The role of the extra-man play actions in elite water polo matches: which elements lead to a good shot?

Alessandro Lubisco

1. Introduction

Many studies on team sports seek to identify which elements set the winning team apart from the losing one and which elements of play lead to victory (Lupo *et al*., 2014). This is one of the reasons why match analysis has developed a great deal over recent years in many disciplines, including water polo.

In water polo, two teams, each of six outfield players and a goalkeeper, compete for four quarters of 8 minutes' real play in a playing area of 30x20m. All players are involved in both attack and defence. Generally speaking, the attacking team places one player at the centre (position 6, the centre forward) and arranges the others in a semicircle (Fig. 1a). Defence has a number of strategies which range from pressing to one of various types of defence zones. Each team has 30 seconds to complete a play action. If the attacking team still has possession of the ball after a shot, they then have at least 20 available seconds. This is a similar system to that adopted in basketball: 24 seconds for an action and at least 14 seconds following a shot. The team that scores the most goals wins. The match may also finish with a tie and, in direct elimination matches, a penalty shootout is used to determine the winner.

A frequent situation thought to be very significant to the final result of a match (Takagi *et al*., 2005) is one of numerical superiority usually called extra-man, man-up or a 6-on-5 situation (XM). This occurs when a player is temporarily excluded following a major foul (FINA, 2020) and is sent out of play for 20 seconds.

Coaches dedicate a lot of time to training their team to attack and defend in an XM situation. Briefly, players in attack line up along two lines: two players at 5/6 metres from the goal, each in line with the goal posts, and the others on the two-metre line, a sort of off-side line. So, there are two players in line with the posts and two on the flanks. This kind of attack is known as a 4-2 and is used by most teams. There is an initial attack formation called a 3-3, where 3 players are positioned on the external line and 3 others on the two-meter line. This formation is less frequent.

In reference to the attack formation 4-2, the positions of the players are numbered from 1 to 6 clockwise as you face the goal, starting from the player on the right on the 2-metre line (Fig. 1b).

The defending team generally places three players on the 2-metre line who 'jump' sideways to mark the two opponents either side of each defender and stop the wings, at 2 metres (1 and 4), from scoring by raising their arms. The two external players also move backwards and forwards to cover the goal area with raised arms, stopping the wings from scoring (2 and 3) and intercepting any passes toward the central players on the 2-metre line (5 and 6) as shown by the arrows in Fig. 1b. This formation is called a 2-3 defence.

As there are 20 seconds available for concluding the action (with some exceptions depending on the area where the exclusion takes place), the attacking team, with a series of passes and player movements must quickly try to disrupt the defence and enable a shot. For those in defence these 20 seconds are never-ending because the physical effort involved in mounting an aggressive defence able to prevent the attack from scoring is huge. This is why, for the attack, a coach will aim to improve the players' ability to move the ball quickly from one position to another without leaving the defence enough time to take up positions. And defence has to work on coordination of movement between players so that the attack finds it difficult to score too easily.

It has to be said that nothing is easy in water polo, particularly at high levels. Even in the so-called 1 against 0 situation, when one attacker is alone in front of the goalkeeper, actually scoring

Alessandro Lubisco, University of Bologna, Italy, alessandro.lubisco@unibo.it, 0000-0002-3440-7867

FUP Best Practice in Scholarly Publishing (DOI 10.36253/fup_best_practice)

Alessandro Lubisco, *The role of the extra-man play actions in elite water polo matches: which elements lead to a good shot?*, pp. 111-115, © 2021 Author(s), CC BY 4.0 International, DOI 10.36253/978-88-5518-461-8.21, in Bruno Bertaccini, Luigi Fabbris, Alessandra Petrucci (edited by), *ASA 2021 Statistics and Information Systems for Policy Evaluation. Book of short papers of the on-site conference*, © 2021 Author(s), content CC BY 4.0 International, metadata CC0 1.0 Universal, published by Firenze University Press (www.fupress.com), ISSN 2704-5846 (online), ISBN 978-88-5518-461-8 (PDF), DOI 10.36253/978-88-5518-461-8

is by no means a foregone conclusion.

This paper investigates the issue of XM actions in detail. More specifically, the study analyses data from a recent European men's water polo championships, whose aim is to identify whether XM actions have any elements that lead to a good shot, meaning a ball in the goal even if it is saved.

Section 2 describes a preliminary analysis of the 48 matches in this championship. The results of the analysis carried out into the XM actions are presented in Section 3. The final section discusses some concluding remarks.

Fig. 1a: Waterpolo player positions

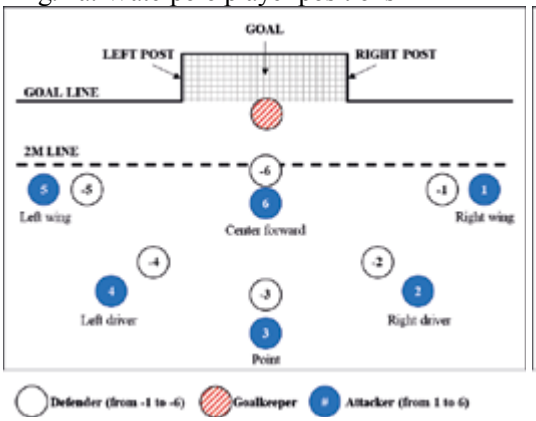
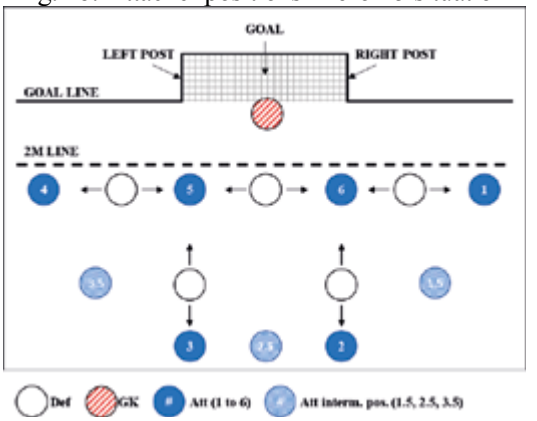


Fig. 1b: Attacker positions in 6-on-5 situation



2. Preliminary analysis

The forty-eight matches of the 34th European men's water polo championships held in Budapest in January 2020 were taken into consideration.

To verify the importance of XM actions in water polo matches, a preliminary analysis on all the matches was carried out starting from the information obtained from the play-to-play tables available on the championship site[1].

For each match, the following variables were taken into consideration: outcome, number of possessions, total number of actions (i.e. possessions that end with a shot, an exclusion or a penalty), number of 6-on-6 actions (EA), number of 6-on-5 actions (XM), total number of goals, number of goals scored in 6-on-6 actions (EG) and number of goals scored in 6-on-5 actions (XG).

After regular time, three of the 48 matches ended with a draw and the winner was decided with a penalty shootout: Spain defeated Hungary in the preliminary phase and Serbia in the quarter-finals, but lost the match for 1st place against Hungary. The definition of the winning/losing team in this case corresponds to the result of the match after penalties.

In the tournament, the number of possessions per team averaged 37.8 (SD=3.1) per match. With regard to actions, there were significant differences between winning (mean=30.8; SD=4.1) and losing (mean=26.0; SD=4.1) teams, as is the case for the number of goals per match, in both even (6-on-6) and in man-up (6-on-5) situations (Table 1).

Overall, most goals resulted from even-player actions (6.6 per match against 3.7 in man-up). This is due to the fact that 72% of actions were played in this situation.

Unquestionably, the probability that an even-player action concludes with a goal is lower than the same probability for man-up actions. As you can see in Table 1, 31.2% of even-player actions concludes with a goal, whilst with an extra man the percentage is 46.6%.

Differentiating between winning and losing teams, the percentages become 38.2% and 24.2% respectively in 6-on-6 actions (EG/EA). That is to say, the winning teams score a goal for approximately every three play actions with even players, whilst the losers score one every four.

[1] http://wp2020budapest.microplustiming.com/

When considering a numerically superior formation, the winning teams score on average one goal every two play actions (51.9%), whereas losing teams score 41.3% per action (XG/XM). There is, therefore, a distinctly higher performance in situations of numerical superiority, which is emphasised when differentiating between winning and losing teams.

So, when the opponent is given an exclusion it provides an opportunity to play an action with a higher probability of scoring a goal. This is why the objective for most of the game is to give the ball to the centre forward in order to obtain an exclusion.

Table 1: European men's water polo matches. Means, standard deviations, differences between winning and losing teams and p-value of ANOVA F test (significant differences in bold)

	Total (n=96)				Winning teams (n=48)				Losing teams (n=48)				F
	N	%	Mean	SD	n	%	Mean	SD	n	%	Mean	SD	pval
Possessions	3624		37.8	3.1	1838		38.3	3.5	1786		37.2	2.6	0.089
Actions	2726	100.0	28.4	4.7	1479	100.0	**30.8**	4.1	1247	100.0	**26.0**	4.1	**0.000**
6-on-6 (EA)	1964	72.0	20.5	4.5	1091	73.8	**22.7**	4.1	873	70.0	**18.2**	3.8	**0.000**
6-on-5 (XM)	762	28.0	7.9	3.1	388	26.2	8.1	2.7	374	30.0	7.8	3.4	0.642
Goals	988	100.0	10.3	4.6	628	100.0	**13.1**	4.4	360	100.0	**7.5**	2.6	**0.000**
6-on-6 (EG)	633	64.1	6.6	3.8	427	68.0	**8.9**	3.8	206	57.2	**4.3**	1.8	**0.000**
6-on-5 (XG)	355	35.9	3.7	2.1	201	32.0	**4.2**	2.2	154	42.8	**3.2**	1.9	**0.019**
EG/EA			0.312	0.134			**0.382**	0.120			**0.242**	0.109	**0.000**
XG/XM			0.466	0.221			**0.519**	0.223			**0.413**	0.208	**0.018**

3. The extra-man action analysis

In the previous section, analysis underlined the importance of a man-up situation.

The decision was made to proceed with an analysis of all man-up actions in all 48 matches in order to understand if any characteristics of numerically superior play actions can be identified which increase the probability of scoring a goal or at least of making a good throw at the goal.

For this purpose, data from official FINA[2] video footage of the European men's water polo championships were collected and analysed. The dataset is formed of 979 extra-man plays. This number is higher than the total number of play actions in Table 1 (762); the reason being that numerically superior play actions were also considered when the excluded player had already returned to play, but had yet to reach his position in defence.

Focusing attention on the characteristics of an action that depend on the way the team plays, for each of the chosen actions, regardless of the outcome, the following variables were considered: number of passes, action duration (in seconds), sequence of passes (positions in Fig. 1b), time out call (Yes/No).

The following variable were then defined:

- GoodShot: 1 means an action which ended with a goal or a shot saved by the goalkeeper; otherwise 0.
- ZoneCat. This is defined by three categories considering the last zone in a sequence of passes, meaning, for example, the origin of a shot: "Lateral"=Zone 1 or 4, "Posts"=Zone 5 or 6, "External"=Other zone.
- DurationCat. This is defined by three categories considering the duration in seconds of an action: "Less than 11", "From 11 to 15", "More than 15".
- NPassesCat. This is defined by three categories considering the number of passes of an action: "Less than 5", "From 5 to 7", "More than 7".
- Rotation: 1 means an action where at least one player moves to an intermediate position (1.5, 2.5 or 3.5) or an action where players in position 1 or 4 move within the 2-meter line

[2] Dailymotion platform

with the ball; otherwise 0.
- LongPasses: 1 means an action with passes between nonadjacent zones (from 1 to 3, from 1 to 4, from 2 to 4 and vice versa); otherwise 0.

The reason behind using the GoodShot variable instead of Goal relates to the fact that a well-played action may not lead to a score because the goalkeeper performs an exceptional save. It can still be defined as a well-played action that satisfies the coach, even though a score would have been preferable.

Pearson's Chi Square test showed a significant association between the occurrence of a good shot and some of the variables considered (in bold), as shown in Table 2.

Table 2: Pearson's Chi Square test results for the selected variables and GoodShot

Variable	p-value
ZoneCat	**0.010**
DurationCat	**0.000**
NPassesCat	**0.000**
Rotation	0.065
LongPasses	**0.028**
TimeOut	0.054

In order to illustrate the effect of significant variables on the probability of performing a good shot, a logistic regression model was estimated. As the number of passes is strongly correlated with the duration of the action (r=0.774), NPassesCat was not included in the model. These results are shown in Table 3.

Table 3: Logistic regression model for GoodShot

	B	S.E.	Wald	df	P-Value	Exp(B)
Duration "From 11 to 15"			15.716	2	0.000	
Duration "Less than 11"	0.352	0.157	5.045	1	0.025	1.423
Duration "More than 15"	0.742	0.191	15.101	1	0.000	2.100
Zone "External"			6.784	2	0.034	
Zone "Lateral"	-0.359	0.171	4.416	1	0.036	0.698
Zone "Posts"	-0.485	0.193	6.277	1	0.012	0.616
LongPasses	-0.015	0.192	0,006	1	0.937	0.985
Constant	0.498	0.171	8.518	1	0.004	1.646

Given substantial heterogeneity in the data, a Nagelkerke pseudo R-squared of 0.21 can be considered acceptable (Hu *et al*., 2006)

The results show that DurationCat and ZoneCat variables both significantly affect the probability of performing a good shot. In particular, an action that lasts less than 11 seconds has 1.423 times the probability of concluding with a good shot than an action that lasts from 11 to 15 seconds. And the probability of "long" actions, as in those which last more than 15 seconds, finishing with a good shot is 2.1 times higher than the probability associated to 'intermediate' ones. The reason may be that short actions are often the result of an extremely fast conclusion. For example, if the centre forward attains an exclusion and finds himself in front of the goal unmarked for a few seconds, this provides a great opportunity to score if the ball is passed to him rapidly. Longer actions, on the other hand, permit the attacking team to 'upset' the defence, thus creating good opportunities for goals.

As far as the ZoneCat variable is concerned, play actions which are more likely to generate a good attempt at scoring are those concluded from the 'external' zone. Attempts from 'lateral' zones

are more difficult because the angle of attack is narrower and the defence covers the goal area more effectively. Conclusions from the goal posts are also difficult because it is hard to get a good ball into that area. The defence covers that area densely and easily succeeds in neutralising the play action.

Despite a significant connection to a good shot, the LongPasses variable was not relevant in the model, even though long passes are thought to contribute to upsetting the defence.

Conclusions

This paper concentrates on extra-man play actions, believed to bear great importance on the outcome of a water polo match. Forty-eight matches comprising the men's 2020 European water polo championships in Budapest were considered.

A significant association was observed between the duration of man-up actions, the origin of the shots and the occurrence of good shots in the 979 actions analysed. Man-up actions that last less than 11 seconds and 'long' actions are more likely to produce good shots. In addition, external shots are more likely to be good shots than posts or lateral shots.

Several characteristics were recorded on each man-up action, but few of them seemed to influence its outcome. This may be explained by the fact that the outcome of a play action is not only linked to the execution of a strategy, but it is influenced by factors which cannot all be measured. The opponents' performance naturally has an effect on the game. When faced by a solid defence, the effectiveness of the attack is likely to suffer negatively. Psychological conditions can also have a positive or negative effect. The coach's role is to motivate his team and bring out the best in them particularly when the opponent is better or the odds at stake are high.

It is not unsurprising that clear cut indications to follow for a numerically superior attack were not found: the result of a match is not only a question of technique. The beauty of team sports also lies in observing the more unexpected result.

References

FINA (2020). *FINA Water Polo rules*, https://www.fina.org/water-polo. Book

Hu, B., Shao, J. and Palta, M. (2006). Pseudo-R^2 in logistic regression. *Statistica Sinica*, **16**, pp. 847-860. Journal Article

Hraste, M., Jelaska, I. and Clark, C. (2020). Impact of Time-Outs on Efficiency of Man-Up in Water Polo: An Analysis of the Differences between the Three Levels of Water Polo Players. *SportMont*, **18** (2020) 3, pp. 67-71. Journal Article

Lubisco A., Mignani S., Trivisano C. (2019). Assessment of game actions performance in water polo: a data analytic approach, in *ASA Conference 2019 Statistics for Health and Well-being*, CLEUP Coop. Libraria Editrice, 2019, pp. 141-144. Paper in Conference Proceedings

Lupo, C., Condello, G., Capranica, L., Tessitore, A. (2014). Women's water polo world championships: technical and tactical aspects of winning and losing teams in close and unbalanced games. *Journal of Strength and Conditioning Research*, **28**, pp. 210-222. Journal Article

Nagelkerke, N. J. D. (1991). A note on a general definition of the coefficient of determination. *Biometrika* **78**, pp. 691-693. Journal Article

Takagi, H., Nishijima, T., Enomoto, I., Stewart, A. (2005). Determining factors of game performance in the 2001 world water polo championships. *Journal of human movement studies*, **49**, pp. 333-352. Journal Article

Tucher, G., de Souza Castro, F., Garrido, D., Silva, A. (2014). Relationship between origin of shot and occurrence of goals in competitive men's water polo matches. *Revista Brasileira de Cineantropometria e Desempenho Humano*, June 2014, **16** (2), pp. 136-143. Journal Article