DOI 10.26773/smj.231003

SportMont

ORIGINAL SCIENTIFIC PAPER

Differences in Technical and Tactical Efficiency between Winning and Defeated Water Polo Teams: A Comparative Analysis

Mladen Hraste[1], Karlo Antonio Bulić[2], Igor Jelaska[2]

[1]Faculty of Science, University of Split, Split, Croatia, [2]Faculty of Kinesiology, University of Split, Split, Croatia

Abstract

Notation analysis is basically the gathering and analyzing of information that has been gained from observing performance in a competitive situation. The aim of this paper was to determine and explain the results and differences in technical and tactical efficiency in men's water polo between winning and defeated teams. The sample of the entities included 31 matches from the men's tournament held at the Olympic Games in Tokyo 2021. The sample of variables covered 18 defense and attack parameters of efficiency. Using a t-test for independent samples led to a result that the winning and losing teams differed significantly in four variables. Significant differences of winning teams in the realization with an equal number of players was probably stemmed from having better skills in achieving optimal conditions in preparation and performance. The reasons for the superiority of the winning teams in the part of defensive actions can probably be found in better and more coordinated actions of all defensive players in exclusions, blocking the ball and goalkeeper shot saves. These findings encourage coaches to improve players' skills by providing optimal conditions for the part of the technical-tactical solutions in defense and attack.

Keywords: *men water polo players, match analysis, technical indicators, tactical indicators*

Introduction

Notation analysis is basically the gathering and analyzing of information that has been gained from observing performance in a competitive situation. Success in any sport, including water polo, depends on several factors such as morphological structure, psychomotor abilities, cognitive abilities, conative characteristics, physiological and functional characteristics, technical and tactical knowledge, theoretical knowledge of water polo players and other (Hraste, 2021). Playing tactics in water polo is one of the most important segments because the outcome of the game depends greatly upon it (Hraste, 2021). According to Hraste (2021) there are numerous tactical possibilities in the defense and attack phase in water polo. In the defense phase, there are pressing, zone and combined defense, while in attack, the team can rely on a quick transition, outside shot, play with one or two center forwards, etc. The team will develop a style of play according to their fitness and technical capabilities (Hraste, 2021). In addition to adjusting the tactics according to one's own abilities, the tactics are also adjusted depending on the opponent, in a way of attempting to annul the opponent's advantages and take advantage of the disadvantages. Several investigations showed that a difference in the level of water polo players has a relevant impact on the occurrence of technical and tactical indicators especially in relation to even, counterattack, and power play situations. (Argudo, Ruiz, & Alonso, 2008; Lupo, Condello, & Capranica, 2012; Garcia-Marin, Iturriaga, & Manuel, 2017a; Garcia-Marin, Iturriaga, & Manuel, 2017b; Hraste, Jelaska, & Clark, 2020). In men´s games, eight game-related statistics, i.e. shots, extra player shots, 5 m-shots and assists (offensive efficiency), blocked shots, goalkeeper-blocked shots, goalkeeper-blocked extra player shots and goalkeeper-blocked 5 m shots (de-

Correspondence:

M. Hraste
University of Split, Faculty of Science, Independent Chair of Social and Humanities Sciences, 33 Ruđer Bošković Street, 21 000 Split, Croatia
E-mail: mhraste@pmfst.hr

fensive efficiency) were considered (Escalante, Saavedra, Mansilla, & Tella, 2011) to distinguish between winning and losing teams in the final phase of the 2008 Olympic Games held in Beijing. In other studies, the offensive performance indicators i.e. centre goals, power play goals, counterattack goals, assists, offensive fouls, steals, blocked shots and won sprints, as well as defensive indicators i.e. goalkeeper blocked shots, goalkeeper-blocked inferiority shots and goalkeeper-blocked 5 m shots (Escalante et al., 2013) were used to distinguish between performances in international championships and their relationship with the phases of competition. In the research of Argudo, Ruiz and Alonso (2009) at 10 World Championships in the men's water polo between the winning team and defeated team, the authors found differences in the determination of the action, precise passing and shooting. Differences between two different levels in men's water polo emerged in the frequency of occurrence of counterattack and power play actions, the duration of even situations, the mean number of players directly involved during power play actions, the mean number of the passes during even and power play actions, the frequency of occurrence of the shots during counterattack and power play actions, the frequency of occurrence of goals during even actions, the frequency of occurrence of shots originating from different zones of the court, and the type of shots performed (Lupo, Tessitore, Minganti, & Capranica, 2010). One more research was conducted on how much certain factors affect the game of water polo, i.e. which elements of the game are the key to achieving success in men's water polo. Takagi et al. (2005), based on data from 108 matches from the 2001 World Cup in water polo, factorized the structure of both men's and women's water polo games and found that out of 32 variables, only two determine the winner of a water polo match: the ability to realize counterattacks and players more, and success in blocking and rescuing from the opponent's shots in a game with one less player. Observing the differences between the winning and losing water polo teams led to a conclusion that top 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 (Canossa et al., 2020). Hraste, Jelaska and Stipić (2022) found and explained eight of eighteen technical-tactical variables that differentiate top women's winning and losing teams (goals in a situation with an equal number of opposing players, shots from the counterattack, goals from the counterattack, man-up goals, goalkeeper shot save, opponent's shots on goal, blocks and swimming for the ball).

Looking at previous research on the technical-tactical structure of differences between defeated and winning teams, it can be noticed that there was inconsistency in the decisive factors. The reasons for the above can be found in the diversity of research methodologies and, above all, in the dynamism of the water polo game in space and time. Namely, water polo is a sport in which frequent changes in the rules of the game and the development of the energy component of the game lead to changes in technical and tactical efficiency. Because of all of the above, continuous research into the technical-tactical structure of the water polo game is required.

The aim of this paper is to determine and explain the results and differences in technical and tactical efficiency in men's water polo. There is an assumption that top men water polo players would differ in some variables of technical and tactical efficiency.

Material and methods

Participants

The sample of the entities included matches from men's tournament held at the Olympic Games in 2021. The results of matches of teams that lost more than 2 games with 8 goals difference and more (South Africa and Kazakhstan), were excluded from the sample of the entities. So called outliers were left out of the overall tournament statistics in order to get relatively homogeneous participating teams (Hungary, Greece, Italy, Australia, USA, Japan, Spain, Serbia, Montenegro and Croatia). One match that ended in a draw was also excluded from the entity sample. At the Olympic Games held in Tokyo, 42 matches were played in the men's tournament, and for the purposes of this research, 31 matches were analysed.

Measures

The sample of variables included 18 parameters of efficiency: total number of shots (TS), shots in a situation with an equal number of opposing players (SE), goals in a situation with an equal number of opposing players (GE), shots from fouls (SF), goals from fouls (GF), number of penalties (TP), goals from the penalties (GP), shots from the counterattack (SC), goals from the counterattack (GK), man-up shots (MS), man-up goals (MG), goalkeeper shot save (GS), opponent's shots on goal (OS), blocks (BL), stolen balls (SB), swimming for the ball (SB), exclusions (E) and lost balls (LB). Variables from previous research (Lupo et al., 2012; Graham & Mayberry, 2014; García-Marín & Iturriaga, 2017) were partly used to shape the set of technical and tactical efficiency parametars. Four top water polo experts participated in the selection of all 18 statistical parameters, who believed that the selected parameters cover the entirety of the water polo game very well. The selected variables appear for the first time in a design scientific paper covering men's water polo.

Procedures

The data were collected from the official records of the Total Waterpolo platform which are tracked during the playing of water polo games. Upon a request of the authors, Total Waterpolo sent their data of the observed matches. The data can also be found at the following link: https://total-waterpolo.com/tokyo-2020-mens-olympic-water-polo-tournament/. Official staff registered all of the collected data. Reliability of the data was tested by additional reviewing of 10 matches. The reviewing was done by two independent water polo experts. Each frequency of variable for each group of players was collected and compared to data from the official records. Reliability coefficients for single data was calculated as a ratio of reviewed observed frequencies and official record frequencies.

Statistical Analysis

For the purposes of this study, basic statistical parameters in the form of arithmetic mean (AM), median (MED), minimum score (MIN), maximum score (MAX), standard deviation (SD), skewness (SK) and kurtosis (KUR) were calculated, and a t-test for independent samples was calculated. The level of statistical significance was set to 5%. Data were processed using software system Statistica ver. 13.2. (Dell Inc., Tulsa, OK, USA).

Results

Table 1 shows basic descriptive parameters of the variables of situational efficiency of the winning teams (mean, median, minimum score, maximum score, standard deviation, skewness and kurtosis).

Table 1. Descriptive statistics: arithmetic mean (AM), median (MED), minimum score (MIN), maximum score (MAX), standard deviation (SD), skewness (SK) and kurtosis (KUR) for the variables of situational efficiency of the winning teams

VAR	AS	MED	MIN	MAX	SD	SK	KUR
TS	30,00	29,50	24,00	35,00	3,17	-0,06	-1,00
SE	17,83	18,00	12,00	23,00	3,39	0,03	-1,24
GE	5,37	6,00	1,00	10,00	2,27	-0,19	-0,33
SF	0,83	1,00	0,00	3,00	0,91	0,64	-0,79
GF	0,30	0,00	0,00	1,00	0,47	0,92	-1,24
TP	1,33	1,00	0,00	5,00	1,37	1,23	1,56
GP	1,20	1,00	0,00	5,00	1,30	1,23	1,40
SC	0,97	1,00	0,00	3,00	0,93	0,62	-0,44
GC	0,67	1,00	0,00	3,00	0,76	1,17	1,66
MS	8,90	8,50	3,00	15,00	2,76	0,23	-0,38
MG	4,87	5,00	2,00	9,00	1,80	0,29	-0,54
GS	10,77	10,00	7,00	17,00	2,71	0,72	-0,43
OS	19,30	18,50	11,00	28,00	4,32	0,32	-0,55
BL	4,93	5,00	0,00	11,00	2,32	0,12	0,50
STB	6,07	6,00	1,00	13,00	2,48	0,59	0,95
SWB	2,10	2,00	0,00	4,00	1,21	0,04	-1,15
E	14,03	14,00	7,00	20,00	3,48	-0,12	-0,70
LB	10,33	9,00	5,00	21,00	3,74	0,82	0,62

Legend TS - total number of shots, SE - shots in a situation with an equal number of opposing players, GE - goals in a situation with an equal number of opposing players, SF - shots from foul, GF - goals from foul, TP - number of penalties, GP - goals from the penalties, SC - shots from the counterattack, GC - goals from the counterattack, MS - man-up shots, MG - man-up goals, GS - goalkeeper shot save, OS - opponent's shots on goal, BL - blocks, STB - stolen balls, SWB - swimming for the ball, E – exclusions, LB - lost balls

Table 2 shows basic descriptive parameters of the variables of situational efficiency of the defeated teams (mean, median, minimum score, maximum score, standard deviation, skewness and kurtosis).

Table 2. Descriptive statistics: arithmetic mean (AM), median (MED), minimum score (MIN), maximum score (MAX), standard deviation (SD), skewness (SK) and kurtosis (KUR) for the variables of situational efficiency of the defeated teams

VAR	AS	MED	MIN	MAX	SD	SK	KUR
TS	30,57	30,50	24,00	42,00	4,17	0,79	0,71
SE	17,13	17,00	10,00	26,00	3,45	0,34	0,42
GE	3,33	3,00	1,00	8,00	1,83	0,85	0,21
SF	1,13	1,00	0,00	5,00	1,17	1,40	2,79
GF	0,10	0,00	0,00	1,00	0,31	2,81	6,31
TP	1,00	0,00	0,00	9,00	1,91	2,89	10,14
GP	0,80	0,00	0,00	7,00	1,56	2,68	8,19
SC	0,57	0,00	0,00	2,00	0,73	0,90	-0,47
GC	0,37	0,00	0,00	2,00	0,61	1,50	1,33
MS	10,53	10,00	4,00	19,00	3,78	0,46	-0,76
MG	4,13	4,00	0,00	10,00	2,26	0,87	0,86
GS	9,00	9,00	3,00	16,00	2,85	0,39	0,45
OS	21,27	21,50	12,00	29,00	3,71	-0,36	0,40
BL	2,57	2,50	0,00	6,00	1,55	0,26	-0,64
STB	6,17	5,00	1,00	15,00	3,31	0,94	0,73
SWB	1,87	2,00	0,00	4,00	1,22	0,03	-1,22
E	11,83	12,00	6,00	20,00	2,90	0,49	0,74
LB	10,23	10,00	3,00	17,00	3,27	0,13	-0,02

Legend: TS - total number of shots, SE - shots in a situation with an equal number of opposing players, GE - goals in a situation with an equal number of opposing players, SF - shots from foul GF - goals from foul, TP - number of penalties, GP - goals from the penalties, SC - shots from the counterattack, GC - goals from the counterattack, MS - man-up shots, MG - man-up goals, GS - goalkeeper shot save, OS - opponent's shots on goal, BL - blocks, STB - stolen balls, SWB - swimming for the ball, E – exclusions, LB - lost balls

Table 3 presents the results of the t-test for independent samples. According to the results from table 3, in men's water polo, the winning and losing teams differ statistically and significantly in four of eighteen situational variables: goals in a situation with an equal number of opposing players, goalkeeper shot save, blocks and exclusions.

Table 3. T-test for independent samples (AS DEF - arithmetic mean of defeated men's teams; AS WIN - arithmetic mean of winning women's teams; t value; p-level of significance)

VAR	AS DEF	AS WIN	t value	p
TS	30,57	30,00	0,59	0,56
SE	17,13	17,83	-0,79	0,43
GE	3,33	5,37	-3,83	0,00
SF	1,13	0,83	1,11	0,27
GF	0,10	0,30	-1,97	0,05
TP	1,00	1,33	-0,78	0,44
GP	0,80	1,20	-1,08	0,29
SC	0,57	0,97	-1,86	0,07
GC	0,37	0,67	-1,68	0,10
MS	10,53	8,90	1,91	0,06
MG	4,13	4,87	-1,39	0,17
GS	9,00	10,77	-2,46	0,02
OS	21,27	19,30	1,89	0,06
BL	2,57	4,93	-4,65	0,00
STB	6,17	6,07	0,13	0,90
SWB	1,87	2,10	-0,74	0,46
E	11,83	14,03	-2,66	0,01
LB	10,23	10,33	-0,11	0,91

Legend: TS - total number of shots, SE - shots in a situation with an equal number of opposing players, GE - goals in a situation with an equal number of opposing players, SF - shots from foul GF - goals from foul, TP - number of penalties, GP - goals from the penalties, SC - shots from the counterattack, GC - goals from the counterattack, MS - man-up shots, MG - man-up goals, GS - goalkeeper shot save, OS - opponent's shots on goal, BL - blocks, STB - stolen balls, SWB - swimming for the ball, E – exclusions, LB - lost balls

Discussion

In this research the winning team on average scored more than two goals in a situation with an equal number of opposing players. The reasons for the observed statistically significant difference can most likely be sought in better selection and higher quality of players of the winning teams. Namely, the higher quality of the players probably collectively contributes to a better preparation of all the actions that precede a shot, as well as the realization itself (Hraste et al., 2022). The goalkeepers of the winning teams had almost two more saves than the goalkeepers of the losing teams. The goalkeeper is a very important link within the team. The significant role of the goalkeeper in the overall result of a water polo match has already been confirmed in a previous study (Escalante et al., 2013). A good goalkeeper makes a team better, but also having players in the field with a well-placed defense certainly helps the goalkeeper save more shots. Also, players from the winning teams blocked almost twice as many shots on goal as players from the losing teams which represents a statistically significant difference which was also determined in the research of Escalante et al. (2011). The reason for this can also be sought in a better quality of individuals. Just as with the execution of the shot, a better player performs all the necessary actions to set up a high-quality and successful block. It is interesting to note that the winning teams had statistically significantly more expulsions than the defeated teams. The number of exclusions is a seemingly "negative" variable of situational efficiency. However, it must be considered that good teams do not want to concede easy field goals (Hraste, 2021). They prefer to make an exclusion, so they defend with one less player. Given a good goalkeeper and well-placed blocks, this tactic is clearly successful (Hraste, 2021). The dominance of winning teams in the realization with an equal number of players probably stemmed from better skills in achieving optimal conditions in the preparation and implementation of all offensive actions (Escalante et al., 2011; Hraste et al., 2022). The reasons for the superiority of the winning teams in the part of defensive actions can probably be found in better and more coordinated actions of all defensive players in blocking the ball, reducing the opponent's shots and goalkeeper shot save. This research confirmed some previous research in differentiating top male water polo players according to match outcomes (Takagi et al., 2005; Lupo et al., 2010).

In the previous chapter, the significant difference observed between winning and losing teams in the variables: goals in a situation with an equal number of opposing players, goalkeeper shot save, blocks and exclusions is partially consistent with some research (Canossa et al., 2020; Escalante et al., 2011; Escalante et al., 2013; Hraste et al., 2022) but different from other studies (Argudo et al., 2008; Lupo et al., 2012; Garcia-Marin et al., 2017b). The reasons for the observed discrepancies can probably be found in different research methodologies, evolution of the technical-tactical and energy structure of water polo players, and especially in the fact that the wa-

ter polo rules have been continuously changing over the past twenty years. The changes in water polo rules that were adopted in 2019 had the goal of making water polo faster and more dynamic, and based on the aforementioned characteristics, to reduce the gap between the so-called "big" and "small" national teams. The existence of statistically significant differences in only four variables and their absence in the remaining fourteen variables can most likely be attributed to the very equal quality of the ten national teams that were observed, which is mostly indicated by the results of the matches. The opinions of water polo experts and the results of the matches suggest that the changes in the water polo rules justified the goal and that today's water polo research is different compared to the research until 2019 (Takagi et al., 2005; Argudo et al., 2008; Lupo et al., 2010; Escalante et al., 2011; Lupo et al., 2012; Escalante et al., 2013; Garcia-Marin et al., 2017b).

This study has some limitations. The first limitation can be found in the unequal distribution of the total number of analyzed matches in different phases (preliminary phase, n=19; quarter-final/semi-final phase/play-offs for 5th to 8th place/bronze medals/gold medals, n=12). Another limitation can be found in the preliminary stage, in which some matches often happened with some teams with no longer having the possibility to advance to the next round, which could have affected some of the statistics related to the game.

In future research, it is necessary to continue working with this type of analysis, adding variables that would give an even better insight into the structure and differences of technical-tactical activities (e.g. the number and effectiveness of shots with regard to the position on the field and/or the role in the game).

Conclusion

This research showed that the technical and tactical indicators of the top men's water polo competitions vary in relation to the outcome of the match. The statistically significant higher number of goals scored by the winning teams during the actions of an equal number of opposing players suggests better skills in preparation and execution. Better indicators of winning teams in three defensive actions confirmed their overall superiority. Selected defensive and offensive variables indicated the need for a good balance between the two groups of variables. All defensive and offensive factors related to the performance of the winning team showed that more goals were combined with defensive tasks in terms of goalkeeper shot save, blocks and exclusions. Notation analysis is a great tool for water polo coaches, fitness coaches and sports scientists to be aware of the real requirements of the game. In one hand, these findings encourage coaches to improve the player's skills in providing optimal conditions for the execution of shots, and on the other hand to enhance the ability to cover and guard the direct striker playing in different internal and external positions in the game.

Acknowledgements
The authors thank to Total waterpolo for the data sent.

Conflict of Interest
The authors declare that there is no conflict of interest.

Received: 15 March 2023 | **Accepted:** 15 August 2023 | **Published:** 01 October 2023

References

Argudo, F., Ruiz L., & Alonso, R. (2008). Influence of the efficacy values in numerical equality on the condition of winner or loser in the 2003 Water Polo World Championship. *International Journal of Performance Analysis in Sport, 8*(1), 101-112. doi:10.1080/24748668.2008.11868426

Argudo, F., Ruiz L., & Alonso, R. (2009). Were differences in tactical efficacy between the winners and losers teams and the final classification in the 2003 water polo world championship? *Journal of Human Sport and Exercise, 4*, 142–153. doi: https://doi.org/10.4100/jhse.2009.42.07

Canossa, Sofia & Abraldes, J. Arturo & Estriga, Maria & Fernandes, Ricardo & Garganta, Júlio. (2020). Water Polo Shooting Performance: Differences Between World Championship Winning, Drawing and Losing Teams. *Journal of Human Kinetics, 72,* 203-214. doi: 10.2478/hukin-2019-0107

Escalante, Y., Saavedra, J. M., Mansilla, M., & Tella, V. (2011). Discriminatory power of water polo game-related statistics at the 2008 Olympic Games. *Journal of Sports Sciences*, *29*(3), 291-298. doi: 10.1080/02640414.2010.532230

Escalante, Y., Saavedra, J.M., Tella, V., Mansilla, M., García-Hermoso, A., & Domínguez, A.M. (2013). Differences and discriminatory power of water polo game-related statistics in men in international championships and their relationship with the phase of the competition. *The Journal of Strength and Conditioning Research, 27*(4), 893-901. doi: 10.1519/JSC.0b013e318260ed85

Garcia-Marin, P., Iturriaga, A., & Manuel, F. (2017a). Water polo shot indicators according to the phase of the championship: medallist versus non-medallist players. *Interntional Journal of Performance Analysis in Sport, 17*, 642–655. doi: 10.1080/24748668.2017.1382215

Garcia-Marin, P., & Iturriaga, A. (2017). Water polo: Technical and tactical shot indicators between winners and losers according to the final score of the game. *Interntional Journal of Performance Analysis in Sport, 17*, 334–349. doi: 10.1080/24748668.2017.1339258

Graham, J., & Mayberry, J. (2014). Measures of tactical efficiency in water polo. *Journal of Quantitative Analysis in Sports, 10*(1), 67-79. doi: 10.1515/jqas-2013-0127

Garcia-Marin, P., Iturriaga, A., & Manuel, F. (2017b). Water polo: Technical and tactical shot indicators between winners and losers according to the final score of the game. *Interntional Journal of Performance Analysis in Sport, 17*, 334–349. doi: 10.1080/24748668.2017.1339258

Hraste, M. (2021). *Water polo / Vaterpolo.* Faculty of Kinesiology, Split, Croatia.

Hraste, M., Jelaska, I., & Stipić, M. (2022). Notation analysis of the Women's Olympic Water Polo Tournament held in Tokyo in 2021. *The proceedings book of 1st International Conference on Science and Medicine in Aquatic Sports, 58-64.* Split, University of Split, Faculty of Kinesiology. https://www.bib.irb.hr/1247844

Hraste, M., Jelaska, I., & Clark, C. 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. *Sport Mont*, *18*(3), 67-71. doi: 10.26773/smj.201019

Lupo, C., Condello, G., & Tessitore, A. (2012). Notational analysis of elite men's water polo related to specific margins of victory. *Journal of Sports Science & Medicine, 11*(3), 516. From https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3737947/

Lupo, C., Tessitore, A., Minganti, C., & Capranica, L. (2010). Notational Analysis of Elite and Sub-Elite Water Polo Matches. *Journal of Strength and Conditioning Research, 24*, 223–229. doi:10.1519/JSC.0b013e3181c27d36

Lupo, C., Minganti, C., Cortis, C., Perroni, F., Capranica, L., & Tessitore, A. (2012). Effects of competition level on the centre forward role of men's water polo. *Journal of Sports Sciences. 30*(9), 889-897. doi: 10.1080/02640414.2012.679673

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*, 333–352. from https://www.researchgate.net/publication/261474423