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Analysis of the game statistics of the top eight teams at the European and World Championships 2020/24 in men's water polo

Vladan Marković[1], Diana Timotijevic[2], Zlatko Ahmetovic[2], Miloš Milošević[1]

[1] Faculty of Physical Education and Sports Management, Singidunum University, Serbia; [2] Faculty of Sport and Psychology, TIMS, University Educons, Novi Sad, Serbia

Abstract

Study aim: The aim of this study was to examine statistical parameters and determine which had the greatest influence on the final score at the European and World Championships in the period of 2020-2024.
Material and methods: The analysis included 24 water polo matches, featuring the top 8 placed teams from the last 3 European and World Championships. From the official statistical reports of the matches, 28 statistical parameters were analyzed, which were taken from the Total Waterpolo website.
Results: Based on the descriptive statistics, flaws and analysis of the variance of water polo parameters in the game, a total of 7 variables (Total goals, Total goal efficiency, Penalty goals efficiency, Fastbrake goals, Fastbrake shots, Powerplay goals efficiency, Saved shots efficiency) were identified as significant for winning the matches at the European and World Championships 2020-2024, and 6 variables (Total goals, Total shots, Penalty shots, Penalty saved, Penalty goals, Blocked shots) were found to be significantly different between the games at the European and World Championships, while the leading parameters were the number of shots on target and saved shots.
Conclusion: In this research, we found that the outcome of a match can be predicted and scientifically explained with 95.8% accuracy, based on the statistical parameters and their analysis.

Keywords: Water polo – Statistical parameters – Efficacy – Match analysis – Success

Introduction

Water polo is the oldest team sport in the history of the modern Olympic Games. It is played in a pool with a ball, the winner being the team that scores the most goals (Markovic, 2019; Markovic & Milosevic, 2023). Water polo is defined by rules and is characterized by dynamic action in the defense and attack phase with a lot of specific swimming motions, which makes it attractive for spectators (Lozovina et al., 2009; Vila et al., 2011), ball handling, passing and accurate shooting at the goal. Modern water polo has become fast-paced both in defense and attack, as well as technically, tactically, and physically more demanding (Markovic, 2019), and shots taken are stronger and more accurate (Hraste et al., 2014).

Water polo is a sport in which interest has been growing, with a noticeable increase in the number of more and less recent publications (Markovic & Milosevic, 2023; Prieto et al., 2013). Research in water polo has attempted to identify game performance characteristics for male and female competitions (Escalante et al., 2010; Escalante et al., 2012; Lupo et al., 2011; Lupo et al., 2011; Markovic & Milosevic, 2023). As for the difference in game-related statistics between men and women, it seems that they are determined to a greater extent by technical and tactical actions (Canossa et al., 2009; Canossa et al., 2020) than by physiological characteristics (Konstantaki et al., 1998).

Good performance of water polo players determines the success of national and local teams (Escalante et al., 2010; Escalante et al., 2012; Escalante et al., 2013; Lupo et al., 2014) competing at the Olympic Games (Garcia & Tourino, 2022; Escalante et al., 2010), World Championships (WCs) (Escalante et al., 2013; Saavedra et al., 2020), the European Championship (EC) (Escalante et al., 2013), and the LEN Champions League matches (Markovic, 2019). These major competitions provide the technical-tactical parameters of the game (offensive and defensive) and the variables that influence the outcome of matches; these were analyzed among the winners in different stages of their matches (preliminaries, the finals).

Author's address Vladan Markovic, PhD, Faculty of Physical Education and Sports Management, Singidunum University, Danijelova 32, 11000 Belgrade, Serbia vladanmarkovic@singidunum.ac.rs

As the World Water Polo Championship rounds progress, the game becomes more demanding and the teams move closer to the final outcome (Lupo et al., 2012), and the margin of play between the winning and losing top teams decreases (Graham & Mayberry 2014). However, the finals are usually decided on a one-goal margin, limiting team differentiation through classical performance analysis due to a lack of statistical significance (Lames & McGarry 2007). Therefore, alternative methods are needed to obtain qualitative information from the game interaction process (Novitović et al., 2018).

On the other hand, national water polo matches have been analyzed by different authors (García, et al., 2015; Lupo et al., 2010; Lupo et al., 2012; Özkol et al., 2013; Prieto et al., 2013). They focused on matches between teams who either won or lost a match in terms of champion standards (Lupo et al., 2010), offensive and defensive coefficients (Argudo et al., 2007), game situations (Lupo et al., 2011; Madera et al., 2007), positions (Platanou, 2004), goalkeeper relevance (Enomoto et al., 2004), gender (Escalante et al., 2010; Takagi et al., 2005), from the perspective of physiology (Botonis et al., 2019) and shot types (Lupo et al., 2011). The main goal of their analysis was to identify the strengths and weaknesses of the teams in order to improve their performance (Madera et al., 2007; Ordóñez et al., 2016). The studies indicated that counter-attack actions in winning teams (Lupo et al., 2010; Lupo et al., 2011; Saavedra et al., 2020) and especially shots within 5 meters (Escalante et al., 2010; Lupo et al., 2011) and defensive and offensive actions are significant determinants of performance. Examples are the goalkeeper's save (Escalante et al., 2010) and blocking (Takagi et al., 2005; Vila et al., 2011). In the "player more" situation, the wing achieves a higher shooting percentage than the outside players (Platanou, 2004).

Studies on the topic of differences between winning and losing teams have focused on analyzing game statistics, known as performance analysis (Argudo et al., 2007; Argudo et al., 2009; Escalante et al., 2010; Medić et al., 2014), in terms of champion standards (Argudo et al., 2009), effectiveness shooting percentages (Argudo et al., 2020; Canossa et al., 2020), game dynamics that include changes in speed and tempo (Stojmenović et al., 2023), game situations (Lupo et al., 2012), shot types (Takagi et al., 2005), and statistics related to the goalkeeper in the final phase of the competition (Escalante et al., 2013). Technical and tactical aspects of the game are included in this analysis through game link statistics, which are mainly based on frequency and efficiency percentages, helping the coaching team to improve the training plan (Hatzimanouil et al., 2017). The differences between winning and losing men's teams can be related to both defense and offense. Winning teams have greater motor skills, better court dynamics, and faster swimming and score a large number of counterattack goals (Mirvic et al., 2014). In men's games, passing (assistance), aggressive play (clearances), efficiency in the center position (central shots) and goalkeeper defense (goalkeepers blocked shots from 5 m) prevailed, and the most emphasized performance was kicks (Escalante et al., 2010). Winning teams were found to differ from losing teams in seven (offensive and defensive) variables, the game-related statistical reliability was 85% or higher, and two parameters determined the outcome of the game: shots taken and blocked shots (Saavedra et al., 2014). In recent research (Markovic & Milosevic, 2023), the key parameters were blocked shots and player exclusion in the center position, which showed 91.9% accuracy in predicting the outcome. Game-related statistics can be used to distinguish between winning and losing teams at each stage of international competition (Trivun et al., 2019).

Although this is already a well-studied topic, much previous research did not rely on a longitudinal approach, i.e. analysis of several competitions at the top level over several years, which would allow a comparison of parameters between different time periods as well as competition levels and the observation of trends. This study aimed to extend and complement the analyses of water polo parameters that influence the victory of the best teams from the last three European and World Championships in the period 2020–2024, as well as to identify variables that influence the prediction of water polo match winners at the European and World Championships 2020–2024.

Material and methods

Participants

The research used a sample of 24 men water polo matches of the top 8 competition stage at the European and World Championships between 2020 and 2024. The sample analyzed included water polo matches from 3 European and 3 World Championships played in the final rounds (best 8 male teams). The results were retrieved from the box scores available on the official website of Total Waterpolo (http://www.total-waterpolo.com/). No informed consent was necessary because the information used is in the public domain online.

Sample of variables

The sample of 28 dependent variables (game-related statistics) was based on certain player segments of offensive and defensive stages (Markovic, 2019) and specific analysis of goalkeeper-related game statistics (Argudo et al., 2020), because the goalkeeper is the most important defensive player. These were: Total – goals/shots, % Total – total goal efficiency; A – action goals/shots, % A – Action goals efficiency; D – Direct foul goals/shots, % D – Direct foul goals efficiency; P – Penalty goals/shots, % P – Penalty

goals efficiency; F – Fastbrake goals/shots, % F – Fastbrake goals efficiency; PP – Powerplay goals/shots, % PP – Powerplay goals efficiency; S – Shots on target; SS – Saved shots; SS % – Saved shots efficiency; PPc – Powerplay conversion; P – Penalty foul; BL – Blocked shots; ST – Steals; SP – Swimoffs (won/sprints) PF – Personal foul; TU – Turnovers. Efficiency was calculated as a percentage of success in relation to the total number of attempts.

The two independent variable variables were context (winning or losing teams) and the competition events, namely the European and World Championships. In total, 24 men's matches were played in 6 International Championships (34th European Water Polo Championships 2020, Budapest; 35th European Water Polo LEN Championships 2010, Split; 19th FINA World Championships 2022, Budapest; 20th FINA World Championships 2023, Fukuoka, Japan; 36th European Water Polo LEN Championships 2024, Zagreb, Croatia; and 21st FINA World Championships 2024, Doha, Qatar) in knockout format.

Data collection and analysis

Descriptive statistical analysis, analyses of variance, multiple analyses of variance, and canonical discrimination analysis were performed on the collected data using the SPSS 20 software package.

Basic descriptive statistics (minimum, maximum, mean, and standard deviation) were calculated according to type (European and World) and year of competition for all parameters together. Data were tested with the Kolmogorov-Smirnov test to determine the normality of the data distribution and Levene's test for homogeneity of variance. When it was confirmed that all the necessary assumptions for the use of parametric statistics were met, we moved on to further analysis. Next was the multiple analysis of variance, using the method of dividing the samples into winning and losing teams as well as the type of competition (European, World and overall). Statistical significance was established at the level of $p < 0.05$. Relationships that are significant were determined by canonical discrimination. The overall predictive model was built using the canonical discrimination analysis by evaluating Wilks' lambda, canonic correlation, and the percentage of correctly classified matches.

Results

The results of descriptive statistics and MANOVA are presented separately for the European (Table 1) and World (Table 2) Championships, as well as for the total sample (Table 3).

Table 1. Descriptive statistics of the indicators for 3 European championships according to outcomes of 12 matches

	EC 2020			EC 2022			EC 2024		
	Min	Max	M ± SD	Min	Max	M ± SD	Min	Max	M ± SD
TOTAL goals	7	14	10.13 ± 2.42	6	14	9.38 ± 2.50	7	18	11.3 ± 3.8
TOTAL shots	21	34	29.13 ± 4.39	23	35	28.00 ± 3.96	23	34	28.9 ± 4.0
Total %	23	41	34.75 ± 6.14	23	44	33.63 ± 8.21	29	60	38.8 ± 12.4
A goals	1	8	3.75 ± 2.31	1	8	4.13 ± 2.47	1	9	5.1 ± 2.5
A shots	10	23	17.13 ± 4.49	11	23	15.88 ± 3.64	13	22	17.4 ± 3.3
A %	10	36	21.13 ± 10.05	6	53	26.25 ± 15.42	6	50	30.1 ± 14.4
D goals	0	1	0.38 ± 0.52	0	0	0.00 ± 0.00	0	1	0.1 ± 0.4
D shots	0	2	0.88 ± 0.83	0	6	1.63 ± 2.00	0	3	1.4 ± 1.4
D %	0	100	25.00 ± 37.80	0	0	0.00 ± 0.00	0	33	4.1 ± 11.7
P goals	0	5	1.63 ± 1.69	0	3	1.13 ± 1.25	0	2	0.8 ± 0.7
P shots	0	5	1.88 ± 2.03	0	3	1.38 ± 1.30	0	3	1.0 ± 1.1
P %	0	100	70.00 ± 45.36	0	100	45.88 ± 50.22	0	100	52.1 ± 46.7
F goals	0	1	0.13 ± 0.35	0	2	0.38 ± 0.74	0	2	0.8 ± 0.9
F shots	0	1	0.25 ± 0.46	0	3	0.63 ± 1.19	0	3	1.1 ± 1.0
F %	0	100	12.50 ± 35.36	0	100	16.63 ± 35.61	0	100	45.9 ± 50.2
PP goals	2	6	4.25 ± 1.28	2	6	3.75 ± 1.91	2	9	4.5 ± 2.4
PP shots	6	11	9.00 ± 1.69	6	13	8.50 ± 2.51	3	12	8.0 ± 3.0
PP %	25	63	47.25 ± 11.68	29	60	42.25 ± 11.52	30	75	56.6 ± 18.8
S	7	13	10.25 ± 2.25	6	11	8.75 ± 1.67	5	14	8.4 ± 3.0

	EC 2020			EC 2022			EC 2024		
	Min	Max	M ± SD	Min	Max	M ± SD	Min	Max	M ± SD
SS	15	26	20.38 ± 3.34	16	25	18.13 ± 3.09	13	25	19.6 ± 3.9
SS %	38	65	50.38 ± 8.03	35	63	48.63 ± 8.72	22	59	43.1 ± 12.5
PPc	2	6	4.25 ± 1.28	2	6	3.75 ± 1.91	2	9	4.5 ± 2.4
P	0	5	1.88 ± 2.03	0	3	1.38 ± 1.30	0	3	1.0 ± 1.1
BL	2	7	4.25 ± 1.75	1	7	4.63 ± 2.07	2	10	5.6 ± 2.8
ST	1	5	3.25 ± 1.28	7	11	8.75 ± 1.49	4	12	8.0 ± 3.3
SP	1	3	2.13 ± 0.64	1	3	1.88 ± 0.99	0	4	2.0 ± 1.6
PF	1	20	11.88 ± 5.30	11	18	14.13 ± 2.42	4	14	10.5 ± 3.1
TU	6	14	9.50 ± 2.93	8	15	10.88 ± 2.30	5	16	10.1 ± 3.3

Results of MANOVA revealed significant differences between the winning and losing teams for Total goals (F = 7.57, P = 0.01), Total % (F = 4.84, P = 0.04), and SS (F = 10.46, P = 0.01), as well as between EC 2020, EC 2022, EC 2024 for ST (F = 14.31, P = 0.01).

Table 2. Descriptive statistics of indicators for 3 World Championships according to outcomes of 12 matches

	WC 2022			WC2023			WC2024		
	Min	Max	M ± SD	Min	Max	M ± SD	Min	Max	M ± SD
TOTAL goals	6	15	10.25 ± 3.37	6	17	12.38 ± 3.93	10	18	14.00 ± 2.62
TOTAL shots	19	39	30.75 ± 6.45	24	40	32.00 ± 4.81	24	36	31.13 ± 4.22
Total %	21	42	33.38 ± 8.42	19	57	39.00 ± 11.82	37	58	45.13 ± 7.59
A goals	2	6	3.38 ± 1.51	3	7	5.13 ± 1.36	5	11	7.88 ± 2.03
A shots	8	22	16.75 ± 4.56	13	22	17.13 ± 2.85	14	27	20.13 ± 4.39
A%	9	42	21.25 ± 10.02	18	47	30.38 ± 9.10	31	50	39.13 ± 5.89
D goals	0	1	0.13 ± 0.35	0	1	0.25 ± 0.46	0	1	0.50 ± 0.53
D shots	0	4	1.25 ± 1.28	0	3	1.25 ± 1.28	0	2	0.88 ± 0.83
D %	0	50	6.25 ± 17.68	0	100	18.75 ± 37.20	0	100	37.50 ± 44.32
P goals	0	6	2.00 ± 2.56	0	7	3.25 ± 2.12	0	2	1.00 ± 0.76
P shots	0	8	2.50 ± 3.16	0	8	4.63 ± 2.92	0	3	1.38 ± 1.06
P %	0	100	57.63 ± 48.49	0	100	62.50 ± 31.09	0	100	58.38 ± 41.80
F goals	0	2	0.63 ± 0.74	0	2	0.50 ± 0.76	0	2	0.63 ± 0.92
F shots	0	3	1.38 ± 1.30	0	2	0.75 ± 0.71	0	2	0.88 ± 0.99
F %	0	100	31.25 ± 38.29	0	100	37.50 ± 51.75	0	100	31.25 ± 45.81
PP goals	2	6	4.13 ± 1.55	2	4	3.25 ± 0.89	1	6	4.00 ± 1.60
PP shots	5	13	8.88 ± 2.90	5	13	7.63 ± 2.77	3	11	7.88 ± 2.85
PP %	23	67	48.38 ± 15.56	20	67	42.25 ± 14.97	33	75	51.50 ± 16.05
S	7	18	11.38 ± 4.10	8	13	9.88 ± 1.89	4	13	9.00 ± 2.83
SS	14	29	21.63 ± 5.29	18	25	22.25 ± 3.33	18	25	23.00 ± 2.39
SS %	35	72	52.38 ± 11.20	32	68	45.38 ± 11.58	22	55	38.88 ± 11.47
PPc	2	6	4.13 ± 1.55	2	4	3.25 ± 0.89	1	6	4.00 ± 1.60
P	0	8	2.50 ± 3.16	0	8	4.63 ± 2.92	0	3	1.38 ± 1.06
BL	0	6	3.38 ± 2.26	0	8	3.25 ± 3.01	1	5	3.25 ± 1.58
ST	4	14	7.75 ± 3.11	1	5	3.00 ± 1.77	2	12	5.75 ± 3.49
SP	1	3	2.13 ± 0.99	0	4	2.13 ± 1.46	0	5	2.25 ± 1.91

	WC 2022			WC2023			WC2024		
	Min	Max	M ± SD	Min	Max	M ± SD	Min	Max	M ± SD
PF	7	19	12.25 ± 3.96	9	17	13.38 ± 2.83	5	19	12.38 ± 4.27
TU	4	15	8.75 ± 3.28	7	15	9.75 ± 2.76	6	14	10.38 ± 2.92

The results of MANOVA revealed significant differences between winning and losing teams for Total % (F = 11.45, P = 0.01), A % (F = 4.47, P < 0.05), F goals (F = 4.8, P = 0.04), S (F = 8.84, P = 0.01) and SS (F = 9.97, P = 0.01), while F shots was of borderline statistical significance (F = 4.41, P = 0.05), as well as between WC 2022, WC 2023, and WC 2024 for Total % (F = 4.31, P = 0.03), A goals (F = 13.92, P = 0.01), A % (F = 9.72, P = 0.01), SS % (F = 3.75, P = 0.04), and ST (F = 5.28, P = 0.02).

Table 3. Descriptive statistics for 3 European and 3 World Championships in the period 2020–2024 according to outcomes of 24 matches

	Min	Max	M ± SD
TOTAL goals	6	18	11.23 ± 3.38
TOTAL shots	19	40	29.98 ± 4.68
Total %	19	60	37.44 ± 9.78
A goals	1	11	4.90 ± 2.48
A shots	8	27	17.40 ± 3.94
A %	6	53	28.04 ± 12.36
D goals	0	1	0.23 ± 0.42
D shots	0	6	1.21 ± 1.29
D %	0	100	15.27 ± 30.91
P goals	0	7	1.63 ± 1.78
P shots	0	8	2.13 ± 2.34
P %	0	100	57.75 ± 42.66
F goals	0	2	0.50 ± 0.74
F shots	0	3	0.83 ± 1.00
F %	0	100	29.17 ± 42.61
PP goals	1	9	3.98 ± 1.64
PP shots	3	13	8.31 ± 2.56
PP%	20	75	48.04 ± 15.06
S	4	18	9.60 ± 2.79
SS	13	29	20.83 ± 3.84
SS %	22	72	46.46 ± 11.12
PPc	1	9	3.98 ± 1.64
P	0	8	2.13 ± 2.34
BL	0	10	4.06 ± 2.35
ST	1	14	6.08 ± 3.35
SP	0	5	2.08 ± 1.27
PF	1	20	12.42 ± 3.75
TU	4	16	9.90 ± 2.85

The results of MANOVA revealed significant differences between winning and losing teams for Total goals (F = 8.93, P = 0.01), Total % (F = 13.58, P = 0.01), F goals (F = 6.36, P = 0.01), F shots (F = 4.44, P = 0.04), % (F = 7.51, P = 0.01), and SS % (F = 7.76, P = 0.01) while PP % was of borderline statistical significance (F = 4.08, P = 0.05), as well as between EC and WC for Total goals (F = 4.97, P = 0.03), Total shots (F = 4.02, P < 0.05), P shots (F = 4.63, P = 0.04), PS saved (F = 8.90, P = 0.01), P (F = 4.63, P = 0.04), and BL (F = 5.74, P = 0.02).

MANOVA also revealed significant interactions (Figures 1 and 2) of competition and match outcome factors on S (F = 7.61, P = 0.01) and SS (F = 5.13, P = 0.03).

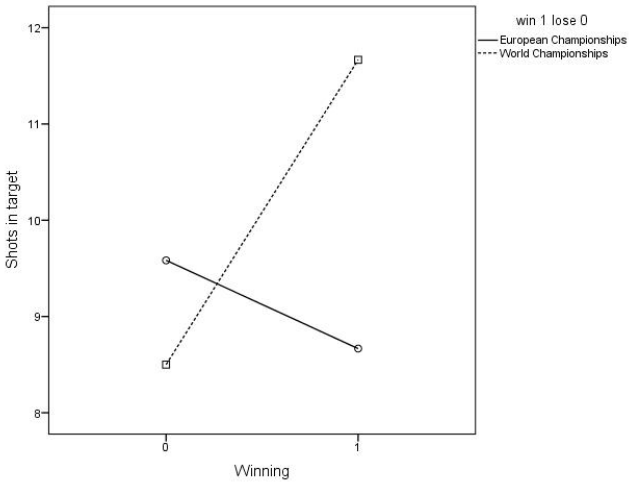

Figure 1. Interaction of competition and match outcome factors with shots on target

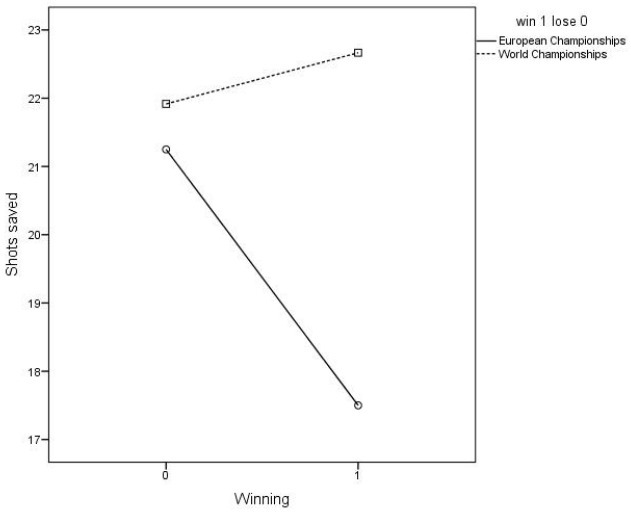

Figure 2. Interaction of competition and match outcome factors with shots saved

The results of the canonical discriminative analysis show the existence of a statistically significant (p = 0.01) discriminative function (Λ = 0.26) with high canonical correlation (CCA = 0.86). The expressiveness of the difference between the groups on the discriminative function is also significant (Figures 1 and 2).

The structure of the discriminative function shows that the discriminative function is determined by three variables that correlate with the function with coefficients whose absolute value is greater than 0.25 (Table 4). The most significant variables for the discrimination of winners and losers according to the results of the analysis are Total %, F goals, Total goals, F %, and SS % with the fact that the correlation of SS, PP shots, TU, D shots, and Total shots with the discriminative function was negative.

Table 4. Matrix structure of the discriminative function

Total %	F goals	TOTAL goals	F %	SS %	F shots	PP %	D goals	A goals	A %	S	SS	BL	P %
0.32	0.26	0.26	0.25	0.25	0.19	0.18	0.15	0.14	0.14	0.13	−0.12	0.12	0.10
D %	PP shots	TU	PP goals	PP	ST	SP	PF	P goals	D shots	A shots	P shots	P	TOTAL shots
0.10	−0.10	−0.09	0.09	0.09	0.08	0.06	0.05	0.04	−0.04	0.04	0.01	0.01	0.00

The results of the canonical discriminant analysis show that based on the discriminative function, the total of 95.8% of match outcomes can be correctly classified into winning and losing groups according to the team match statistics, while only one losing and one winning case were incorrectly classified.

Discussion

This study aimed to extend and complement the analysis of water polo parameters that influence the outcome of matches (with a focus on games won), as well as to identify variables that influence the prediction of winners. To the best of our knowledge, this was the first study to statistically analyze the game parameters of men's water polo teams in the final competition phase (matches for seventh and fifth places and bronze/gold medals) at three European and three World Championships in the period 2020-24. A significant canonical function, which discriminates between the winners and losers with more than 95% accuracy, was obtained. This finding is important because statistical data related to water polo games help coaches to prepare their teams for matches (Escalante et al., 2013). Analyzing all the strengths and weaknesses of the opponent will help them to prepare better for matches and increase the chances of winning (Lozovina et al., 2009).

Descriptive parameters (Tables 1 and 2) showed a high level of play and performance of the teams at both the European and World Championships in the entire analyzed period. Considering that these are the finals of the competition at the highest representative level, this result is more than expected.

The results of MANOVA showed numerous differences in statistical parameters at the European and World Championships in the period 2020–2024, indicating the different ways in which teams play at various levels of a competition. Analyzing the last 3 European championships, we found 3 significant variables between winners and losers (Total goals, Total % and SS), which indicates that better shooting efficiency and more effective goalkeeper defense decide the winner at this major championship. The main difference between these three competitions was steals, which indicates greater aggressiveness in defense and better skill in taking away the ball from the opponent. In a similar study, the teams from the final phase of the 2021/22 Champions League competition showed homogeneity in shooting compared to the preliminary phase, which indicated a higher quality of play and efficiency in the attack in the final phase of the tournament, while significant differences in the preliminary and final phase competitions are reflected in the following parameters: total shots, goals scored from action, from the center, from 6 m and with a player more, steals, blocked shots and efficiency of swimming for the ball, which indicates a different organization and more efficient implementation in attack and defense (Markovic & Milosevic, 2023). In other game-related statistics, there was a difference between winning and losing teams in each phase of a game in different international championships (Escalante et al., 2013), in attack (goals from the center, goals from counterattacks, assists, sprints won) and defense (shots blocked by players and goalkeepers, stolen balls and saved penalties). This indicates a different organization and execution of attacks in different WCs, while the defensive parameters, such as steals and the efficiency of the goalkeeper's defense, were significantly different, which was also observed at the European Championships. In matches at the Olympic Games of 2008, the difference in defensive parameters was reflected in the parameters of exclusions and penalty defenses, and in attack the parameters of center shots and assists (Escalante et al., 2010).

In the last 3 World Championships we found 5 significant variables which show diversity in the games of these 3 World Championships (Total %, A goals, A %, SS %

and ST), as well as 6 significantly different parameters of winners and losers (Total %, A %, F goals, F shots, S and SS). These observations indicate that the efficiency in the attack and counterattack as well as the defense of the goalkeeper decided the winner at this World Championship. In similar research, the winning and losing teams of the Champions League 2020/21 differed in relation to the execution of counterattacks and the number of exclusions in 20 seconds (Markovic & Milosevic, 2023). In another study, the winners were more dominant in almost all variants related to shooting efficiency (Trivun et al., 2019). They had a more efficient goalkeeper, more blocked shots, efficient use of more players, and successful swimming for the ball. In the research by Saavedra et al. (2020), ten variables distinguished between winning and losing teams: four of them were related to shooting efficiency, three to goalkeeping efficiency, and three to other actions.

The results of MANOVA statistics in the total sample (24 games) show the highest number of statistically significant variables between winning and losing teams: Total number of goals (F = 8.93, P = 0.01), Total % (F = 13.58, P = 0.01), F goals (F = 6.36, P = 0.01), F shots (F = 4.44, P = 0.04), F % (F = 7.51, P = 0.01), SS % (F = 7.76, P = 0.01) and PP % (F = 4.08, P = 0.05), of borderline statistical significance. Saavedra et al. (2014) found that penalty effectiveness differed between winners and losers in final matches, while Iglesias et al. (2016) found that these were the parameters of counterattacks and center goals. Between the total simple EC and WC, statistically significant variables were: Total goals (F = 4.97, P = 0.03), Total shots (F = 4.02, P < 0.05), P exclusions (F = 4, 63, P = 0.04), PS preserved (F = 8.90, P = 0.01), P (F = 4.63, P = 0.04) and BL (F = 5.74, P = 0.02). The different level of competition affected the quality of technical-tactical indicators, especially in uncertain matches (Lupo et al., 2012), and the winners performed better in faster actions, with more efficient passes that led to goals (Madera et al., 2007); also, the winners showed significantly better counterattacks and shots from distance and in front of the goal (García et al., 2015).

MANOVA also revealed significant interactions (Figures 1 and 2) of the competition factor and match outcome in the variables S (F = 7.61, P = 0.01) and SS (F = 5.13, P = 0.03). This shows the different interaction of victory and defeat in prominent parameters at the European and World Championships. While winners and losers did not differ much in S in ECs, in WCs the winners had much more S than the losers as well as all teams in ECs. Similarly, while winners and losers did not differ much in SS in WCs, in ECs the winners had less SS than the losers as well as all teams in WCs. This can be referred to as the key winning game variables in the analyzed period. This result can be compared with a study on club competition (Markovic & Milosevic, 2023) where, in addition to significant differences between winners and losers in Champions League matches in 2020/21, MANOVA showed the existence of two very significant interactions: BL and 20C.

The results of the canonical discriminant analysis show the existence of a statistically significant (p = 0.01) discriminative function with several coefficients whose absolute value is greater than 0.25, which are the most significant for the discrimination between winners and losers, namely: Total goals, T %, F goals, F %, and SS %, with the fact that the correlation of Total shots, PP shots, D shots, SS, and TU with the discriminative function was negative (Table 4), which shows that higher values of these variables are inversely proportional to victory. Similarly, the significant difference analyzed by MANOVA between the preliminary and the final level of the 2020/21 Champions League competition was reflected in the two key components that determine the outcome of the match (Markovic & Milosevic, 2023): counterattack efficiency (higher-ranked teams score more goals) and teams' ability to defend with fewer players (better teams are more successful in defending the goal). Based on the discriminant function in this research, the total of 95.8% of match outcomes can be correctly classified into the winning and losing group, while in a similar study by the same authors, the results of the canonical discriminant analysis were found to determine the match outcome with an accuracy of 91.9% (Markovic & Milosevic, 2023), and referring to the analysis of the statistics in the game preliminary, qualifying and final results can also be predicted with a high percentage of 91, 90 and 73% (Escalante et al., 2013).

This research, in addition to its theoretical contribution, should have clear application in the technical and tactical preparation of teams for competitions at the top level. We have pointed out the key aspects that lead to victory at the top level of competition so that coaches with teams can emphasize them both in preparing the team to be better at them but also in placing focus on these aspects in defense. The results of this research also pave a way for future research. First, there is the possibility of analyzing the influence of the previous situation (player's position with or without the ball) on the specific technical element, dominant side of the players, as well as gender specificities in all mentioned variables. Also, our study showed that the speed of the game is one of the key variables for future research, which again should have a direct impact on training practice and match preparation.

Conclusions

The statistics in water polo matches are important for successful preparation of each match. They display the defensive and attacking qualities and weaknesses of the whole team and individual players as well as their performance in games. By analyzing these parameters, one can plan

the tactics in advance and determine the key factors for the outcome of the matches.

This research revealed differences in the parameters related to the game at the European and World Championships in the period 2000–2024. Concerning both winners and losers at the European Championships, these were Total goals, T %, and SS, and there was a significant difference between them in steals (Table 1), while at the World Championships the main differences between winners and losers were in Total %, A %, F shots, F goals, S, and SS, while the statistically significant variables among them were Total %, A goals, A %, SS, and ST (Table 2). From this analysis, it can be concluded that the game differed at the European and World Championships both in terms of defense and attack. The biggest differences in parameters were observed in the total sample, between winners and losers, and they were Total goals, Total %, F goals, F shots, A %, PP % and SS %, as well as between EC and WC in Total goals, Total shots, P shots, PS saved, P, and BL (Table 3). MANOVA also identified relationships that are particularly important, namely S and SS (Figures 1 and 2), and the number of shots on goal and the defense of the goalkeeper correlated with victory at the World Championship, but not at the European Championship. The structure of the discriminant function (Table 4) determined several variables that are most significant for the winner (F goals, Total %, F % and SS %). With the help of the results provided by the canonical discrimination analysis and game indicators, we can determine the key factors for the outcome of games with an accuracy of 95.8 %. In similar studies, the winners showed a better ability to perform faster actions (Lupo et al., 2012), a better shooting percentage (Markovic & Milosevic, 2023), action shots, sprints and goalkeeper-blocked shots (Escalante et al., 2013).

Finally, this research complemented the results of studies performed so far and highlighted the most important parameters for winning a water polo match at the top competitive level of play. The results of this study can be beneficial for water polo coaches in their preparations for a game as well as when choosing tactical variants. This information should also help in optimizing the training process by placing focus and attention on specific elements of the game and practicing them both in attack and defense. In view of this, this research fulfilled its aims and paved the way for more research on this topic.

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