories are also presented.

Variables	Winning teams		Drawing teams		Losing teams	
	Mean ± SD	min-max	Mean ± SD	min-max	Mean ± SD	min-max
Offensive sequences (n)	39.8 ± 5.2	31-52	43.9 ± 5.9	39-57	39.7 ± 4.64	34-50
Aborted sequences (%)	31.0 ± 7.6	22.6-47.6	32.9 ± 7.6	22.8-41.5	32.7 ± 7.39	18.0-41.7
Sequences with shots (%)	69.0 ± 7.6	52.4-77.4	67.1 ± 7.6	58.5-77.2	67.3 ± 7.39	58.3-82.0
Shot speed (m·s⁻¹)	18.5 ± 2.7	13.0-25.0	18.5 ± 2.8	6.0-24.0	18.4 ± 3.15	7.0-24.0
Shot type (%):						
-drive	69.6 ± 9.1	58.3-82.8	67.2 ± 10.5	50.0-84.0	67.2 ± 9.08	50.0-83.3
-bounce	25.4 ± 9.3	37.5-10.3	24.2 ± 7.2	16.0-37.5	27.3 ± 9.06	13.0-41.7
-lob	2.4 ± 2.7	0.0-6.7	6.9 ± 4.1*	0.0-12.5	1.3 ± 1.87*	0.0-4.2
-back	2.6 ± 2.8	0.0-9.1	2.4 ± 2.2	0.0-5.6	4.2 ± 4.72	0.0-13.1
Player individual tactical resources (%):						
-spontaneous shot	64.9 ± 15.9	50.0-91.7	66.9 ± 4.8	58.3-74.1	66.0 ± 9.03	48.6-79.2
-feint shot	33.7 ± 1.4	8.3-58.3	32.1 ± 4.0	25.9-36.1	31.4 ± 6.23	20.8-37.5
-(1x1) struggle	1.4 ± 3.8	0.0-13.1	1.1 ± 2.1	0.0-5.6	2.6 ± 4.34	0.0-14.8
Shot opposition (%):						
-with a block	47.3 ± 15.1	31.6-75.9	51.6 ± 12.5	36.0-68.0	42.9 ± 13.57	26.1-74.2
-without a block	52.8 ± 15.1	24.1-69.6	48.4 ± 12.5	32.0-64.0	56.2 ± 13.26	25.8-73.9
Total goals (%)	39.5 ± 9.6	23.3-53.9	28.6 ± 11.3	11.5-45.8	34.8 ± 13.76	10.7-56.5
Failed shots (%):	60.5 ± 9.6	6.9-50.8	71.4 ± 11.3	13.1-79.1	63.7 ± 14.04	3.7-68.9
-went out	7.9 ± 4.5	2.6-13.6	10.1 ± 6.0	4.6-21.9	10.6 ± 9.05	0.0-32.1
-goal post/crossbar	11.6 ± 5.8	4.4-20.5	12.7 ± 7.0	4.6-29.2	8.7 ± 5.52	0.0-17.4
-blocked	9.5 ± 5.9	0.0-16.7	10.1 ± 8.7	4.0-28.0	10.9 ± 5.55	3.7-19.4
-goalkeeper defence	29.2 ± 10.8	13.3-45.8	36.6 ± 13.9	12.5-52.8	32.9 ± 7.19	17.4-48.2
Penalty shots (%):	3.7 ± 4.0	0.0-10.3	7.1 ± 6.2	0.0-20.5	3.7 ± 5.57	0.0-19.5
-penalty goals	5.4 ± 7.3	0.0-20.0	19.1 ± 17.1	0.0-50.0	7.1 ± 11.42	0.0-38.5
Man-up shots (%):	37.1 ± 11.5	16.7-52.2	31.9 ± 12.5	12.5-55.6	28.9 ± 12.95	14.8-52.4
-man-up goals	50.0 ± 19.0	25.0-77.8	37.0 ± 17.6	66.7-21.4	42.0 ± 24.01	14.3-100
Absolute efficacy (%)	27.3 ± 7.5	18.0-41.0	19.4 ± 7.4	7.0-27.5	23.5 ± 8.06	8.1-34.2
Relative efficacy (%)	39.2 ± 9.6	29.2-53.9	28.6 ± 11.3	11.4-45.8	34.8 ± 13.76	10.7-56.5
Team productivity (%)	69.0 ± 7.6	52.4-77.4	67.8 ± 7.6	58.5-77.2	67.7 ± 7.39	58.3-82.0
Shot accuracy (%)	69.7 ± 9.2	53.3-83.3	65.1 ± 14.0	46.9-84.1	67.7 ± 10.35	46.4-81.5

* denotes significant differences between groups (p = 0.009; ES: 1.66)
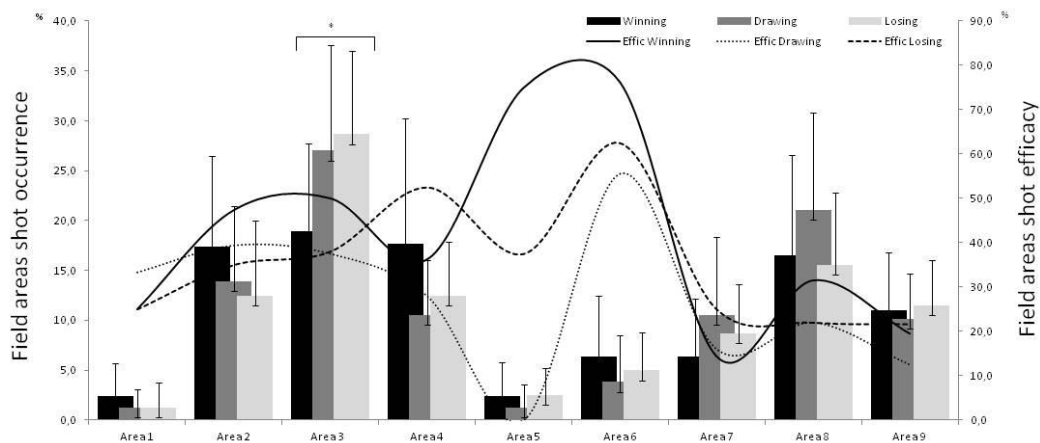
Figure 2

Shot origin by field-areas (mean ± SD; min-max values) and relative shot efficacy by winning, drawing and losing teams.
* denotes significant differences between groups (p = 0.05, ES: 0.16 - 0.36)

Table 3
Variables of which mean limits were exceeded on the mean for goal proportions analysis.

Variables	Prob>ChiSq	Sub variables	n	Group Proportion	Lower 95% CI	Upper 95% CI	Limit Exceeded	OR	$d_{(Cohen)}$	ES
Field origin	$p \leq 0.000$	6	46	0.674	0.190	0.588	upper	0.577	2.867	large
		9	89	0.202	0.250	0.528	lower	1.923	2.696	large
Shot direct opposition by a defensive block	$p = 0.006$	With	343	0.335	0.351	0.429	lower	1.163	2.705	large
		Without	447	0.432	0.360	0.420	upper	0.903	2.791	large
Goal-zones	$p = 0.012$	1	147	0.497	0.295	0.485	upper	0.786	2.230	large
Game tactical situations	$p \leq 0.0001$	Other tactics	522	0.328	0.361	0.417	lower	1.187	4.327	large
		Man-Up	268	0.507	0.335	0.444	upper	0.767	4.317	large

Shots at goal zone 4 occurred more in winners than in losers (p = 0.039, ES: 1.04), however this did not result in a different number of goals. Regarding goal zone 4 relative shot efficacy, it was observed that losing teams had higher results than drawing teams (41.1 ± 27.4, 25-100% vs. 20.8 ± 13.7, 0-36.4%, respectively; p = 0.026, ES: 1.22). In addition, although all groups presented similar goal-zone 2 shot occurrence, winners achieved a higher number of goals (p = 0.025, ES: 1.10) and had better relative shot efficacy than losers (44.9 ± 23.8, 0-83% vs. 28.3 ± 27.9, 0-100%, respectively) in goal-zone 2 shots. Comparing goal zones, the best relative efficacy scores were attained from goal zone 1 by winners and losers (57.8 ± 38.8, 0-100% and 56.4 ± 33.9, 0-100%, respectively) and from goal zone 2 by drawing teams (46.2 ± 27.1, 0-100%).

Man-up game tactical situations were similar between groups, but losing and drawing teams tended to present fewer shot attempts than winners (29.3 and 30.0 vs. 36.6, respectively). Furthermore, winners and losers had similar man-up relative efficacy (54.2 ± 12.7, 38-82% and 56.4 ± 18.9, 23-83%), but attained higher scores than drawing teams (p = 0.026, ES: 1.68 and p = 0.011, ES: 1.48, respectively), the latter presenting the lowest relative efficacy (34.3 ± 10.7, 22-56%). However, man-up goals contributed more to total goals in the winning group than for drawing and losing teams (50.0 and 37.0 vs. 47%, respectively). In other tactical situations, winners attained better relative efficacy scores than drawing and losing teams (31.3 ± 12.6, 38-82%; 26.2 ± 12.4, 22-56% and 26.0 ± 13.2, 23-83%, respectively).

The results of the goal proportion analysis by the shot final outcome per variable, regardless of team classification, are shown in Table 3. Within the upper limits of the goal proportion mean, shots originating in field areas 2, 3 and 4 resulted in 45%, 44% and 43% of the goal proportion (showing an ascending tendency to surpass mean limits), while field areas 7 and 8 stood within the lower limits (showing the opposite tendency, i.e. 26% and 30% of the group proportion, respectively). Similarly, goal zones 2 and 5 stood within the upper goal proportion mean, tending to ascend from its limits (40% and 41% of the group proportion, respectively), while goal zone 4 stood within the lower limits, showing the opposite tendency (41% of the group proportion).

Discussion

The current study aimed to assess performance-related differences between winning, drawing and losing elite water polo teams regarding shooting action variables, in order to determine the most significant technical and tactical success indicators. As expected (Escalante et al., 2013), groups showed similar shot-related variables due to their high performance level and corresponding game results (mostly close games). However, winning teams obtained better scores in offensive sequences, failed shots, man-up shot opportunities and goals, resulting in better efficacy indices, team productivity and shot accuracy (Escalante et al., 2013; Lupo et al., 2010). In addition, unsuccessful shots had a negative influence on the game outcome (not caused by goalkeeper ability, as no differences were found in their defensive performance, contradicting Escalante et al. (2011)).

The most frequent shot type was the drive shot (Lupo et al., 2012a) but, despite presenting a lower rate of lob and back-shots, drawing teams had a higher number of lobs than their counterparts (in opposition to Hughes et al., 2006). In addition, drawing teams lob shot efficacy tended to be lower than that of winners and losers, which, added to their number of failed shots, might indicate true offensive difficulties in overcoming a goalkeeper or/and a defensive block. Furthermore, the use of back-shots by losing teams suggests that they elected to play the centre-forward position more often than their counterparts, using it frequently (Lupo et al., 2012b). This idea is supported by the frequent occurrence of centre-forward shots by losing teams, with lower relative efficacy of back-shots than winners (with a back-shot frequency of only 2.6%).

A similar shot speed between groups was also found by Vila et al. (2011), with values in agreement with the data from official games (Canossa et al., 2016), but lower than those from standardised testing conditions (Melchiorri et al., 2015), probably due to game constraints and the players' option to perform a shot action aiming its accuracy (Ferragut et al., 2015). These aspects might explain the slower shot speeds close to the

goal, higher speeds at distances further from the goal and the consequent differences in shot speed distribution according to the field area (Alcaraz et al., 2012). Despite recognising shooting speed as being vital to the match outcome, since it hampers the actions of the defence and the goalkeeper, accuracy also seems crucial. In fact, high speed and shot precision are probably the key factors needed for a successful score (Platanou and Botonis, 2010).

The more frequent shooting action from the central corridor is in agreement with Tucher et al. (2014), but in disagreement with Lupo et al. (2010), who reported more frequent shot attempts from the left corridor and a tendency for more frequent left field area shots beyond 5 m. This may be due to the fact that Lupo et al. (2010) studied the Euro League (a club competition), whereas the current study focused on a world championship with national teams where set of players and top shooters could be more evenly distributed (with left-handed players positioned on the right). Also, the defensive abilities of elite teams could better constrict offensive actions, forcing shots from less favoured field areas. In fact, winners showed fewer discrepancies than their counterparts in terms of the 5 m shot distribution, although shots from the right were more frequent and effective than those from the left. Also, the data from the current study disagree with Lupo et al. (2010) as to the higher number of goals attained from the right field area beyond 5 m, since the most successful field areas were those within rather than beyond 5 m (García et al., 2015).

The observed playing positions confirm the most frequent involvement of centre-backs as team connection players and major shooters (Özkol et al., 2013; Passos et al., 2011), followed by other peripheral players (Melchiorry et al., 2015; Saavedra et al., 2014). Nevertheless, losers preferred shooting from the centre-forward position, confirming its importance in the game (Lupo et al., 2012b), even if their best shot efficacy was attained by right-wingers (who had the second lowest shot frequency). Centre-forward shots were also preferred by the drawing group, but with a similar frequency as left-drivers (Hraste et al., 2014). In turn, centre-forward play aiming to finish offensive actions with a shot seemed less relevant for winners (Pfeiffer et al.,

2010) despite those players achieving the best efficacy scores. This indicates that winning teams seek an offensive solution by playing around their centre-forward teammate, not passing him the ball while waiting for the eventual exclusion of the centre-forward direct defender. When this is achieved, the team has the opportunity to play the man-up tactic situation. Winners were very efficient at scoring in these situations, mainly by centre-forward players (Özkol et al., 2013).

The trend of the winning teams shooting to upper goal corners is in disagreement with a previously described low goal corner pattern (Hughes et al., 2006; Özkol et al., 2013), evidencing the ability of elite teams to find solutions by varying their shot direction and lower goal corner defensive protection. Moreover, winners had a higher score and greater goal zone 2 efficacy than losers, indicating their superior accuracy and ability to overcome defensive blocks and the goalkeeper (Vila et al., 2011), while losers had more went out shots of the failed shot subcategory. However, winners and losers had their best efficacy in goal zone 1 (the one with the lowest shot attempt frequency) followed by goal zone 5 (in which the efficacy of drawing teams was largely surpassed by their counterparts). Once again, superior goalkeeper ability cannot explain these dissimilarities, as no significant differences were found in their performance.

Winning and losing teams presented similar man-up goals (values in accordance with Graham and Mayberry, 2014 and Lupo et al., 2012b), but the former registered more goal attempts than the latter. In fact, losers made more shots from other tactical situations, whereas winners had more exclusion faults in total, reinforcing the centre-forward role in leading the team to the man-up strategy (Tucher et al., 2015). Winners and losers also had similar man-up efficacy scores, with the drawing group presenting lower values than the losers. We cannot consider greater man-up shooting efficacy as part of the winning profile in close games (contradicting Saavedra et al., 2014). Adding to other factors (e.g. went out shots and other tactics), a slight break in efficiency levels when performing man-up play may have contributed to the final team classification since, in a given round, it can prevent that team from contesting higher ranking games (Vila et al., 2011).

The current study is the first to apply goal proportion analysis in water polo, searching for specific performance indicators and contributing to better game understanding. This procedure highlighted field area 6 as the most predictable location from which to achieve a goal (as Hughes et al., 2006 did with different methodology), corresponding to better shot efficacy by winning teams. In addition, the winners greater SD values and field area 6 lower frequent shots demonstrated that shooting opportunities occur in other field areas. In fact, winners distributed their shot attempts with great balance, particularly in areas 2, 3 and 4, where equal shooting rates and efficacy scores (up to 50%) were achieved. These areas were in the upper limits of the goal proportion analysis, showing a positive and predictable trend for a successful shot. Conversely, the negative impact of field area 9 shots mainly affected the drawing group, who had one of the lowest efficacy scores in that field area. These findings corroborate the significant association between shot origins and goals, as well as the ability of winners to create offensive conditions, involving more players to increase variability (Hughes et al., 2006; Lupo et al., 2012a; Tucher et al., 2014).

Goal proportion analysis of shots with direct opposition showed a high success probability when players shoot without a direct defensive block, particularly in the winning group (who registered higher frequency and efficacy scores, both when shooting without a block and with a block). The current study is also the first to analyse the direct defensive block facing shooting action as an independent variable. This is highly relevant since, although defensive blocks have been shown to discriminate winners from losers (e.g. as being part of the equation that calculates shot accuracy; cf. Vila et al., 2011), the distinction between goalkeeper blocked shots and blocks made by defenders is not clear. Moreover, other studies have pointed out that blocked shots do not discriminate winners from losers in close contests and advanced competition rounds (Escalante et al., 2013; Saavedra et al., 2014). Therefore, the current findings show that top players skilfully obtain advantageous positioning in the field of play to score, looking to shoot without a direct defensive block and increasing their efficacy (Escalante et al., 2013). This positioning is obtained by fast dry pass assistance, contributing to greater shooting accuracy and effectiveness (Hughes et al., 2006; Pfeiffer et al., 2010; Vila et al., 2011).

Current goal proportion analysis by goal zones highlighted goal zone 1 as the most probable goal corner from which to score (Hughes et al., 2006), corresponding to the best efficacy scores of winners and losers (more than for a drawing group). However, the studied teams largely preferred to shoot to the upper goal corners, contradicting the team preference for lower corners during the European B Championship (Özkol et al., 2013), probably due to defensive constraints and offensive tactics. Nevertheless, the fact that the winning group had better efficacy scores than their counterparts in goal zones 1 and 5, adding to their weaker shooting trend in these goal corners and lower shot frequency by right and left wingers, suggests that players attempted to shoot only when excellent conditions were met. Also, the difference in the shot frequency of winners and losers in goal zone 4 and goals scored in zone 2 reinforces the notion that winners created shot variability by being unpredictable (Saavedra et al., 2014).

The contingency analysis method also showed that the tactical situation of man-up play had a higher probability of scoring, meaning that man-up success differences between teams could differentiate winners from losers (Escalante et al., 2013; Lupo et al., 2012b). However, we did not observe any differences, with winners presenting better relative efficacy in other tactics (with a negative probability to score), probably contributing to the differentiation between groups. Although a fast break is known as the most efficient tactic (García et al., 2016), it is very infrequent in close games, with even tactics being dominant and being the offensive play through which teams achieve man-up game situations (Graham and Mayberry, 2014; Lupo et al., 2012b). In the current study, the probability of not scoring a goal using other tactics was mainly related to even situations.

The above-mentioned findings show clear performance differences between winning and drawing teams, but not among winners and losers. This probably happened because losers faced winning teams in quarter final matches (two of them ending with only a one-goal difference)

and were thus withdrawn from contesting higher ranking games. Even though the goalkeeper efficacy scores of losers and winners were similar, losers had more shot attempts using other tactics, but with poorer relative efficacy; additionally, they failed more total shots and their man-up efficacy was lower at 34% (<16% than winners), scoring fewer goals in that specific situation. Therefore, although no statistical differences were found, that game setting favoured winners and excluded losing teams from the semi-finals (having thus to play for fifth to eighth places). Hence, decisive matches require greater efficacy and shot accuracy to better seize game opportunities (Saavedra et al., 2014; Vila et al., 2011).

Finally, from the current data, it can be seen that unpredictable shots on the part of winners unbalanced defensive performance, creating more opportunities to shoot without a defensive block. However, beyond the ability to move the ball faster to assist shooters by dry passes (Hughes et al., 2006; Escalante et al., 2013), player perception of the best moment to shoot is vital (Tucher et al., 2014). Thus, perceptual skills are probably linked to the efficacy and accuracy of winners, an idea reinforced by the ability of top players to sacrifice shot technical components under increased fatigue and to maintain accuracy levels (Royal et al., 2006). Hence, if efficacy is a discriminating performance indicator (Hraste et al., 2014), it seems crucial to uncover, beyond other aspects (e.g. technical), how players can be more effective, leading to decision making as a major topic for further analysis.

The current study had some limitations inherent to pooling teams in three groups, leading to unequal game numbers in the groups (eight in the drawing group and 12 in the winning and losing groups). Therefore, although no differences were found, the total shot numbers of winning and losing groups were not similar to those of the drawing group. This might have led to less favourable results for the drawing group, notwithstanding the fact that data analysis was performed using group ratios and that the observed inequality could have happened by itself (depending on team performance). Furthermore, the data are from a single world championship, so it would be valuable to extend this research topic to other international competitions, groups and teams.

We conclude that winners distributed their shot opportunities homogeneously at the second offensive line (with equilibrated efficacy), creating variability and uncertainty in the defensive action of their opponents. Winners tended not to shoot at the first offensive line, which corresponded to more effective centre-forward and left winger shots, since the best teams wisely selected the most appropriate moment to shoot at the first offensive line. In doing so, they were highly effective, with outstanding right winger efficacy, showing that winners had many shooting options. Indeed, the ability of the top three national teams to earn shooting opportunities without a direct and frontal defensive block was evident. Shooting without a direct and frontal defensive block was pointed out by the goal proportions analysis as a game success performance indicator, along with those variables already recognised in the literature. All the factors associated with winning team performance show that their better shot efficacy and higher number of goals were combined with the higher probabilities detected and positive trends highlighted by goal proportion analysis for a successful shot. These results support training suggestions related to instructing players to first assess the second offensive line shooting options in a varied way and quickly try to avoid a defensive block. At the highest competition level, players should be able to solve game situations with intelligence and with effective decision making.

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Corresponding author:

Ricardo J Fernandes
Center of Research, Education, Innovation and Intervention in Sport (CIFI²D),
Faculty of Sport, University of Porto. Rua Plácido Costa, 91. 4200-450 Porto, Portugal.
Telephone: +351 (22) 5074762; Fax: +351 (22) 5500689;
E-mail: ricfer@fade.up.pt