



# Do Water Polo's Rule Changes Affect Team Performance at Different Levels and Genders?

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## Cite this article:

Paixão, D., Tucher, G., Vasques, D. & A. de S. Castro, F. (2023). Do Water Polo's Rule Changes Affect Team Performance at Different Levels and Genders? *Apunts Educación Física y Deportes*, 152, 36-43. [https://doi.org/10.5672/apunts.2014-0983.es.\(2023/2\).152.04](https://doi.org/10.5672/apunts.2014-0983.es.(2023/2).152.04)

## Editor:

© Generalitat de Catalunya  
Departament de la Presidència  
Institut Nacional d'Educació  
Física de Catalunya (INEFC)

ISSN: 2014-0983

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## Section:

Sport Training

## Original language:

English

## Received:

April 15, 2022

## Accepted:

September 29, 2022

## Published:

April 1, 2023

## Front cover:

A young sprinter prepares herself with a track series to work on her explosiveness.  
@Jérôme Aufort/Adobestock

## Abstract

The aim of this study was to verify the effect of rule changes in the 2019 water polo (WP) rules on the performance of sub-elite and elite level teams of both genders, comparing pre- and post- moments. The data were collected through official game reports from Brazilian and European WP tournaments, totaling 533 matches, referring to goals (G), goals per quarter (GQ1 to GQ4), exclusion fouls (EF) and penalty fouls (PF). Mean, standard deviation and 95 % confidence intervals were calculated for all variables. Generalised estimating equations were used to compare the variables pre- and post-WP rule changes. Effect sizes (Cohen's *d*) were calculated. SPSS 20.0 was used in all analysis. The alpha significance level was established at .05. At the level of the sub-elite teams, women decreased GQ1 and increased GQ2, GQ3, GQ4 and EF, while men increased only EF and PF. At the level of the elite teams, women did not change the variables, whereas men increased G, GQ1, GQ2, EF and PF. The 2019 WP rule changes provoked different responses according to gender and the competitive level of the teams.

**Keywords:** notational analysis, rule modification, team sports, water sports.

## Introduction

Water polo (WP) is an invasion team sport with opposition-cooperation played in water (Argudo et al., 2020a, 2020b). The high shot rate and its effectiveness, positional attack with successful individual defense-breaking actions, the high conversion rate of power-play situations and goals per quarter are determining factors for victory (Canossa et al., 2009; Ruano et al., 2016; Tucher et al., 2015). The development of WP throughout its history has been conditioned by technical-tactical innovations and rule changes, a common way to change game conditions (Hraste et al., 2013). In general, the rule changes provide the specific requirements of game action and impose technical-tactical demands, which modify the player's perception and actions in the game (Rodrigues et al., 2013). Usually, rule changes are applied to improve performance, attract spectators, address commercial interests, adapt the sport to new practitioners and to avoid injuries (Madera et al., 2017).

The continuous rule changes throughout its history has hampered the dynamics and speed of the WP (Hraste et al., 2013). The changes in WP rules provided, over the years, the reduction of ball possession time, and the increase of game duration, which consequently led to a rapid ball circulation, rapid counter-attacks and great physical, technical-tactical and cognitive demands (Canossa et al., 2009; Hraste et al., 2013). Basically, time element changes have been present in WP development (Canossa et al., 2020).

In 2018, the International Amateur Swimming Federation (FINA) presented a new set of WP rules, implemented in 2019 (Lozovina & Lozovina, 2019). The intention of rule changes is to make WP more attractive to the media and the public through a faster game, with more goals and less violence (FINA, 2019). The main rules changed were: (i) reduction of the ball time possession at the second attack from 30 to 20 s (after a 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; and (vi) expanding the penalty foul's repertoire of actions (FINA, 2019).

Despite research about the effects of the WP rule changes (Argudo et al., 2020a, 2020b; Lozovina &

Lozovina, 2019), no studies aiming to verify the effects on different levels and genders in the same research, with notational analysis, were found. According to Lupo et al. (2012b), notational analysis has been shown to be an effective tool for increasing the knowledge of team sports and for better coaching, especially regarding complex sports, like WP. Therefore, the aim of this study was to verify the effects of 2019 WP rule changes on the goals (G), goals scored per quarter (GQ), exclusion fouls (EF) and penalty fouls (PF) performance in different technical levels and both genders. The hypothesis is that the rule changes will induce an increase in the frequency of goals, especially in the initial quarters. This must occur by increasing in offensive actions frequency caused by the reduction of the ball time possession at the second attack. In addition, there should be an increase in exclusion fouls and penalty fouls. The rule changes intended to induce dynamism and fair play into the game, making it more attractive and penalizing players who carry out brutal actions. In addition, it is supposed that the 2019 WP rule changes will affect differently women and men in different competitive level of the teams.

## Methodology

### Experimental Approach

The analyses were performed by comparing the effects of pre- and post-rule-changes on the sub-elite and elite-level teams for both genders through the G, GQ, EF and PF. The GQ were described as GQ1, GQ2, GQ3 and GQ4.

### Procedures for obtaining the data

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

## Sample

The WP teams participated in two tournaments (pre- and post-rule changes) at the sub-elite and elite level for females and males. In this way, an overall of 533 WP matches from the preliminary phases of the tournaments were analysed.

### *The sub-elite level*

The teams participating in the Brazilian WP League in 2018 and 2019 were analysed. Three women's teams that participated in the two editions of the Brazilian Women's WP League were selected. In the pre-rule changes (2018), data were collected regarding 30 matches played by these teams. In the analysis of the post-rule changes, data were collected from the Brazilian Women's WP League games played in 2019, with a total of 23 matches. Eight male teams that participated in the two editions of the Brazilian Men's WP League were selected. In 2018, referring to the pre-rule changes, data were collected over 95 matches played by these teams. In the post-rule changes, data were collected from the Brazilian WP League matches played in 2019, totaling 98 matches.

### *The elite level*

The teams participating in the Ligue Européenne de Natation (European WP leagues, LEN) in the 2017/2018 and 2019/2020 seasons were analysed. All twelve female teams that participated in the two editions of the LEN Euro League Woman were selected. In the 2017/2018 season, referring to the pre-rule changes, data were collected regarding 36 matches played by these teams. In the post-rule changes, data were collected from the LEN Euro League Woman played in 2019/2020, with a total of 36 matches. Nine male teams that participated in the two editions of the LEN Champions League were selected. In the 2017/2018 season, with respect to the pre-rule changes, data were collected regarding 126 matches played by these teams. In the post-rule changes, data were collected from the LEN Champions League matches played in 2019/2020, with a total of 89 matches.

## Statistical analyses

A longitudinal study analysis with pre- and post-measures was performed. As descriptive statistics, mean, standard deviation, and 95 % confidence intervals were calculated

for all variables. To compare all variables, variables pre- and post-WP rule changes, generalised estimating equations (GEE) were applied. The GEE were 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.

## Results

Table 1 presents the G, GQ1 to GQ4, EF and PF for females and males at the sub-elite-level championships. Comparisons were performed between the pre- and post-WP rule changes of 2019. For females, only G and PF did not statistically change from pre to post. For these variables, effect sizes were small and trivial, respectively. The EF presented a statistical increase with a large effect size in the post-WP rule changes. The GQ1 decreased statistically, and the effect size was very large. However, GQ2, GQ3 and GQ4 increased statistically with moderate to very large effect size. Although for males, just the EF and PF increased statistically, with a moderate to large effect size. The other variables did not statistically change from pre to post. For these variables, effects sizes varied from trivial to small. Table 2 presents G, GQ1 to GQ4, EF and PF for females and males at elite-level championships. Comparisons were performed between the pre- and post-WP rule changes of 2019. For females, no statistical differences were found, and the effects sizes were just from small to moderate (only for the PF). Although for males, with the post-WP rule changes, there were statistical increases in G, GQ1, GQ2, EF and PF, and effect sizes were from moderate to large (only for the EF and PF). The GQ3 (moderate effect size) and GQ4 (small effect size) did not statistically change from pre to post.

## Discussion

The aim of this study was to verify the effect of the 2019 WP rule changes on the performance of teams of different levels and genders. Specifically, we compared (i) goals, (ii) goals per quarter, (iii) exclusion fouls and (iv) penalty

**Table 1**

Mean  $\pm$  standard deviation, 95% confidence intervals, *p*-value and effect size (ES-d) for the goals (G), goals per quarter (GQ1 to GQ4), exclusion fouls (EF), and penalty fouls (PF) at sub-elite-level championships for females and males, pre- and post-WP rule changes (*n* = number of games).

	Females			Males		
	pre <i>n</i> = 30	post <i>n</i> = 23	<i>p</i> -value; d	pre <i>n</i> = 95	post <i>n</i> = 98	<i>p</i> -value; d
G	9.3 $\pm$ 2.1 [7.0 to 11.7]	10.3 $\pm$ 1.0 [9.2 to 11.3]	0.17; 0.6 small ES	9.5 $\pm$ 2.8 [7.6 to 11.4]	9.7 $\pm$ 1.6 [8.5 to 10.8]	.94; 0.1 small ES
GQ1	3.6 $\pm$ 0.2 [3.3 to 3.8]	2.5 $\pm$ 0.8 [1.6 to 3.5]	< 0.001; 2.0 very large ES	2.4 $\pm$ 0.9 [1.8 to 3.1]	2.4 $\pm$ 0.4 [2.1 to 2.7]	.61; 0.1 small ES
GQ2	1.8 $\pm$ 0.8 [0.9 to 2.6]	3.0 $\pm$ 0.3 [2.6 to 3.4]	< 0.001; 2.2 very large ES	2.3 $\pm$ 0.7 [1.8 to 2.7]	2.4 $\pm$ 0.6 [1.9 to 2.8]	.53; 0.1 small ES
GQ3	1.8 $\pm$ 0.6 [1.2 to 2.4]	2.3 $\pm$ 0.3 [1.9 to 2.7]	0.05; 1.0 moderate ES	2.4 $\pm$ 0.6 [2.0 to 2.8]	2.3 $\pm$ 0.4 [2.0 to 2.6]	.59; 0.3 small ES
GQ4	1.8 $\pm$ 0.2 [1.6 to 2.0]	2.5 $\pm$ 0.2 [2.2 to 2.7]	< 0.001; 2.9 very large ES	2.5 $\pm$ 0.6 [2.0 to 2.9]	2.6 $\pm$ 0.5 [2.3 to 3.0]	.82; 0.3 small ES
EF	6.5 $\pm$ 0.8 [5.6 to 7.4]	7.9 $\pm$ 1.5 [6.1 to 9.6]	< 0.001; 1.2 large ES	6.1 $\pm$ 1.4 [5.1 to 7.0]	7.4 $\pm$ 1.2 [6.6 to 8.3]	.03; 1.0 moderate ES
PF	1.1 $\pm$ 0.7 [0.3 to 1.8]	1.1 $\pm$ 0.2 [0.9 to 1.3]	0.94; < 0.01 trivial ES	0.8 $\pm$ 0.1 [0.7 to 0.9]	1.2 $\pm$ 0.3 [0.9 to 1.4]	< .001; 1.6 large ES

G = Goals; GQ = Goals per Quarter; EF = Exclusion Fouls; PF = Penalty Fouls

**Table 2**

Mean  $\pm$  standard deviation, 95% confidence intervals, *p*-value and effect size (ES-d) for the goals (G), goals per quarter (GQ1 to GQ4), exclusion fouls (EF), and penalty fouls (PF) at elite-level championships for females and males, pre- and post-WP rule changes (*n* = number of games).

	Females			Males		
	pre <i>n</i> = 36	post <i>n</i> = 36	<i>p</i> -value; d	pre <i>n</i> = 126	post <i>n</i> = 89	<i>p</i> -value; d
G	10.9 $\pm$ 2.6 [9.5 to 12.4]	11.7 $\pm$ 2.8 [10.1 to 13.3]	0.37; 0.3 small ES	10.3 $\pm$ 1.7 [9.2 to 11.4]	11.9 $\pm$ 1.9 [10.7 to 13.1]	.03; 0.9 moderate ES
GQ1	3.1 $\pm$ 1.1 [2.4 to 3.7]	2.8 $\pm$ 0.8 [2.3 to 3.2]	0.43; 0.4 small ES	2.6 $\pm$ 0.6 [2.2 to 3.0]	3.0 $\pm$ 0.3 [2.9 to 3.2]	.02; 0.9 moderate ES
GQ2	2.8 $\pm$ 1.2 [2.1 to 3.5]	3.0 $\pm$ 1.0 [2.4 to 3.6]	0.44; 0.2 small ES	2.4 $\pm$ 0.6 [2.1 to 2.8]	3.0 $\pm$ 0.6 [2.6 to 3.4]	< .001; 0.9 moderate ES
GQ3	2.7 $\pm$ 1.0 [2.1 to 3.3]	3.0 $\pm$ 0.7 [2.6 to 3.4]	0.34; 0.4 small ES	2.5 $\pm$ 0.5 [2.2 to 2.9]	3.0 $\pm$ 0.7 [2.5 to 3.4]	.09; 0.7 moderate ES
GQ4	2.7 $\pm$ 0.7 [2.3 to 3.1]	2.9 $\pm$ 1.1 [2.3 to 3.5]	0.29; 0.2 small ES	2.7 $\pm$ 0.3 [2.5 to 2.8]	2.9 $\pm$ 0.6 [2.5 to 3.3]	.41; 0.4 small ES
EF	8.2 $\pm$ 1.4 [7.4 to 9.0]	8.9 $\pm$ 1.7 [7.9 to 9.8]	1.00; 0.4 small ES	9.1 $\pm$ 1.2 [8.3 to 9.9]	11.2 $\pm$ 1.3 [10.4 to 12.1]	< .001; 1.7 large ES
PF	0.6 $\pm$ 0.6 [0.3 to 1.0]	1.1 $\pm$ 0.5 [0.8 to 1.3]	0.06; 0.7 moderate ES	0.4 $\pm$ 0.2 [0.3 to 0.6]	0.9 $\pm$ 0.3 [0.7 to 1.1]	< .001; 1.9 large ES

G = Goals; GQ = Goals per Quarter; EF = Exclusion Fouls; PF = Penalty Fouls

fouls. The 2019 WP rule changes intention was make the game more attractive, instigating more dynamism and creativity by the speed promotion and violence reduction. Therefore, it was expected an increase in goal frequency, penalty fouls and exclusion fouls. However, the different genders and level teams could provoke different results.

At the sub-elite level, for females, goals in second, third and fourth quarters and exclusion fouls increased, while goals in first quarter decreased. For males, just exclusion fouls and penalty fouls increased. At the elite level, no statistical difference was observed for females; however, for males, goals, goals in first and second quarter, exclusion fouls and penalty fouls increased. These results must be interpreted considering the changes in rules and the short time given to players to adapt to these changes. Thus, the hypotheses were partially confirmed: the increase in goals, especially in the initial quarters, exclusion fouls and penalty fouls occurred only in male elite level teams.

### Sub-elite-level analysis

Goals did not change from pre to post for females, and the effect size was only small. Although goals in second, third and fourth quarters increased statistically, and the effect sizes were from moderate to very large, goals in first quarter decreased, and the effect size was very large. Thus, the combined effect of increasing the average number of goals in second, third and fourth quarters, with the reduction in goals in first quarter, led to the behaviour observed in the total number of goals. There were important changes in goals per quarter distribution. The first time that Brazilian teams played with the new rules was in 2019. This fact may have caused a conservative attitude in offensive actions, which may have led to a reduction in goals in first quarter, an increase in the other quarters (especially in second quarter goals) and an increase in exclusion fouls but not in penalty fouls.

Although the exclusion fouls increased with a large effect size, it seems that it was not enough to increase goals. The high performance in power-play situations could be a determining factor for scoring goals (Lupo et al., 2012a; Tucher et al., 2015). Lupo et al. (2010), comparing elite and sub-elite male WP matches, showed that the competition level has a relevant impact on the occurrence and performance of power-play situations. Lupo et al. (2010) observed a higher percentage of scored

goals from power-play situations in elite-level teams than in sub-elite ones. In addition, more than half of the power-play situations in the 2014 Women's WP World Championship resulted in goals for the winners' teams (Lupo et al., 2014).

Penalty fouls did not change and presented a trivial effect size. These results indicate that the new rules may not have caused the offensive actions of entering the 6-m area by the sub-elite-level women's teams. This assumption is supported by the increase in exclusion fouls but not in penalty fouls, indicating that most exclusion fouls did not occur in penalty fouls situations. Previous studies (Lupo et al., 2010; Tucher et al., 2014) found that the sub-elite-level teams' shots are preferably inside the 5-m area and from the centre zone, indicating a reduced ability to generate other ways to score. It is likely that the Brazilian women's teams were not able to make better use of the possibilities of the new rules.

For males, goals did not change statistically and presented a trivial effect size after the new rules were imposed. For the goals in first, second, third and fourth quarters, there were no statistical differences between pre- and post-rule changes. The effect sizes were only small for all of them. However, the exclusion fouls and penalty fouls increased significantly with moderate and large rule-change effect sizes, respectively. This reveals the inability of the male Brazilian teams to take advantage of the new rules' possibilities. For the first league match after the new rules, the changes may have induced a conservative attitude or the players had not yet seen the new possibilities for goals.

The increase in exclusion fouls at the post-rule changes may have occurred due to great rigour in the application of the ruled in comparison to the pre-rule changes in order to restrain violent actions and prioritise the abilities of offensive players. This may have revealed that the short adaptation time to the rule changes did not allow players to change their technical-tactical behaviour, in which intense physical contact is predominant, both in women and men at the sub-elite level. These results corroborate Tucher et al. (2015) research, which showed that the power-play performances by Brazilian male teams, even among the winners, was only average. This performance in power play supposes a low technical quality of sub-elite teams in overcoming defences and scoring goals. Despite the increase in exclusion fouls with a consequent increase in power plays, goals remained unchanged.



The penalty fouls increase in male teams and might indicate a different technical-tactical behaviour in female and male teams regarding the offensive actions of entering the 6-m area. It seems that the sub-elite male teams have taken more 6-m area entry actions than female teams. This fact, in addition to the game characteristics involving intense physical contact, may have influenced the increase in penalty fouls. On the other hand, the short time to adapt to interpreting and applying the new rules by Brazilian referees may have influenced the increase in penalty fouls. After the 2019 Brazilian National League, some initiatives such as refresher courses for Brazilian coaches and referees were carried out to improve the interpretation of the new rules and their possibilities. This leads one to believe that the application of the rules could be suffering from bias.

The sub-elite male teams shoot preferably from the centre zone and inside the area, unlike international and elite Italian ("Serie A") teams, which presented a high frequency of diagonal shots originating outside the 5-m area (Lupo et al., 2010; Tucher et al., 2014). That indicates a lower performance level for the men's sub-elite than elite teams. This technical-tactical behaviour leads us to deduce that the increase in exclusion fouls and penalty fouls may have occurred through the increased number of offensive actions allowed by the new rules. On the other hand, the male Brazilian teams' quality performance in power play was only average (Tucher et al., 2015). That can explain why the increase in exclusion fouls did not influence goals and goals per quarter. The individual WP competitive performance depends, among other aspects, on the player's anthropometry and good physical and technical capacity (Castro et al., 2021). In this sense, it seems that the lower shot velocity of the sub-elite male teams in comparison to the elite male teams could affect decision-making (regarding the distance and location of the shots) and average performance in power plays (Lupo et al., 2010; Tucher et al., 2014, 2015).

### Elite level analysis

For females, at the elite level championships no statistical differences were found between pre- and post-rule changes. The effect sizes were only from small to moderate (moderate only for penalty fouls). These results corroborate the those of Vila et al. (2011), suggesting that penalty micro situations

are not a determining factor in the winning or losing status of a team. In a study conducted by Lamas et al. (2020) with World Championship teams, the women presented a lower correlation (.78) between shots and points per possession in comparison to the men (.81), although both have shown similar efficiency in creating score opportunities.

The high number of passes, great ball circulation and duration of offensive actions in situations of positional attack in female elite teams (Canossa et al., 2009) may partially explain the results of the present study. Throwing velocity tends to decrease over the course of the game due to the fatigue in female collegiate WP but not in elite junior male WP players (Royal et al., 2006; Stevens et al., 2010). Both technical-tactical, physiological and anthropometric characteristics differentiate female WP players from male players, which may justify the small effects of the rule changes for female teams in comparison to male teams (Abralde et al., 2011). Moreover, women's WP was developed later than male WP, which can also influence performance quality and game dynamics. The first male WP team to participate in the Olympic Games (Paris) was in 1900, while female teams have only done so since 2000 (Sydney) (Lupo et al., 2014).

The elite male teams were those that showed a statistical increase in goals. This increment was due the statistical increases in goals in first and second quarters (moderate effect size) and no statistical changes in goals in third quarter (but a slight increase, moderate effect size). Exclusion fouls and penalty fouls also presented statistical increases for the elite male teams. The effect sizes were from moderate to very large. The more physically demanding game with the post-rule changes in comparison to pre, probably with more displacements, may have affected the goals per quarter distribution. The statistical increase in goals in first and second quarters (moderate effect size) may indicate a higher game intensity with the post-rule changes than pre. This hypothesis is supported by the non-significant increase of goals in third quarter (moderate effect size) and goals in fourth quarter (small effect size), indicating fatigue over the course of the game. Botonis et al. (2016) showed that handgrip strength, repeated sprint ability and ball shooting accuracy decreased after the game, which may support especially why goals in fourth quarter did not increase in this study. It seems that the increase in the two initial quarters were responsible for the increase in goals.

In the present study, the statistical increase in goals (moderate effect size) added to the increase in exclusion fouls and penalty fouls (large effect size) and may induce us to believe in the improved performance of these game situations. However, Argudo et al. (2020b) found an increase in frequency of shots per match in situations of inequality and penalty fouls but not in goals in this situation. On the other hand, in balanced games, winners engage in a larger number of attacks in power-play situations than in unbalanced games (Escalante et al., 2012; Lupo et al., 2012b). The high effectiveness of power-play situations can be decisive in defining the game's score (Tucher et al., 2015).

The increase in penalty fouls average at the post-rule changes indicated that the elite male teams may have taken advantage of the new penalty rules to explore entry movements into the 6-m area, which may have caused goals directly through penalties shots or power-play situations. The high-level teams should present conditions to score from different positions in the field (Escalante et al., 2012; Lupo et al., 2010; Tucher et al., 2014).

In this study, the sample was limited to Brazilian and European leagues referring to sub-elite and elite levels respectively. Furthermore, the different levels of rule interpretation by the Brazilian and European referees may have influenced the results. This study did not seek specific information about team's power-play performances and changes in penalty shot goals for pre- and post-rule changes. A video analysis could provide information such as the origin of shots and the actions' outcomes, as well as making it possible to rate the entry movements into the 6-m area pre- and post-rule changes (Argudo et al., 2020a; Lupo et al., 2014; Tucher et al., 2014). In addition, the present study did not compare winning and losing teams in terms of technical-tactical behaviour.

## Conclusions

The 2019 WP rule changes provoked different responses according to the gender and the competitive level of the teams. At the sub-elite level, women increased exclusion fouls, goals in second, third and fourth quarters and decreased goals in first quarter. In contrast, men had practically no change in the analysed variables, presenting increases only in exclusion fouls and penalty fouls. For elite-level games, women do not seem to have changed the variables, whereas men increased goals, exclusion fouls, penalty

fouls, goals in first and second quarter. According to the results of the present study, the elite-level male WP teams were the most sensitive to the rule changes, achieving one of the main objectives of the FINA rule changes, that is increasing goal frequency and providing more spectacular WP. For future studies, obtaining WP players', coaches' and referees' perceptions of the new rules could improve our understanding of the effects of the 2019 rule changes.

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**Conflict of Interests:** No conflict of interest was reported by the authors.



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