



Only unbalanced games are affected by technical and tactical aspects able to discriminate winning and losing performance in women's water polo Olympic Games

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Abstract

Purpose This study aimed to analyze technical and tactical parameters characterizing the women's water polo Olympic Games (Rio, Brazil, 2016) to discriminate winning and losing performance profile in general and according to close and unbalanced games with different margin of victory (i.e., \leq or $>$ of 3, 4, and 5 goals of difference between teams).

Methods Twenty-four games were analysed through the frequency of occurrence of the following technical and tactical indicators: goals scored (GS), goals scored and shots without goals inside (AsG, AsWG) and outside (5-mG, 5-mWG) the 5-m area, goals scored (5-mFG) and shots without goals (5-FWG) after a 5-m fouls, penalties scored (PS) and failed (PWG), turnovers (TO), assists (AS), blocked shots (BS), and counterattack goals (CG). Mann–Whitney *U* test was applied to compare the values of winning and losing teams for each indicator.

Results Regardless of GS, no difference between teams emerged in close games. Conversely, for unbalanced games, differences between teams emerged for AS ($p \leq 0.001$; effect size, $ES \geq 0.5$) in each margin of victory, and for AsWG and 5-mWG ($p \leq 0.05$; $ES \geq 0.3$) in > 5 goals of margin of victory.

Conclusion The outcomes of women's water polo Olympic close and unbalanced games are determined by not specific playing events, and few technical and tactical factors (such as AS), respectively. Therefore, top-level women's water polo coaches and physical trainers can plan a sound training session according to specific game data reported for the Olympic Games contest.

Keywords Elite women's water polo · Notational analysis · Successful performance · Margin of victory · Team sports

Introduction

Although the men's water polo is one of the oldest team sport played at the Olympic Games (i.e., Paris, in 1900), the first appearance of the women's water polo was only in 2000 during the Sydney (Australia) edition, after a previous appearance at the Olympic Games in Atlanta in 1996 as promotional sport. Similarly to the men's water polo, the women's version of this game reported crucial rule

modifications in the last years, with games consisting of four 8-min clock-time (i.e., excluding breaks in play) quarters, in a 25 m \times 20 m court, and power play (i.e., playing actions occurring when a player commits an exclusion foul) of 20 s or until the defense gains possession of the ball. The penalty line is 5-m from the goal line and the free throw can occur when an attacker receives a fault out of this area, whereas the maximal duration to play a single ball possession is 30 clock-time seconds [1].

Although several authors [2–14] studied the playing aspects of men elite water polo, a substantial occurrence of studies focused on the technical and tactical aspects of the women's water polo is also emerging in literature with particular reference to the analysis of European [15, 16] and World Championships [2, 3, 9, 14–18], National Collegiate Athletic Association (NCAA) [19], and Spanish First division [20].

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Among the above mentioned studies, successful women's water polo games seem to be principally characterized by the duration of attacks, number of players, passes, shots, and penalties from 5 m, which highlighted that winning teams are more able than losers of performing fast actions and counterattacks, also providing successful passes and shots, as well as effective defensive playing phases. Nevertheless, even though these studies refer to valuable national and international championships, there is a need of technical and tactical feedbacks from the Olympic Games, which represent the most important women's water polo competition level.

Actually, only a study was focused on the technical and tactical aspects of the women's water polo Olympic Games [4]. In particular, in this study, men's and women's water polo games played in the final phase of the Olympic Games held in Beijing in 2008 were analysed, reporting a discrimination between winning and losing teams in relation to offensive and defensive actions. Although winning men's games resulted characterized by effects in both playing phases (i.e., higher number of shots, actions ended with shots, extra player actions ended with shot, 5-m shots after receiving foul, assists, steal balls, blocked shots, and lower number of turnover fouls), successful parameters were found only for offensive actions in the women's games, highlighting the importance of a better efficacy in shooting (i.e., in general and for the 5-m shots after receiving foul) for the latter championship.

Although valuable information could emerge by discriminating winning and losing technical and tactical performances, the reference to close and unbalanced games could highlight deeper aspects for a better interpretation of game [9, 10, 12], consequently promoting an improvement in the quality of training plans. Several technical and tactical indicators have been introduced to discriminate women's elite water polo winning and losing teams [2, 3, 9, 14–17, 19, 20], but very few information relative to the tactical aspects that characterized the winning and losing teams in close and unbalanced games [9]. In addition, despite it could be easily expected that differences would emerge in terms of technical and tactical aspects, elite water polo resulted often characterized by close games with reduced (i.e., no significant effect) technical and tactical divergences between winning and losing teams [9, 10], highlighting only episodic game factors as crucial. Thus, in previous study [9, 10], technical and tactical analyses contrasted the typical low repeatability of the situational sports such as water polo, only considering substantial effects (i.e., significance with medium-large effect sizes) to provide a reliable interpretation in discriminating winning and losing teams.

However, a paucity of studies about technical and tactical analyses considering the margin of victory is evident in elite women's water polo, and no study were provided for Olympic Games in particular. Therefore, adjourned

performance values on this competition level could crucially improve the coaches' awareness of game characteristics such as shot efficacy (i.e., discrimination of successful and failed shots in general as well as specified playing phases), action performance and ball managements (i.e., assists, turn over foul, goals during counteracts), and defensive skills (i.e., blocked shots). In addition, training could benefit from these game information providing valuable references ranging from technical and tactical to physical workouts as already reported for the circumstance of the Fina Water Polo Championships of Rome 2009 [9, 10].

Therefore, the aim of this work was to analyze the women's water polo games played during the XXXI edition of the Olympic Games (Rio 2016, Brazil), comparing the values of technical and tactical indicators of winning and losing teams during close and unbalanced games with different margins of victory (i.e., 3, 4, and 5 goals of difference between teams at the end of the game). In particular, it has been hypothesized that, for each considered technical and tactical indicators, in relation to the three margins of victory: (1) no effect (excepting for the occurrence of goals) would emerge for close games; whereas (2) several effects would emerge for unbalanced games.

Methods

Participants

The local Institutional Review Board approved this study to investigate the technical and tactical aspects of the women's elite water polo games. The 24 women's water polo games (12 group games, 4 quarter finals, 4 semi finals, and 4 finals) of the Rio (Brazil) Olympic Games were played by eight different women national water polo teams from 6 to 20th August 2016. Among these teams: 4 from Europe (Italy, Hungary, Russia, and Spain), 1 from Asia (China), 1 from North (USA) and 1 from South (Brazil) America, and 1 from Oceania (Australia).

According to a previous study on the same water polo gender and competition level [9], the teams observed in this study consisted of players usually experiencing a minimum of 10 years of competitions and trainings, characterized by a minimum of six to a maximum of nine 120-min sessions per week (excluding the strength training ones performed in gym that may range from a minimum of two to a maximum of five per week).

Procedures

Game-related statistics of each game played during the women's Rio 2016 Olympic Games were collected from the official Web domain "Omega" (<https://www.omegamin.com>)

g.com), where data were collected by professional technicians. In particular, the frequencies of occurrence of the parameters reported in Table 1 were selected for the present analysis.

Data analysis

A descriptive approach (i.e., median, Mdn; and interquartile values, IQR) was provided for each technical and tactical parameter in relation to winning and losing teams. In addition, statistical analyses were conducted using a SPSS package (version 17.00, Institute Inc., Cary, NC) and the criterion for significance was set at $p \leq 0.05$.

After establishing the absence of a normal distribution for each variable data (Shapiro–Wilk normality test), a non-parametric approach (Mann–Whitney U test) was applied for each dependent variable to compare winning and losing game data in each considered margin of victory. Finally, in case of differences, the *phi* ESs was calculated, considering 0.1, 0.3, and 0.5 as small, medium, and large ESs, respectively [21].

Results

From all 24 water polo games played at the final phase of the Rio Olympic Games (12 group games, 4 quarter finals, 4 semi finals, and 4 finals), two games (8% of the total number of games) were excluded because of their even outcome at end of the 4th quarter (quarter final: Australia–Hungary; final for the 3rd final position: Hungary–Russia). Therefore, close games with 3, 4, and 5 goals of margin were 6 (25%),

8 (33%), and 13 (54%), respectively; whereas unbalanced games with 3, 4, 5 and goals of margin were 16 (67%), 14 (58%), and 9 (38%), respectively. In general, winning teams scored 12 goals, whereas losing teams 6 goals, with a median margin of victory of 5 goals, ranging between 1 and 10 goals.

Regardless of the margin of victory (Fig. 1), strong effects ($p \leq 0.001$) emerged for the GS and AS (winning: Mdn 5; IQR 3; losing: Mdn 2; IQR 2), whereas less evident differences ($p \leq 0.05$ with $IQR > Mdn$, or $ES < 0.4$) were reported for AsG (winning: Mdn 2; IQR 2; losing: Mdn 1; IQR 2), 5-mG (winning: Mdn 2; IQR 2.75; losing: Mdn 1; IQR 2.75), 5-mFG (winning: Mdn 2; IQR 1.75; losing: Mdn 1; IQR 2); 5-mFWG (winning: Mdn 6; IQR 4.75; losing: Mdn 9; IQR 4.5), and BS (winning: Mdn 3; IQR 2; losing: Mdn 2; IQR 2). Differently, no divergence between teams was reported for AsWG (winning: Mdn 6; IQR 5.5; losing: Mdn 5; IQR 3.75), 5-mWG (winning: Mdn 9.5; IQR 7.75; losing: Mdn 11.5; IQR 5); PG (winning: Mdn 1; IQR 1; losing: Mdn 0; IQR 1), PWG (winning: Mdn 1; IQR 1; losing: Mdn 1; IQR 1), TO (winning: Mdn 13; IQR 4.5; losing: Mdn 14.5; IQR, 2), and CG (winning: Mdn 2; IQR 2; losing: Mdn 2; IQR 2).

The analysis of close games (Table 2) reported differences between teams only for GS regarding the margins of victory until 5 ($p \leq 0.001$) and 4 ($p \leq 0.05$) goals, respectively. Differently, for unbalanced games (Table 3), strong ($p \leq 0.001$) differences between winning and losing teams emerged for GS and AS for each considered margins of victory. Additional effects ($p \leq 0.05$) were found for AsWG and 5-mWG related to the margins of victory over 5 goals. Finally, differences between winning and losing teams

Table 1 Definition of game indicators used in the study

Variable name	Abbreviation	Definition
Goals scored	GS	Goals scored during game
Goals scored inside 5-m area	AsG	Actions ended with a shot inside the 5-m area and goal scored
Shots without goal inside the 5-m area	AsWG	Actions ended with a shot inside the 5-m area, without a goal scored
Goals scored outside 5-m area	5-mG	Actions ended with a shot outside the 5-m area and goal scored
Shots without goal outside the 5-m area	5-mWG	Actions ended with a shot outside the 5-m area, without a goal scored
Goals scored after a 5-m fouls	5-mFG	Actions ended with a shot outside the 5-m area, after receiving a foul, with a goal scored
Shots without goal after a 5-m fouls	5-mFWG	Actions ended with a shot outside the 5-m area, after receiving a foul, without a goal scored
Penalties scored	PG	Penalty (5-m) shots followed by the scoring of a goal
Penalties failed	PWG	Penalty (5-m) shots not followed by the scoring of a goal
Turnovers	TO	Fouls committed during an offensive action, which determine the change of the ball possession
Assists	AS	Passes determining an advantage playing situation and goal scored
Blocked shots	BS	Blocked shots (from defenders or goalkeeper) during defensive actions
Counterattack goals	CG	Goals scored during counterattacks (i.e., playing situations where, relatively to the ball position, the number of offensive players is larger than that of the defensive players)

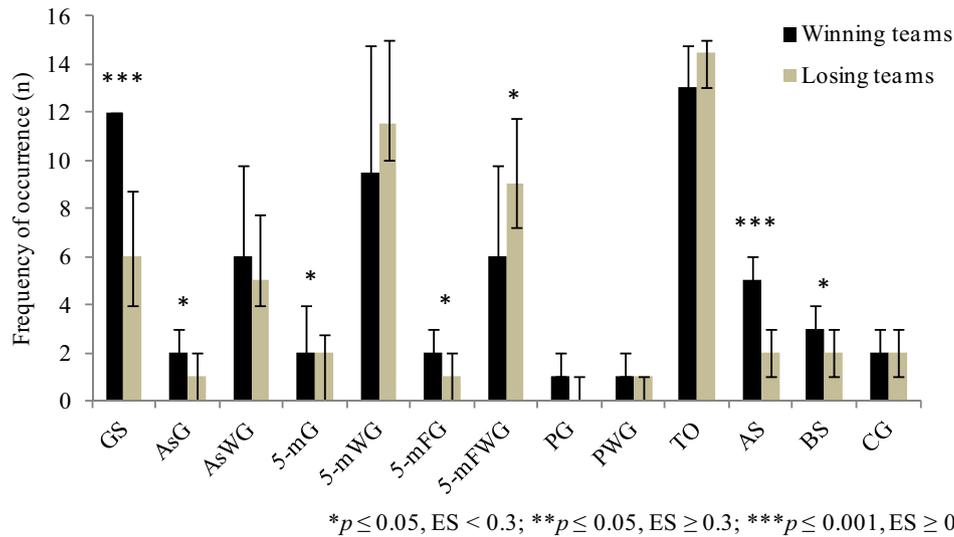


Fig. 1 Women’s water polo Olympic Games. Medians (and interquartile ranges) of the occurrence of each considered technical and tactical parameter (*GS* goals scored, *AsG* goals scored inside 5-m area, *AsWG* shots without goals inside the 5-m area, *5-mG* goals scored outside 5-m area, *5-mWG* shots without goals outside the 5-m area, *5-mFG* goals scored after a 5-m fouls, *5-mFWG* shots without goals

after a 5-m fouls, *PG* penalties scored, *PWG* penalties failed, *TF* turnovers, *AS* assists, *BS* blocked shots, *CG* counterattack goals) in relation to the game outcome (i.e., winning vs losing teams). * $(p \leq 0.05$; effect size < 0.3), ** $(p \leq 0.05$; effect size ≥ 0.3), *** $(p \leq 0.01$; effect size ≥ 0.5) differences between winning and losing teams

Table 2 Women’s water polo Olympic Games

#	Performance indicators	1–3 goals of margin of victory ($n = 6$ games)		1–4 goals of margin of victory ($n = 8$ games)		1–5 goals of margin of victory ($n = 13$ games)	
		Winning teams	Losing teams	Winning teams	Losing teams	Winning teams	Losing teams
1	Goals scored (GS)	12 (0.75)	10 (0.75)	12 (0.5)**	10 (1.25)	12 (1)***	8 (1)
2	Goals scored inside 5-m area (AsG)	1.5 (1)	1.5 (1.75)	2 (1.25)	1.5 (1.25)	2 (1)	1 (1)
3	Shots without goals inside the 5-m area (AsWG)	5 (1.5)	6 (2.75)	5.5 (1.75)	5 (3.25)	5 (2)	5 (2)
4	Goals scored outside 5-m area (5-mG)	3 (2)	2 (1.5)	2 (2.25)	2 (0.5)	3 (2)	2 (2)
5	Shots without goals outside the 5-m area (5-mWG)	12 (5.75)	10.5 (5.5)	12 (5.5)	11 (2.5)	11 (6)	11 (6)
6	Goals scored after a 5-m fouls (5-mFG)	2.5 (1)	2 (1.5)	2 (1.25)	2 (0.5)	3 (1)	2 (1)
7	Shots without goals after a 5-m fouls (5-mFWG)	6 (4.25)	8.5 (5.5)	6.5 (5)	8 (4)	7 (5)	9 (5)
8	Penalties scored (PG)	1.5 (1)	1 (0.75)	1.5 (1.25)	1 (1.25)	1 (2)	0 (2)
9	Penalties failed (PWG)	1.5 (1)	2 (0.75)	1.5 (1.25)	1.5 (1.25)	1 (1)	1 (1)
10	Turnovers (TO)	14 (1.5)	13.5 (1.75)	13.5 (2.75)	14.5 (2)	13 (3)	14 (3)
11	Assists (AS)	3.5 (2.5)	3.5 (1)	4.5 (3.25)	3 (1.5)	4 (4)	3 (4)
12	Blocked shots (BS)	2 (0.75)	2 (3.5)	2 (1)	2 (2.5)	2 (1)	2 (1)
13	Counterattack goals (CG)	2.5 (1.75)	1.5 (1.75)	2.5 (2)	1.5 (2)	2 (2)	2 (2)

Medians (and interquartile ranges) of the occurrence of each considered technical and tactical parameter for close games according to three margins of victory (i.e., ≤ 3 , 4, and 5 goals of difference between winning and losing teams)

** $(p \leq 0.05$; effect size ≥ 0.3), *** $(p \leq 0.01$; effect size ≥ 0.5) differences between winning and losing teams

Table 3 Women's water polo Olympic Games

#	Performance indicators	> 3 goals of margin of victory (<i>n</i> = 16 games)		> 4 goals of margin of victory (<i>n</i> = 14 games)		> 5 goals of margin of victory (<i>n</i> = 9 games)	
		Winning teams	Losing teams	Winning teams	Losing teams	Winning teams	Losing teams
1	Goals scored (GS)	11.5 (1.5)***	5 (2.25)	11 (1.75)***	4.5 (1.75)	12 (2)***	4 (1)
2	Goals scored inside 5-m area (AsG)	2.5 (2.25)*	0.5 (1.25)	3 (2.5)*	0 (1)	3 (3)*	0 (1)
3	Shots without goals inside the 5-m area (AsWG)	8 (5.25)	5 (3.5)	9 (5.75)	5 (4.5)	10 (2)**	5 (1)
4	Goals scored outside 5-m area (5-mG)	2 (2.25)	1.5 (3)	2 (2.25)	1 (3)	2 (1)	1 (3)
5	Shots without goals outside the 5-m area (5-mWG)	9 (9.25)*	12.5 (5.75)	8 (9)*	13.5 (9.25)	5 (4)**	14 (5)
6	Goals scored after a 5-m fouls (5-mFG)	2 (2)*	1 (2)	2 (1.75)*	1 (1.75)	2 (1)*	1 (2)
7	Shots without goals after a 5-m fouls (5-mFWG)	6 (6.25)*	9 (4.75)	6 (5.75)*	9 (5.5)	3 (4)*	9 (5)
8	Penalties scored (PG)	1 (0.5)*	0 (0)	1 (0)*	0 (0)	1 (1)*	0 (0)
9	Penalties failed (PWG)	1 (0.25)*	0 (1)	1 (0)*	0 (1)	1 (1)	1 (1)
10	Turnovers (TO)	11.5 (5.25)	15 (3.25)	12 (5.25)	14.5 (3.5)	14 (6)	15 (2)
11	Assists (AS)	5 (2.5)***	1.5 (2)	5 (3.5)***	1.5 (1.75)	5 (2)***	1 (1)
12	Blocked shots (BS)	3 (2.25)	2 (1.25)	4 (2.5)	2 (1)	4 (2)	1 (1)
13	Counterattack goals (CG)	2 (2)	2 (2)	2 (2)	2 (2)	2 (1)	2 (1)

Medians (and interquartile ranges) of the occurrence of each considered technical and tactical parameter for unbalanced games according to three margins of victory (i.e., > 3, 4, and 5 goals of difference between winning and losing teams)

*($p \leq 0.05$; effect size < 0.3), **($p \leq 0.05$; effect size ≥ 0.3), ***($p \leq 0.01$; effect size ≥ 0.5) differences between winning and losing teams

with reduced ESs (< 0.3) were reported for AsG, 5-mFG, 5-FWG, PG (each margin of victory), and 5-mWG and PWG (margins of victory over 3 and 4 goals), and (each margin of victory).

Discussion

To our knowledge, this is the first study exclusively focused on the analysis of the women's water polo close and unbalanced games (with different margins of victory) played during the Olympic Games (XXXI edition, 2016, Rio, Brazil). The main finding of this study showed that no difference between teams emerged in close games, with the exception of the GS for the margins of victory related to 4 ($p \leq 0.05$; $ES \geq 0.3$) and 5 goals ($p \leq 0.01$; $ES \geq 0.5$). Conversely, in unbalanced games, AS reported strong effects ($p \leq 0.01$; $ES \geq 0.5$) for the entire sample of games as well as for each margin of victory. In addition, the effects shown for AsWG and 5-mWG (in games > 5 goals of margin) highlight how the outcome of women's water polo Olympics close and unbalanced games are determined by episodic playing events, and few technical and tactical factors, respectively. As consequence, the experimental hypotheses that no effect (excepting for the occurrence of goals) would emerge for close games, and several effects would emerge for unbalanced games, can be considered as fully and partially confirmed, respectively. In fact, only unbalanced games are

affected by technical and tactical aspects able to strongly discriminate winning and losing performance in women's water polo Olympic Games.

This study aimed at deeply analyzing the technical and tactical indicators of women's water polo Olympic Games, discriminating successful in terms of margin of victory (i.e., 3, 4, and 5 goals of difference at the final outcome) as well as considering the ES and SD values. Therefore, according to the entire sample of games, only GS and AS can be considered as crucial to get the successful. However, despite GS can be easily expected as different between teams, AS appears as the most strategic element to perceive successful. In particular, this finding seems to be in line with the findings of previous studies [9, 10] for which the scoring opportunities are associated to passing capabilities, also encouraging ball handing as effective practical application. In addition, positioning of players with respect to the ball, teammates, and opponents as well as the identification of the most opportune position to score a goal [9] can be strongly connected to high winnings' AS occurrence emerged for the success in the women's water polo Olympic Games. Even though other effects (AsG, 5-mG, 5-mFG, 5-mFWG, and BS) could be expected as able to strongly discriminate winning and losing performance (especially because directly related to the scoring of goals), they actually reported differences with reduced ESs, making limited any suggestion in correlating technical and tactical indicators with game outcome.

However, the additional value of this work is represented by the different margins of victory used to better discriminate winning and losing performance. Although several differences between elite women's winning and losing water polo teams have been already showed in previous studies [13, 19, 22], the introduction of specific margins of victory determined a more exhaustive analysis. Generally, for close games, a strong reduction of effects is reported [9, 10], often highlighting how the outcome of this type of games is determined by episodic events toward the end of the last quarter in favour of winning teams, which are often in a disadvantage or draw score at the end of the third quarter [9]. In the present study, despite the margins of victory for close games have been expanded until that of 5 goals of difference between teams (5 over 22 games, 23% of total sample of games), effects emerged only for GS in games with 1–4 and 1–5 goals of difference between teams (Table 2). Therefore, no specific game dynamics emerged in determining successful, confirming how the outcome of close games is influenced by episodic, and not systematic, playing events. Nevertheless, other technical and tactical indicators could be able to better recognize the essence of successful performance also for these games.

On the other hand, unbalanced games (Table 3) reported several differences between winning and losing teams in each of the observed margin of victory. In particular, regardless of the expected effects related to GS, a strong discrimination between teams emerged for AS, which can be considered as the most crucial technical and tactical indicator in determining the successful of an unbalanced game, thus remarking what has been already reported for the general scenario of game sample in terms of interpretations and applications. In addition, for unbalanced games with 5 goals of margin of victory, an effect was reported for the higher AsWG occurrence of winning teams with respect to the losers' counterpart. This finding should be considered together the AsGs occurrences, that, despite with a ES, highlights that winning teams perform a higher number of shots inside the 5-m area in general, and confirms what has been already showed for women's NCAA water polo games [19]. On the contrary, in a study on women's water polo World Championships [9], no difference between winning and losing teams playing unbalanced games emerged for the total occurrence of shots performed from three inside the 5-m area zones (i.e., one central, two external zones) during even, counterattack, and power-play situations, making rather complex the definition of a incontrovertible trend.

A different scenario is reported for the shots outside the 5-m area. In fact, losing teams reported more 5-mWG with respect to winning counterparts, whereas no difference emerged for 5-mG (which actually reported higher absolute values for winning teams). In this case, winning teams

seem to be more able in constraining opponents to shoot far from goal, with a higher grade of difficulty and a consequent lower scoring of goals. Therefore, similarly to the analysis of shoots performed inside the 5-m area, the present results appear in line to those of the women's NCAA Championship [19] and discordant to those of World's Championships [9].

However, despite no effect emerged in 3-goal close games (Table 2), the whole consideration of shot occurrences in relation to origin (i.e., inside, outside 5-m area) and outcome (i.e., goal, without goal) showed how, for these type of game, winning teams are able to score more goals than losers mainly from outside the 5-m than inside, highlighting how teams performing games with a balanced score are highly focused on defending, and trying to reduce the opponent's choices in allowing them to shot as far as possible from goal.

Although the effects associated to 5-mFG and 5-FWG in unbalanced games resulted reduced because of small ESs or higher IQR than Mdn, and a more substantial interpretation should be postponed to further studies, the results of these two indicators could suggest that winning teams are able to regularly score more goals and perform less shots without goal from this specific game circumstance. As consequence, it could be also speculated that losing team are not sufficiently able to maintain a high position of body to effectively shot from more than 5-m distance from the goal as well as defend in the opposite situation.

For both close and unbalanced games, the occurrences of PG and PWG are rather reduced in terms of occurrence and statistical effects, limiting eventual interpretations on the comparison of winning and losing teams in close and unbalanced games. Nevertheless, a penalty could be crucial for the outcome of the final score, suggesting that analyses related to the contest of a game [13] should better interpret the present water polo competitions. Equally, the same consideration should be promoted also for TO, BS, and CG indicators.

Some limitations characterized the present work, risking influencing the reliability of values and their interpretation. First of all, indicators values were recorded regardless of their classification into playing situations (i.e., even, counterattacks, power plays, and transitions) making the analysis related to general game objectives. In addition, no information was provided about the offensive and defensive arrangements, and turns of competition (e.g., the first tournaments of qualification and finals could be characterized by different motivation towards success and game dynamics) [23]. Then, the lack of a normalized distribution of the most part of the indicators could be associable to a reduced repeatability of the game events, limiting the substance of findings. Finally, the consideration of accidental playing situation (i.e., technical and tactical aspects occurring close to the end of the game;

“unforced errors” which allow the opponents to score an easy goal; special strategy to score a goal) could have determined the real discrimination between winning and losing teams playing close games.

Conclusions

The findings of this study confirmed that no particular technical and tactical aspect determines game outcome in women’s Olympic water polo close games. Differently, despite for a limited number of indicators and margins of victory, the present analysis resulted able to substantially discriminate the winning and losing performance in general and unbalanced games. However, this work confirms the need to analyze water polo games in relation to specific margins of victory, classifying game patterns to limit the reduced repeatability due to the situational nature of team sports. In addition, the deep technical and tactical information regarding top-elite women’s water polo teams competing into Olympic Games are fundamental for providing a series of useful directions to support coaches in promoting effective sport-specific training programs.

Firstly, the speculated association between winning performance and scoring goals (in close games) or shooting (in unbalanced games) inside the 5-m area tends to highlight the validity to create useful scoring opportunities through a high players’ positioning as well as passing and ball handling capabilities. Although the latter interpretations directly encourage the proposals of technical and tactical drills during training sessions, relevant considerations have to be underline for physical training too. In fact, an effective player’s positioning is determined by visual capabilities to anticipate the imminent game dynamics (tactical training) as well as by swimming competences (physical training). In addition, passing, ball handling, and shots are based on the power of lower-limbs [24–26] which needs of physical workout support. Finally, in line to this consideration, the divergent performance of shooting outside the 5-m area (i.e., 5-mG and 5-mFG in unbalanced games) suggests that losing teams are less able to maintain a high position of body to effectively shot from more than 5-m distance from the goal as well as to defend in the opposite situation. As consequence, the importance of a physical training specifically oriented towards the power of lower-limbs appears as fundamental also for these game circumstances.

Therefore, in consideration of the high need of both tactical and physical training, workouts able to simultaneously involve tactical (i.e., visual drills, interpretation and anticipation of the game events, decision making) and physical (i.e., aquatic drills focused on swimming sprints and quick changes of body position, maximal expressions of the lower-limb power) aspects [27] can be considered

as strongly pertinent to the successful performance in top-level women water polo.

Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

Ethical approval The study was approved by the Ethical Committee of the University of Torino (Turin, Italy; prot. 26,831) and performed in accordance with the Helsinki Declaration.

Informed consent No informed consent due to the nature of the study.

References

1. Federation Internationale de Natation (International Swimming Federation) (2018) Water polo rules. <https://www.fina.org/sites/default/files/rules-print-pdf/8476.pdf>. Accessed 8 Jan 2018
2. Argudo Iturriaga FM, Roque JIA, Marin PG, Lara ER (2007) Influence of the efficacy values in counterattack and defensive adjustment on the condition of winner and loser in male and female water polo. *Int J Perform Anal Sport* 7:81–91. <https://doi.org/10.1080/24748668.2007.11868398>
3. Argudo Iturriaga FM, Ruiz E, Alonso JI (2009) Were differences in tactical efficacy between the winners and losers teams and the final classification in the 2003 water polo world championship? *J Hum Sport Exerc* 4:142–153. <https://doi.org/10.4100/jhse>
4. Escalante Y, Saavedra JM, Mansilla M, Tella V (2011) Discriminatory power of water polo game-related statistics at the 2008 Olympic Games. *J Sports Sci* 29:291–298. <https://doi.org/10.1080/02640414.2010.532230>
5. Escalante Y, Saavedra JM, Tella V, Mansilla M, García-Hermoso A, Domínguez AM (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. *J Strength Cond Res* 27(4):893–901. <https://doi.org/10.1519/JSC.0b013e318260ed85>
6. Gómez MA, DelaSerna A, Lupo C, Sampaio J (2016) Effects of game location, quality of opposition and starting quarter score in the outcome of elite water polo quarters. *J Strength Cond Res* 30(4):1014–1020. <https://doi.org/10.1097/JSC.0000000000000234>
7. Lozovina V, Pavicic L, Lozovina M (2004) Analysis of indicators of load during the game in the activity of the center in water polo. *Nase More* 51:135–141
8. Lupo C, Capranica L, Cugliari G, Gómez MA, Tessitore A (2016) Tactical, swimming activity, and heart rate aspects of youth water polo game. *J Sports Med Phys Fitness*. 56(9):997–1006
9. 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. *J Strength Cond Res* 28(1):210–222. <https://doi.org/10.1519/JSC.0b013e3182955d90>
10. Lupo C, Condello G, Tessitore A (2012) Notational analysis of elite men’s water polo related to specific margins of victory. *J Sports Sci Med* 11:516–525
11. Lupo C, Tessitore A (2010) How important is the final outcome to interpret match analysis data: the influence of scoring a goal, and difference between close and balance games in elite soccer: comment on Lago-Penas and Gomez-Lopez (2014). *Percept Mot Skills* 122(1):280–285. <https://doi.org/10.1177/0031512515262629>

12. Saavedra JM, Escalante Y, Madera J, Mansilla M, García-Hermoso A (2014) Comparison of game-related statistics in men's international championships between winning and losing teams according to margin of victory. *Coll Antropol* 38(3):901–907
13. Smith HK (2004) Penalty shot importance, success and game context in international water polo. *J Sci Med Sport* 7:221–225. [https://doi.org/10.1016/S1440-2440\(04\)80012-4](https://doi.org/10.1016/S1440-2440(04)80012-4)
14. Takagi H, Nishijima T, Enomoto I, Stewart AM (2005) Determining factors of game performance in the 2001 world Water Polo Championships. *J Hum Mov Stud* 49:333–352
15. Abrales JA, Ferragut C, Rodríguez N, Vila MH (2012) Tactical and shooting variables that determine the difference between win or loss in top-level female water polo: analysis by phases of the game. *Int J Perform Anal Sport* 12:373–384. <https://doi.org/10.1080/24748668.2011.11868567>
16. Escalante Y, Saavedra JM, Tella V, Mansilla M, Garcia-Hermoso A, Dominguez AM (2012) Water polo game-related statistics in Women's International Championships: differences and discriminatory power. *J Sports Sci Med* 11:475–482
17. Enomoto I, Suga M, Takahashi M, Komori T, Minami T, Fujimoto H et al (2003) A notational match analysis of the 2001 women's water polo world championships. In: Chatard JC (ed) *Biomechanics and medicine in swimming IX*. University of Saint Etienne, Saint-Etienne, pp 487–492
18. Mirvić E, Kazazović B, Aleksandrović M (2011) Differences between winning and losing teams from world water polo championship for women. *Homo Sporticus* 13:41–43
19. Lupo C, Tessitore A, Minganti C, King B, Cortis C, Capranica L (2011) Notational analysis of American women's collegiate water polo matches. *J Strength Cond Res* 25:753–757. <https://doi.org/10.1519/JSC.0b013e3181cc245c>
20. Gómez MA, DelaSerna A, Lupo C, Sampaio J (2014) Effects of Situational Variables and Starting Quarter Score in the outcome of elite women's water polo game quarters. *Int J Perform Anal Sport* 14(1):73–83. <https://doi.org/10.1080/24748668.2014.11868704>
21. Huck SW (2000) *Reading statistics and research*, 3rd edn. Addison, Wesley Longman, New York, pp 628–629
22. Vila MH, Abrales AJ, Alcaraz PE, Rodríguez N, Ferragut C (2011) Tactical and shooting variables that determine win or loss in top level in water polo. *Int J Perform Anal Sport* 11:486–498. <https://doi.org/10.1080/24748668.2011.11868567>
23. García-Marín P, Argudo Iturriaga FM (2017) Water polo shot indicators according to the phase of the championship: medallist versus non-medallist players. *Int J Perform Anal Sport* 17(4):642–655. <https://doi.org/10.1080/24748668.2017.1382215>
24. Gobbi M, D'ercole C, D'ercole A, Gobbi F (2013) The components of the jumps in expert and intermediate water polo players. *J Strength Cond Res* 27(10):2685–2690. <https://doi.org/10.1519/JSC.0b013e318240ebf1>
25. Platanou T (2006) Simple “in-water” vertical jump testing in water polo. *Kinesiology* 38:57–62
26. Menescardi C, Tessitore A, Estevan I, Condello G, Lupo C (2018) Analysis of shots in relation to the outcome in elite women's water polo matches. *RICYDE* 14(51):84–95. <https://doi.org/10.5232/ricyde2018.05107>
27. Hayley BS, Lee EB, Jared WC, Barry AS (2010) Effect of swim sprints on throwing accuracy and velocity in female collegiate water polo players. *J Strength Cond Res* 24(5):1195–1198. <https://doi.org/10.1519/JSC.0b013e3181d82d3b>

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