

1st International Conference on Science and Medicine in Aquatic Sports

PROCEEDINGS

EDITORS:

Ognjen Uljević
Mia Perić
Dinko Pivalica

Split, 1st - 4th September 2022.

1ST INTERNATIONAL CONFERENCE ON SCIENCE AND MEDICINE IN AQUATIC SPORTS

PROCEEDINGS

PUBLISHER:

University of Split, Faculty of Kinesiology,
Nikole Tesle 6, 21000 Split, Croatia

PUBLISHED:

2022.

FOR THE PUBLISHER:

Damir Sekulić, dean

EDITORS:

Ognjen Uljević
Mia Perić
Dinko Pivalica

EDITOR IN CHIEF:

Ognjen Uljević

TECHNICAL EDITOR:

Dario Vrdoljak

Book no.

ISBN 978-953-7988-06-7

Authorship statement

Author(s) confirms that the above-named article is an original work, did not previously published or is currently under consideration for any other publication

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Notation analysis of the Women's Olympic Water Polo Tournament held in Tokyo in 2021

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ABSTRACT

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. The aim of this paper is to determine and explain the results and differences in technical and tactical efficiency in women's water polo. The sample of the entities are the matches of the women's tournament of the Olympic Games in Tokyo 2021. The sample of variables are 18 defense and attack parameters of efficiency. Using a t-test for independent samples the winning and losing teams differ statistically significantly in eight variables. Statistically significant differences in swimming for the ball and shots from the counterattack between winning and losing teams can very likely be attributed to swimming superiority and the skill of timely counterattack. The dominance of winning teams in the realization with an equal number of players, man-up and counterattack situations probably stems from better skills in achieving optimal conditions in the preparation and implementation of all offensive actions. The reasons for the superiority of the winning teams in the part of defensive actions can probably be found because of better and more coordinated actions of all defensive players in blocking the ball, reducing the opponent's shots and goalkeeper shot saves. These findings encourage coaches both on the one hand to improve the player's skills in providing optimal conditions for the execution of shots and on the other hand to improve the ability to cover and guard the direct opponent who plays on multiple inside and perimeter playing positions on attack.

Keywords: women water polo players. match analysis, technical indicators, tactical indicators

INTRODUCTION

Although women's water polo has a long tradition of over a hundred years at the Olympics it appeared first in Atlanta in 1996 as a demonstration sport and then in Sydney in 2000 as an official sport. Throughout history, water polo has undergone major changes, and they have been most affected by the improvement of organizational conditions, training and competition, the development of training technologies, but also frequent

changes in water polo rules (Hraste et al., 2013).

Some findings characterize today's women's water polo as a high-intensity intermittent sport (Tan et al., 2009). Success in any sport, including water polo, depends on a number of 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

aspects. (Hraste, 2021). There are a lot of tactical variants in attack and defense. In defense 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 some style of play according to their fitness and technical capabilities. In addition to adjusting the tactics according to one's own abilities, the tactics are also adjusted depending on the opponent, in various ways that try to annul the opponent's advantages and take advantage of the disadvantages. Differences between winning and losing teams in women's water polo emerged for duration of actions, number of players, passes, exclusions and penalties achieved, shots originating inside and outside the 5-m area, and occurrence of goals during the even situation; exclusions and penalties achieved, shots following up fake, and goals during the counterattacks; and passes, and goals during the power-play actions (Lupo et al., 2011).

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: (1) The ability to realize counterattacks and players more and (2) Success in blocking and rescuing from the opponent's shots in a game with a player less.

According to Mirvic (2019) and García-Marín (2017) only unbalanced games are affected by technical and tactical aspects able to discriminate winning and losing performance in women's water polo. The game-related statistics were found to have a high discriminatory power in predicting the result of matches with shots and goalkeeper-blocked shots being discriminatory variables in women's water polo (Escalante et al., 2012).

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

METHODS

The sample of the entities are the matches of the women's tournament of the Olympic Games that took place in 2021. The results of matches of teams that lost more than 2 games with 8 goals difference and more (South Africa and Japan) were excluded from the sample of entities. So, called "out layers" were left out of the overall tournament statistics so that we get relatively homogeneous teams that participated (Canada, Australia, USA, Spain, China, the Netherlands, Hungary and the Russian Olympic Committee). One match that ended in a draw was left out of the entity sample. At the Olympic Games in Tokyo, 36 matches were played in the women's tournament, and for the purposes of this research, 23 matches were processed.

The sample of variables are 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-upshots (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).

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 data for this research was collected from the Total Water Polo platform, which allowed us to use it.

RESULTS and DISCUSSION

Table1: 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 | 29,78 | 31,00 | 23,00 | 40,00 | 4,61 | 0,38 | -0,44 |
| SE | 19,65 | 19,00 | 11,00 | 33,00 | 5,50 | 0,57 | -0,05 |
| GE | 7,39 | 7,00 | 4,00 | 13,00 | 2,55 | 0,56 | -0,51 |
| SF | 0,57 | 0,00 | 0,00 | 2,00 | 0,79 | 0,99 | -0,58 |
| GF | 0,13 | 0,00 | 0,00 | 1,00 | 0,34 | 2,35 | 3,86 |
| TP | 0,83 | 1,00 | 0,00 | 4,00 | 1,03 | 1,47 | 2,62 |
| GP | 0,65 | 0,00 | 0,00 | 4,00 | 0,98 | 2,06 | 5,19 |
| SC | 0,91 | 1,00 | 0,00 | 4,00 | 1,08 | 1,13 | 1,17 |
| GC | 0,52 | 0,00 | 0,00 | 3,00 | 0,79 | 1,74 | 3,27 |
| MS | 7,83 | 8,00 | 3,00 | 11,00 | 2,55 | -0,38 | -1,10 |
| MG | 4,43 | 4,00 | 1,00 | 8,00 | 2,11 | 0,23 | -0,69 |
| GS | 9,87 | 9,00 | 4,00 | 17,00 | 3,48 | 0,53 | 0,15 |
| OS | 18,83 | 19,00 | 13,00 | 24,00 | 3,45 | 0,02 | -1,09 |
| BL | 4,87 | 4,00 | 1,00 | 10,00 | 2,16 | 0,54 | 0,05 |
| STB | 5,96 | 5,00 | 2,00 | 13,00 | 3,04 | 0,66 | -0,34 |
| SWB | 2,61 | 3,00 | 0,00 | 4,00 | 1,27 | -0,78 | -0,34 |
| E | 10,96 | 11,00 | 6,00 | 17,00 | 3,35 | 0,22 | -0,94 |
| LB | 11,22 | 11,00 | 4,00 | 18,00 | 3,92 | 0,19 | -0,67 |

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, F - 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: 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 | 31,26 | 31,00 | 24,00 | 37,00 | 3,40 | -0,37 | -0,24 |
| SE | 21,61 | 23,00 | 14,00 | 29,00 | 4,44 | -0,23 | -1,03 |
| GE | 4,91 | 4,00 | 2,00 | 11,00 | 2,70 | 0,88 | -0,15 |
| SF | 0,48 | 0,00 | 0,00 | 2,00 | 0,67 | 1,10 | 0,19 |
| GF | 0,04 | 0,00 | 0,00 | 1,00 | 0,21 | 4,80 | 23,00 |
| TP | 0,91 | 1,00 | 0,00 | 4,00 | 1,16 | 1,70 | 2,76 |
| GP | 0,78 | 1,00 | 0,00 | 4,00 | 1,00 | 1,68 | 3,64 |
| SC | 0,26 | 0,00 | 0,00 | 2,00 | 0,54 | 2,06 | 3,82 |
| GC | 0,09 | 0,00 | 0,00 | 1,00 | 0,29 | 3,14 | 8,61 |
| MS | 8,00 | 8,00 | 3,00 | 13,00 | 2,84 | 0,36 | -0,60 |
| MG | 3,13 | 3,00 | 1,00 | 5,00 | 1,32 | 0,13 | -1,21 |
| GS | 7,91 | 8,00 | 3,00 | 13,00 | 2,68 | 0,21 | -0,70 |
| OS | 21,04 | 19,00 | 17,00 | 27,00 | 3,35 | 0,69 | -1,02 |
| BL | 3,00 | 3,00 | 0,00 | 7,00 | 1,81 | 0,15 | 0,09 |
| STB | 5,83 | 6,00 | 2,00 | 12,00 | 2,55 | 0,84 | 0,85 |
| SWB | 1,39 | 1,00 | 0,00 | 4,00 | 1,27 | 0,78 | -0,34 |
| E | 10,22 | 11,00 | 4,00 | 16,00 | 3,23 | 0,10 | -0,37 |
| LB | 10,57 | 11,00 | 6,00 | 16,00 | 2,83 | 0,20 | -0,61 |

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

| <i>VAR</i> | <i>AS DEF</i> | <i>AS WIN</i> | <i>t value</i> | <i>p</i> |
|------------|---------------|---------------|----------------|-------------|
| <i>TS</i> | 31,26 | 29,78 | 1,24 | 0,22 |
| <i>SE</i> | 21,61 | 19,65 | 1,33 | 0,19 |
| <i>GE</i> | 4,91 | 7,39 | -3,20 | 0,00 |
| <i>SF</i> | 0,48 | 0,57 | -0,40 | 0,69 |
| <i>GF</i> | 0,04 | 0,13 | -1,04 | 0,31 |
| <i>TP</i> | 0,91 | 0,83 | 0,27 | 0,79 |
| <i>GP</i> | 0,78 | 0,65 | 0,45 | 0,66 |
| <i>SC</i> | 0,26 | 0,91 | -2,58 | 0,01 |
| <i>GC</i> | 0,09 | 0,52 | -2,48 | 0,02 |
| <i>MS</i> | 8,00 | 7,83 | 0,22 | 0,83 |
| <i>MG</i> | 3,13 | 4,43 | -2,51 | 0,02 |
| <i>GS</i> | 7,91 | 9,87 | -2,14 | 0,04 |
| <i>OS</i> | 21,04 | 18,83 | 2,21 | 0,03 |
| <i>BL</i> | 3,00 | 4,87 | -3,18 | 0,00 |
| <i>STB</i> | 5,83 | 5,96 | -0,16 | 0,88 |
| <i>SWB</i> | 1,39 | 2,61 | -3,25 | 0,00 |
| <i>E</i> | 10,22 | 10,96 | -0,76 | 0,45 |
| <i>LB</i> | 10,57 | 11,22 | -0,65 | 0,52 |

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

According to the results from Tables 1 and 2, we can conclude that the arithmetic means of the winning and defeated women's teams are quite equal in the following variables of statistical efficiency: man-up shots (AM 7.83; AM 8.00), shots from foul (AM 0.57; AM 0.48), number of penalties (AM 0.83; AM 0.91), stolen balls (AM 5.96; AM 5.83), the total number of shots (AM 29.78; AM 31.26), shots in a situation with an equal number of opposing players (AM 19.65; AM 21.61), goals from fouls (AM 0.13; AM 0.04), goals from penalties (AM 0.65; AM 0.78) and lost balls (AS 11.22; AS 10.57) and exclusions (AM 10.96; AM 10.22). Significant differences were observed in the variables: goals in a situation with an equal number of opposing players (AM 7.39; AM 4.91), shots from the counterattack (AM 0.91; AM 0.26), goals from the counterattack (AM 0.52; AM 0.09), man-up goals (AM 4.43; AM 3.13), goalkeeper shot saves (AM 9.87; AM 7.91), opponent's shots on goal (AM 18.83; AM 21.04), blocks (AM 4.87; AM 3.00) and swimming for the ball (AM 2.61; AM 1.39).

In women's water polo, the winning and losing teams differ statistically significantly in eight situational variables: goals in a situation with an equal number of opposing players, shots

CONCLUSION

This research showed that the technical and tactical indicators of the top women's water polo competitions vary in relation to the outcome of the match. The higher number of goals scored by the winning teams during the actions of an equal number of opposing players, counterattack and man-up suggests better skills in preparation and execution. Better indicators of winning teams in most

from the counterattack, goals from the counterattack, man-up goals, goalkeeper shot save, opponent's shots on goal, blocks and swimming for the ball.

Statistically significant differences in swimming for the ball and shots from the counter attack between winning and losing teams can very likely be attributed to swimming superiority and the skill of timely counterattack. Swimming superiority also contributes to the preparation of a longer attack with an equal number of players. The dominance of winning teams in the realization with an equal number of players, man-up and counterattack situations probably stems from better skills in achieving optimal conditions in the preparation and implementation of all offensive actions (Hraste et al., 2008). 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 saves (Hraste et al., 2010). This research confirms some previous research in differentiating top female water polo players according to match outcomes (Takagi et al. 2005; Lupo et al., 2011).

defensive actions confirm their overall superiority. 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. These findings encourage coaches on the one hand to improve the player's skills in providing optimal conditions for the execution of shots and on the other hand to improve the ability to cover and guard the direct opponent who plays on multiple inside and perimeter playing positions on attack.

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