RESEARCH ARTICLE

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Effect of Rule Changes on Performance Parameters for Women's Water Polo Over Three Seasons

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Abstract: Water polo's rule changes are proposed to improve performance throw a faster game with more goals, less wrestling and more technical skills. The rule changes may modify the players' perception and game actions. However, there are some critical differences between male and female water polo teams. To date, we have not found any study about female water polo rule changes effects over the seasons. This study aimed to verify the effects of water polo rule changes on the performance of female elite-level teams over the three seasons. The data were collected through official game reports from the European water polo league for female tournaments, totaling 63 matches. Goals, goals per quarter, exclusion fouls, and penalty fouls were registered and analyzed. Mean, standard deviation, and 95% confidence intervals were calculated for all variables. Generalized estimating equations were applied to compare the variables in the three moments. Effect sizes (Cohen's d) were calculated. SPSS 20.0 was used in all analyses. The alpha significance level was established at 0.05. No statistical differences were found over seasons' post-water polo rule changes for goals, goals per quarter, exclusion fouls, and penalty fouls variables, and the effect sizes were just from trivial to small. The 2019 and 2021 water polo rule changes do not provoke statistical effects in female water polo teams over the 2019/2020, 2021/2022 and 2022/2023 seasons.

Keywords: Team Sports, Water Sports, Notational Analysis, Game Performance Analysis

1. Introduction

Water polo (WP) is an invasion team sport that requires aquatic skills, high physiological demands, and cognitive skills. The WP players must be fast, strong, resistant, agile, and tactically intelligent (Argudo *et al.,* 2020; Botonis *et al.,* 2019; Tucher *et al.,* 2015). The evolution of WP over time has been shaped by technical and tactical innovations, as well as rule modifications, which are typical methods for altering game dynamics (Hraste *et al.,* 2013). Generally, the rules changes provide the specific requirements of game action and impose technical-tactical demands, which may modify the players' perception and game actions (Rodrigues *et al.,* 2013). Rule changes are typically implemented to enhance performance, attract audiences, address commercial interests, accommodate new participants, and reduce the risk of injuries (Madera *et al.*, 2017).

Over the years, changes to WP rules have reduced ball possession time and extended game duration. These adjustments have resulted in faster ball movement with less wrestling, quicker counterattacks, and increased physical, technical-tactical, and cognitive demands on players (Canossa *et al.,* 2020; Madera *et al.,* 2017). From 2019 to 2023 the main rules changed were: (i) reduction of the ball time possession at the second attack from 30 to 20 s (after rebound or a corner); (ii) a free throw shall be taken at the location of the ball; (iii) shooting after a foul, even if it is not directly to the goal (after the ball is out of hand, the player can swim, pass the ball or shoot); (iv) permission for flying substitutions from the lateral area, outer side of the field; (v) the increase in area in front of the post from 5 to 6 m; (vi) expanding the penalty foul's repertoire of actions, and (vii) creation of 2-m area (FINA, 2019; World Aquatics, 2022).

There are some critical differences between male and female WP teams regarding anthropometry, body composition, physiological capability, and tactical-technical skills (Abraldes *et al.,* 2011; Paixão *et al.,* 2023). Besides the research about female WP rule

changes effects (Argudo *et al.*, 2016, 2020; Paixão *et al.*, 2023), in general, they are inconclusive, especially in goals per match, which is the primary intention of rules changes. In comparison to the male WP, there are few researches regarding the female WP. Thus, to date, we have not found any study about female WP rule changes effects over the seasons. Therefore, this study aimed to verify the effects of 2019 and 2021 WP rule changes over the 2019/2020, 2021/2022, and 2022/2023 seasons on the goals (G), goals per quarter (GQ), exclusion fouls (EF) and penalty fouls (PF) performance in elite-level female teams.

2. Material & Methods

2.1 Experimental Approach

The analyses were performed by comparing the effects of post-rule changes over the seasons' on the elite-level WP teams for females through the G, GQ, EF, and PF. The GQ was described as GQ1, GQ2, GQ3 and GQ4.

2.2 Procedures for Obtaining the Data

The data were collected through official game reports from the European League for female tournaments. The data referring to G, GQ1 to GQ4, EF, and PF were recorded in electronic spreadsheets for later statistical analysis. Considering that the analyzed official game reports were obtained from public sites with free access, analysis by the research ethics committee was not necessary. The research pledged not to disclose any data individually.

2.3 Sample

The WP teams participated in three tournaments post-rule changes at the elite level for females. In this way, 63WP matches from the preliminary phases of the tournaments were analyzed. The teams participating in the LEN Champions League Woman in 2019/2020, 2021/2022, and 2022/2023 seasons' were analyzed. All seven female teams that participated in the three editions of the tournament were selected. In each one of the three WP tournaments seasons', referring to the post-rule changes, data were collected regarding 21 matches played by these teams totaling 63 matches.

2.4 Statistical Analyses

A longitudinal study analysis over the seasons' was performed. As descriptive statistics, mean, standard deviation, and 95% confidence intervals were calculated for all variables. To compare the parameters over the three seasons, generalized estimating equations (GEE) were applied. The GEE was designed to analyze paired and longitudinal data and can be applied regardless of the data distribution. The rule changes effect sizes were identified with Cohen's *d* and interpreted with the following criteria: 0-0.19 trivial, 0.2-0.59 small, 0.6- 1.19 moderate, 1.2-1.99 large, 2.0-3.99 very large and > 4.0 nearly perfect (Hopkins, 2002). SPSS 20.0 was used in all analyses. The alpha significance level was established at .05.

3. Results

For G, no difference between seasons was found ($p = 0.49$), and the rule changes effect size was small ($d = 0.3$). The mean ± SD (95% limits of the mean confidence) of G was 11.1 ± 1.8 (10.1 to 12.1), 10.0 ± 1.4 (9.2 to 10.8), and 11.0 ± 2.7 (9.4 to 12.5), respectively (Figure 1).

For GQ1, no difference between seasons' was found ($p = 0.83$), and the rule changes effect size was just trivial ($d = 0.0$). The mean ± SD (95% limits of the mean confidence) of GQ1 were 2.5 ± 0.5 (2.2 to 2.8), 2.4 ± 0.9 (1.9 to 2.9) and 2.6 ± 0.8 (2.2 to 3.1), respectively. For GQ2, no difference between seasons' was found ($p = 0.73$), and the rule changes effect size was just trivial ($d = 0.0$). The mean ± SD (95% limits of the mean confidence) of GQ2 were 3.1 ± 1.0 (2.5 to 3.6), 3.1 ± 0.5 (2.8 to 3.4) and 2.8 ± 1.0 (2.2 to 3.3), respectively. For GQ3, no difference between seasons' was found ($p = 0.67$), and the rule changes effect size was just trivial ($d = 0.0$). The mean ± SD (95% limits of the mean confidence) of GQ3 were 2.7 ± 0.6 (2.4 to 3.0), 2.6 ± 0.6 (2.2 to 2.9) and 2.8 ± 1.1 (2.2 to 3.4), respectively. For GQ4, no difference between seasons' was found ($p = 0.61$), and the rule changes effect size was just trivial ($d = 0.1$). The mean ± SD (95% limits of the mean confidence) of GQ4 were 2.8 ± 0.6 (2.5 to 3.1), 1.9 ± 0.7 (1.5 to 2.3), and 2.7 ± 1.2 (2.0 to 3.4), respectively (Figure 2).

Table 1 presents EF and PF for females at elite-level championships. Comparisons were performed over seasons' post-WP rule changes. For EF, no difference between seasons' was found ($p = 0.46$), and the rule changes effect size was just trivial ($d = 0.1$). The mean ± SD (95% limits of the mean confidence) of EF were 9.4 ± 1.7 (8.4 to 10.4), 9.6 ± 3.5 (7.6 to 11.5) and 10.6 ± 1.8 (9.6 to 11.6), respectively.

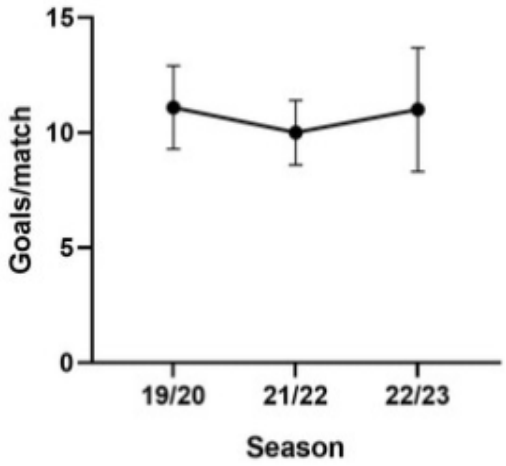

Figure 1. Mean for the goals per match post-WP rules changes at 19/20, 21/22, and 22/23 seasons'

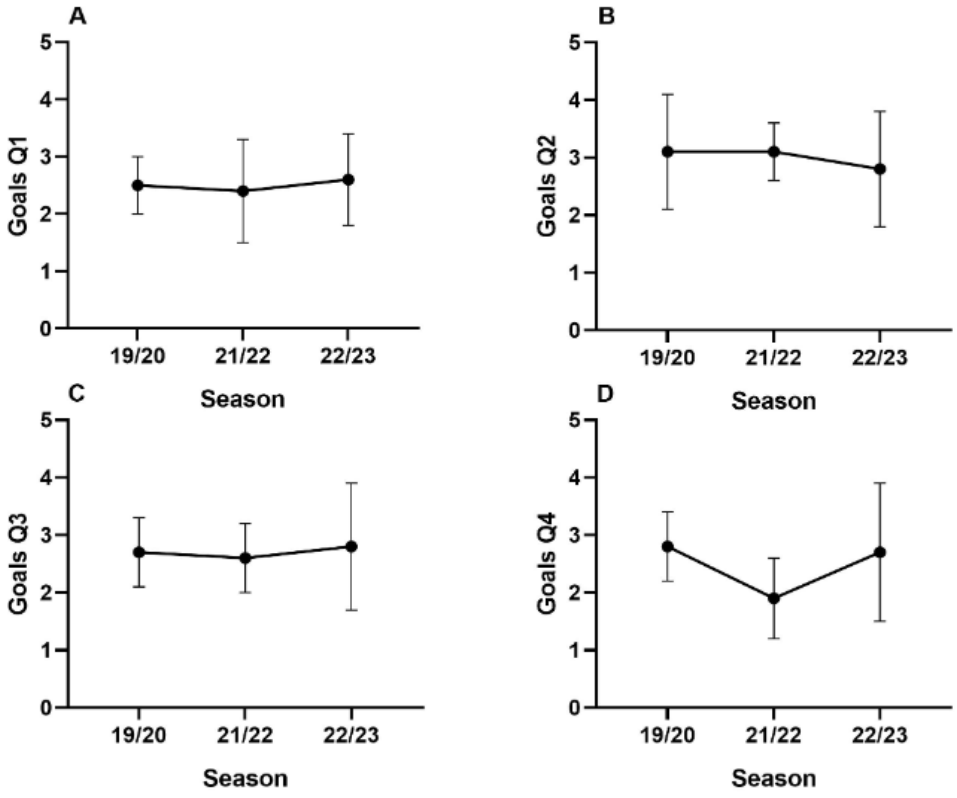

Figure 1. Mean for the goals per quarter (Q1 to Q4) post-WP rules changes at 19/20, 21/22 and 22/23 seasons'.

Table 1. Mean ±standard deviation,95% confidence intervals, p-value, and effect size (ES-d) for the exclusion fouls (EF) and penalty fouls (PF) at elite-level championships for females over seasons' post-water polo rule changes (n = number of games).

Females				
	season 19/20 n = 21	season 21/22 n = 21	season 22/23 n = 21	p-value; d
EF	9.4 ± 1.7 [8.4 to 10.4]	9.6 ± 3.5 [7.6 to 11.5]	10.6 ± 1.8 [9.6 to 11.6]	0.46 ; 0.1 trivial ES
PF	1.1 ± 0.6 [0.8 to 1.4]	1.6 ± 1.3 [0.9 to 2.3]	1.0 ± 0.7 [0.6 to 1.4]	0.84 ;0.0 trivial ES

EF = Exclusion Fouls; PF = Penalty Fouls

For PF, no difference between seasons' was found ($p = 0.84$), and the rule changes effect size was just trivial ($d = 0.0$). The mean ± SD (95% limits of the mean confidence) of PF were 1.1 ± 0.6 (0.8 to 1.4), 1.6 ± 1.3 (0.9 to 2.3) and 1.0 ± 0.7 (0.6 to 1.4), respectively.

4. Discussion

This study aimed to verify the effects of 2019 and 2021 WP rule changes over 2019/2020, 2021/2022, and 2022/2023 seasons on the goals (G), goals per quarter (GQ), exclusion fouls (EF), and penalty fouls (PF) performance in elite-level female teams.No statistical differences were found over seasons' post-WP rule changes for any analyzed variables, and the effects sizes were just from trivial to small. These results are in accordance with a study conducted by Paixão *et al.* (2023) that found no differences in comparing pre and post-rules changes for the same variables in female water polo elite-level. Regarding shot effectiveness comparing the 2003 and 2013 female water polo World Championships (pre and post-rules changes), no statistical differences were found in goals scored in numerical equality or in powerplay (Argudo *et al.,* 2020). However, when the comparison was performed with sub-elite level female teams, statistical increases with moderate to very large effects sizes for goals in the second, third, and fourth quarters, and statistical decreases in the first quarter with very large effect sizes were found (Paixão *et al.,* 2023). Besides that, the goals variable was not statistically affected by post-rules changes.

There are some critical differences between male and female water polo performance. Although power and arm span are determining variables for the tactical position of male players, the same does not occur with female players. In female players, body fat mass and anteroposterior chest width are determinants, especially for central defenders (Vila *et al.,* 2018). In this way, body fat mass is positively related to the floating ability, which probably influences some motor manifestations in water (Peric *et al.,* 2012). However, the strength and power of male water polo players lead to more displacements and higher shot velocity than female ones during the match. Argudo *et al.* (2016) reveal an increase in penalty frequency in male but not in female teams, comparing pre and post-rule changes in World Champion 2003 and 2007. Paixão *et al.* (2023) showed that male elite-level teams had been affected by the rule changes, increasing goals, goals per quarter, exclusion fouls, and penalty fouls.

The throwing velocity in female players is slower than in elite or sub-elite-level male teams (Alcaraz *et al.,* 2011; Castro *et al.,* 2021; Platanou & Varamenti, 2011; Van der Wende, 2005). The lower physical performance level of women's water polo, where even top female players have throwing speeds approximately 4 to 5 m/slower than men (Elliott & Armour, 1988). The main objectives of the rule changes are to make the game dynamic, with more goals (FINA, 2019, 2022). In this sense, female teams probably did not achieve this purpose because a faster game requires players' strength, which is more visible in male teams than in female teams.

The lack of strength may induce female teams to frequent periods of acceleration and deceleration, leading to a positional game with fewer displacements than a male water polo game (Canossa *et al.,* 2009; Van der Wende, 2005). The female water polo game is characterized by more wrestling, dispute for space, and a closer game with greater body contact than males. This may explain why the rule changes, which induced more displacements, did not affect women's water polo variables. The more physically demanding game, with the post-rule changes compared to pre, was not enough to affect the game dynamics in goals on female elite-level water polo teams. Marin *et al.* (2020) showed a reduction in counterattacking frequency in female teams in 2013 in comparison with the 2003 World Championships (pre and post-rule changes). The female physical demand for a faster game explains these results.

The results of this study suggest that coaches could intensify the development of strength manifestations (especially power and resistance) and increase the cardiorespiratory capacity of female players. Aiming at the specificity of training, situational games could improve these physical variables, develop specific cognitive skills and optimize time in training sessions (Vasques *et al.,* 2021). For example, activities with small-sided games with a reduction of 10 meters (5 meters on each side) can be a way to develop offensive/defensive transitions while improving physical capabilities. As for suggestions for future rule changes, maybe reducing the field and quarter time in the female's wp could be tested.

5. Conclusions

The 2019 and 2021 WP rule changes do not provoke effects in female WP teams over the

2019/2020, 2021/2022, and 2022/2023 seasons. There was no effect even in goals, goals per quarter, exclusion fouls, or penalty fouls. According to the results of the present study, the elite-level female WP teams were not sensitive to the rule changes, not achieving one of the main objectives of the FINA rule changes, which is increasing goal frequency and providing more spectacular WP. For further studies, obtaining WP players', coaches and referees' perceptions of the female WP game could improve our understanding of the effects of the rule changes on female teams.

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Author Contribution Statement

The authors confirm contribution to the paper as follows: study conception and design: Diego Andrades Paixão, Flávio Antônio de Souza Castro, Isadora Villanova, Gabriel Aguiar, José Werner; data collection: Diego Andrades Paixão, Flávio Antônio de Souza Castro, Isadora Villanova, Gabriel Aguiar, José Werner; analysis and interpretation of results: Diego Andrades Paixão, Flávio Antônio de Souza Castro, Isadora Villanova, Gabriel Aguiar, José Werner; draft manuscript preparation: Diego Andrades Paixão, Flávio Antônio de Souza Castro, Isadora Villanova, Gabriel Aguiar, José Werner. All authors reviewed the results and approved the final version of the manuscript.

Ethics Approval Statement

The study was approved by the Institutional Review Board (IRB).

Informed Consent

The consent form was signed before the commencement of the study.

Conflict of Interest

The authors declare that there was no conflict of interest.

Does this article pass screening for similarity?

Yes

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