

## The attacking style of teams is determinant of high-intensity actions of soccer referees El estilo ofensivo de los equipos es determinante en las acciones de alta intensidad de los árbitros de fútbol

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**Abstract.** This study aimed to examine the impact of the attacking style of teams and match outcome on the high-intensity activities (HIA) performed by Brazilian field referees (FRs) and assistant referees (ARs). The sample was composed of 20 FRs (age:  $34.4 \pm 5.9$  years) and 36 ARs (age:  $35.4 \pm 6.3$  years). Match activities derived from Global Position System (GPS) were collected from FRs and ARs during 41 official soccer matches over two seasons. A total of 3898 (FRs: 2118; ARs: 1780) actions were analyzed by video-motion to determine attacking style: counterattack (CA), fast attack (FA) and positional attack (PA). Match outcome was assessed as final match outcome (home win, draw and away win) and goal difference (GD) (0, 1 and  $\geq 2$ ). Significance level was set  $p < 0,05$ . Higher proportion of HIA was observed during CA (FRs: 60.7%; ARs: 50.6%) when compared to FA and PA. CA elicited longer HIA in terms of distance and duration than the other attacking styles analyzed. FRs covered significantly ( $p = 0.01$ ) longer total distance (TD) when the away team won the match than in other conditions. In addition, GD 1 and GD 0 resulted in longer TD ( $p=0.01$ ) and distance at sprinting (SPR) ( $p=0.04$ ), respectively. These results provide valuable insights to the influence of different match factors on the performance of referees during soccer matches.

**Keywords:** match status, final match outcome, attacking type, situational variable.

**Resumen.** Este estudio tuvo como objetivo examinar el impacto del estilo de ataque de los equipos y el resultado del partido en las actividades de alta intensidad realizadas por los árbitros de campo (FR) y los árbitros asistentes (AR) brasileños. La muestra estuvo compuesta por 20 FR (edad:  $34,4 \pm 5,9$  años) y 36 AR (edad:  $35,4 \pm 6,3$  años). Las actividades de los partidos derivadas del Sistema de Posición Global (GPS) se recopilaron de los FR y AR durante 41 partidos oficiales de fútbol durante dos temporadas. Un total de 3898 (FRs: 2118; ARs: 1780) acciones fueron analizadas mediante video-motion para determinar el estilo de ataque: contraataque (CA), ataque rápido (FA) y ataque posicional (PA). El resultado del partido se evaluó como resultado final del partido (victoria local, empate y victoria visitante) y diferencia de goles (GD) (0, 1 y  $\geq 2$ ), nivel de significancia establecido  $p < 0,05$ . Se observó una mayor proporción de HIA durante la CA (FR: 60,7%; AR: 50,6%) en comparación con FA y PA. CA provocó una HIA más larga en términos de distancia y duración que los otros estilos de ataque analizados. Los FR cubrieron TD significativamente ( $p = 0,01$ ) más tiempo cuando el equipo visitante ganó el partido que en otras condiciones. Además, GD 1 y GD 0 dieron como resultado una distancia total (TD) ( $p=0,01$ ) y una distancia en el sprint (SPR) ( $p=0,04$ ) más largas, respectivamente. Estos resultados proporcionan información valiosa sobre la influencia de diferentes factores de partido en el desempeño de los árbitros durante los partidos de fútbol.

**Palabras clave:** estado del partido, resultado final, tipo de ataque, variable situacional.

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### Introduction

During a soccer match, field referees (FRs) and assistant referees (ARs) have the freedom to move unrestricted on the field, which ensures them to be at the best position for accurate decision-making (Castagna, Abt, & D'Ottavio, 2007; Rebelo, Silva, Pereira, & Soares, 2002). These displacements are intermittent and predominantly aerobic, with highly anaerobic demands required during high-intensity running (HIR) or short-distance sprint actions (Castagna et al., 2007; Riiser et al., 2017). Elite soccer referees experience significant physical and physiological demands during matches (Castagna et al., 2007; Da Silva et al., 2022; Rebelo et al., 2002; Riiser et al., 2017; Yousefian et al., 2023), as they must constantly be close to the action to make optimal decisions (Alhazmi, 2016; Mallo, Frutos, Juárez, & Navarro, 2012). The body of knowledge in the literature on football referees has also grown regarding the technical factors that can affect referee decision-making (Alhazmi, 2016; Gonçalves, Coutinho, Travassos, Brito, & Figueiredo, 2021; Johansen & Erikstad, 2021). For instance, Alhazmi (2016) found that 12m to the action focus

was better associated with correct decision-making. Johansen e Erikstad (2021) reported that the referees' positioning resulted in the highest rate of correct decisions when the distance was under 10 meters (83% correct decisions), with a clear angle (88%). Lastly, Gonçalves et al. (2021) found an increase in distance from referee to the ball during second half.

The influence of situational and contextual variables on players' running performance have been one of the main fields of research in football setting (Aquino et al., 2020; Carvalho, Esteves, Nunes, Mendez, & Travassos, 2021; Lago-Peñas, 2012). Briefly, contextual factors can be defined as those related to the game context and the environment that surrounds it (e.g., match location), while situational factors are more linked to those situations that occur during the game from the internal dynamics and relationships established between referees, players, coaches and the public (Carvalho, Esteves, Nunes, Mendez, & Travassos, 2021). Match outcome, match status (or scoreline), match location, level of the opponent and the playing style of teams appear among the major variables that have received more attention in the current literature of

football players (Andrzejewski, Konefał, Chmura, Kowalczyk, & Chmura, 2016; Aquino et al., 2020; Chmura et al., 2018). Of interest, most of these previous published studies are limited to outfield players, while corresponding data with FRs and ARs are missing.

The running performance of soccer referees is known to be influenced by various factors, including physical fitness status, competitive level, player movements, tactical organization of teams, and distance covered by the ball (Castagna et al., 2007; Da Silva et al., 2022; Weston, Drust, & Gregson, 2011). However, the potential impact of other situational variables (e.g., match outcome and attacking style) on match running performance of FRs and ARs is still unknown. Given the close connection between players and referees' displacements (Weston et al., 2011), it is plausible to assume that attacking style and match outcome may also play a key role on the running performance of FRs and ARs, especially during HIR and sprinting (i.e., high-intensity activities [HIA]).

In terms of playing style, the attacking style can be categorized as positional (PA), fast (FA) and counterattacks (CA) based on features such as depth, intensity, duration, pace of play, and number of passes (Borges et al., 2019; Fernandez-Navarro, Fradua, Zubillaga, Ford, & McRobert, 2016; González-Ródenas, Aranda, & Aranda-Malaves, 2021). CA elicits longer distances at HIR and greater proportion of goals scored than PA in football players (Forcher et al., 2023; Tenga, Holme, Ronglan, & Bahr, 2010). Interestingly, sprints have been identified as the most frequent actions leading to goals during soccer matches (Faude, Koch, & Meyer, 2012). It is also worth noting that sprints occur more often during defensive organization (33%), attacking (30%) and defensive (27%) transitions than in attacking organization (10%) (Caldbeck & Dos'Santos, 2022). Therefore, from a practical point of view, it makes sense to assume that HIR and sprinting activities of FRs and ARs are more connected to situations of counterattacks, since it requires them to move faster and over longer distances to be closer to actions during the moments of defensive and attacking transition of both teams.

Understanding the running activities of FRs and ARs according to the attacking style of teams and match outcome can provide insights of practical relevance to design soccer-specific situational and tactical drills targeting to improve the running performance of FRs and ARs in these important moments of a match involving HIR and sprinting. Therefore, the aim of this study was to examine and compare the occurrence of HIA (i.e., HIR + sprinting) performed by soccer referees according to the attacking style of teams and match outcome during soccer matches. Our first hypothesis is that soccer referees would experience longer and more often HIA during CA than in other attacking styles. Secondly, it was hypothesized that matches ended in draw or smaller goal differences (i.e., GD 1) would induce greater HIA demands than other conditions.

## Material and Methods

### Participants

The sample of this study was composed of a total of 20 FRs (1 female; age:  $34.4 \pm 5.9$  years) and 36 ARs (4 female; age:  $35.4 \pm 6.3$  years), which held the following licenses: Federation International Football Association - FIFA (FRs: 3; ARs: 1), Brazilian Football Confederation - CBF (FRs: 9; ARs: 17) and Santa Catarina Football Federation - FCF (FRs: 8; ARs: 18). This study was previously approved by the local research ethics committee (Number: 5.521.729).

### Procedures

Forty-one Santa Catarina state championship games were monitored during 2022 and 2023 seasons, the match duration was  $98.5 \pm 2.4$  minutes. This championship has been previously assessed by Da Silva et al. (Da Silva et al., 2022), who found similar distance covered by FRs and ARs compared to national-level competitions. Considering the attacking styles, a total of 3898 (FRs: 2118; ARs: 1780) actions were analyzed by time motion analysis.

### Physical Match Activities

A 18hz global positioning system (GPS, WIMU PRO, Almeria, Spain) unit was used to collect running performance data from FRs and ARs. Data were downloaded and analyzed using a customized software package (Spro®, Almeria, Spain), which allowed synchronization with match video. Displacement activities derived from official games were categorized as follows (Da Silva et al., 2022): total distance covered (TD), high-intensity running (HIR:  $18.1$  to  $23 \text{ km}\cdot\text{h}^{-1}$ ), sprinting (SPR:  $> 23 \text{ km}\cdot\text{h}^{-1}$ ), and high-intensity activity (HIA: HIR + sprinting). All variables were normalized as distance per minute of play (m/min). The distance and duration of each HIA bout was recorded, with the starting point defined as the moment in which referee surpassed the speed threshold, and the end point was determined when the speed dropped below 80% of the speed zone threshold.

### Situational variables

Games were recorded using digital camera (Canon T6i, Tokyo, Japan), positioned diagonally in relation to the bottom and side lines (Costa, Garganta, Greco, Mesquita, & Maia, 2011). The classification of attacking styles was adapted from (Borges et al., 2019), with the following classifications: Positional Attack (PA), Fast Attack (FA), Counterattack (CA) and Other (Table 1). The Kappa index was applied to compare inter and intra reliability. All variables presented  $k > 0.81$ , indicating "near perfect" reliability (Barros, Reis, Hallal, Florindo, & Farias Júnior, 2012). The match outcome was categorized into three groups: Home win, Draw, and Away win. The goal difference (GD) was also classified into three categories: GD 0, GD 1, or  $\text{GD} \geq 2$ , corresponding to the difference in the final score between teams. To enable data synchronization with GPS records, the official scoresheets were consulted.

Table 1.

Characteristics to classification of attacking style.

Counterattack (CA)	Fast attack (FA)	Positional attack (PA)
Performs a maximum 5 passes or less.	Performs a maximum 7 passes or less.	Performs more than 7 passes.
Duration equal to or less than 12 seconds.	Duration equal to or less than 18 seconds.	Offensive sequence duration exceeding 18 seconds.
Opponent team advanced on the field of play and defensively unbalanced.	Opponent team balanced defensively.	Opponent team balanced defensively.
Ball circulation more in depth than width.	Ball circulation in width and depth.	Ball circulation more in width than depth.
Very high play intensity.	High play intensity.	Cadenced play intensity.

### Statistical Analysis

Data are presented as mean  $\pm$  standard deviation. After visual inspection, the Shapiro-Wilk test was used to test normality. One-way ANOVA was used to compare the running performance outputs between the different categories for match outcome (home win, draw, and away win; and goal difference equal to 0, 1 and  $\geq 2$ ), and attacking styles (CA, FA, PA and other). Whenever significant F-value was obtained, post hoc test with Tukey's adjustment was performed for multiple comparison. For the application of Cohen's d, effect size values were considered as follow:  $< 0.2$  trivial,  $0.2$  to  $0.5$  small,  $> 0.5$  to  $0.8$  medium, and  $> 0.8$  large (Cohen, 1988). Statistical analyses were performed using the RStudio software (version 4.2.1, PBC, Boston, MA, USA) and the significance level was set at  $p < 0.05$ .

### Results

The mean values of running activities analyzed were the following: TD (FRs:  $10385 \pm 767$  m; ARs:  $5560 \pm 417$  m), HIR (FRs:  $627.8 \pm 270$  m; ARs:  $200.5 \pm 65.3$  m), sprinting (FRs:  $124.3 \pm 110.7$  m; ARs:  $43.6 \pm 34.3$  m) and HIA (FRs:  $752.2 \pm 354.9$  m; ARs:  $244.2 \pm 89.2$  m). In terms of relative distances (i.e., m/min), the following values were observed for TD (FRs:  $105.4 \pm 7.8$  m/min; ARs:  $56.4 \pm 4.2$  m/min), HIR (FRs:  $6.4 \pm 2.7$  m/min; ARs:  $2.0 \pm 0.7$  m/min), sprinting (FRs:  $1.3 \pm 1.1$  m/min; ARs:  $0.4 \pm 0.3$  m/min) and HIA (FRs:  $7.6 \pm 3.6$  m/min; ARs:  $2.5 \pm 0.9$  m/min).

Figure 1 shows the HIA distribution experienced by FRs and ARs throughout each 15-minute match period. The first period (0'-15": 20 % of cases) showed the greatest amount of HIA for both FRs and ARs.

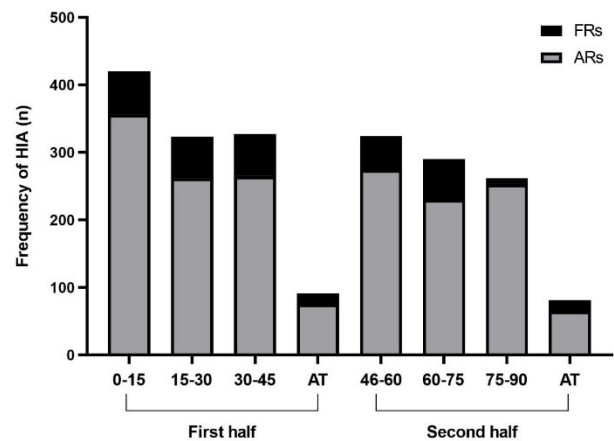


Figure 1. FRs and ARs HIA distribution by time of match. AT: Additional time; HIA: High intensity activities; FRs: Field referees; ARs: Assistant referees.

### Type of attack

Most HIA performed by FRs and ARs during regional soccer matches occurred during CA (61% and 51%), being followed by FA (23% and 33%), PA (10%) and other situations (6%) (Figure 2).

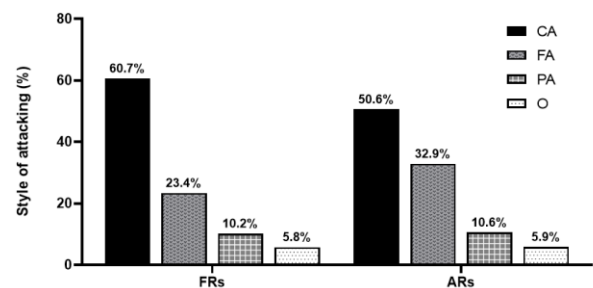


Figure 2. FRs and ARs HIA distribution by style of attack. FRs: Field referees; ARs: Assistant referees; CA: Counterattack; FA: Fast attack; PA: Positional attack, O: Others.

CA elicited significantly ( $p < 0.001$ ) longer HIA (in terms of duration and distance) than the other attacking styles in both FRs and ARs (Table 2).

Table 2.

Description (mean  $\pm$  DP) of HIA by the style of attack.

		PA	FA	CA	Other	p value	Effect size
FR	Duration (s)	$3.5 \pm 1.6^a$	$3.9 \pm 2.1^b$	$4.3 \pm 2.1^c$	$3.2 \pm 1.7^a$	$< 0.001$	0.19
	Distance (m)	$18.4 \pm 8.9^a$	$21.2 \pm 12.1^b$	$24.5 \pm 12.8^c$	$16.4 \pm 9.1^a$	$< 0.001$	0.22
AR	Duration (s)	$2.5 \pm 0.9^a$	$2.8 \pm 1.2^b$	$3.1 \pm 1.3^c$	$2.8 \pm 1.3^a$	$< 0.001$	0.17
	Distance (m)	$13.5 \pm 5.6^a$	$15.5 \pm 7.1^b$	$17.4 \pm 8.2^c$	$14.7 \pm 7.5^a$	$< 0.001$	0.17

FR: Field referees; AR: Assistant referees; PA: positional attack; FA: fast attack; CA: counterattack. Different letters (<sup>abc</sup>) indicate difference between the groups.

### Match outcome

FRs covered significantly ( $p = 0.01$ ) longer TD when the away team won the match than in other conditions (Table 3). When the final score by GD was analyzed, post-hoc

Tukey comparisons revealed that FRs covered longer TD in GD 1 than in GD 0 and  $\geq 2$  ( $p = 0.01$ ), while GD 0 elicited greater distances at sprinting in comparison to GD 1 ( $p = 0.04$ ).

Table 3.

Physical match activities field referees (FRs) and assistant referees (ARs) during different final match outcomes assessed by final score (upper portion of the table) and goals difference (lower portion of the table). Data are presented as mean  $\pm$  SD.

		Draw	Home Win	Away Win	p value	Effect size
FR	TD (m/min)	103.8 $\pm$ 7.4 <sup>a</sup>	103.8 $\pm$ 7.4 <sup>a</sup>	111.1 $\pm$ 8.1 <sup>b</sup>	0.01	0.52
	HIR (m/min)	7.2 $\pm$ 2.7	5.4 $\pm$ 2.9	6.4 $\pm$ 2.7	0.25	0.28
	SPR (m/min)	1.8 $\pm$ 1.1	1.1 $\pm$ 1.2	0.9 $\pm$ 0.9	0.07	0.38
	HIA (m/min)	9 $\pm$ 3.5	6.5 $\pm$ 3.9	7.3 $\pm$ 3.4	0.19	0.3
AR	TD (m/min)	56 $\pm$ 4.3	54.7 $\pm$ 7.5	58.2 $\pm$ 3.8	0.09	0.25
	HIR (m/min)	2 $\pm$ 0.7	1.9 $\pm$ 0.7	2.2 $\pm$ 0.6	0.36	0.16
	SPR (m/min)	0.5 $\pm$ 0.4	0.4 $\pm$ 0.4	0.4 $\pm$ 0.3	0.92	0.05
	HIA (m/min)	2.4 $\pm$ 1	2.3 $\pm$ 1	2.6 $\pm$ 0.8	0.6	0.11
		0	1	2+	p value	Effect size
FR	TD (m/min)	103.8 $\pm$ 7.4 <sup>a</sup>	110.2 $\pm$ 7.8 <sup>b</sup>	101.2 $\pm$ 4.7 <sup>a</sup>	0.01	0.55
	HIR (m/min)	7.2 $\pm$ 2.7	5.6 $\pm$ 2.5	6.7 $\pm$ 3.3	0.24	0.28
	SPR (m/min)	1.8 $\pm$ 1.1 <sup>a</sup>	0.8 $\pm$ 0.8 <sup>b</sup>	1.3 $\pm$ 1.4 <sup>ab</sup>	0.04	0.42
	HIA (m/min)	9 $\pm$ 3.5	6.3 $\pm$ 3.1	8 $\pm$ 4.3	0.12	0.34
AR	TD (m/min)	56 $\pm$ 4.3	57.3 $\pm$ 4.2	54.8 $\pm$ 8.5	0.48	0.14
	HIR (m/min)	2 $\pm$ 0.7	2 $\pm$ 0.6	2.1 $\pm$ 0.8	0.54	0.13
	SPR (m/min)	0.5 $\pm$ 0.4	0.5 $\pm$ 0.4	0.4 $\pm$ 0.3	0.78	0.08
	HIA (m/min)	2.4 $\pm$ 1	2.5 $\pm$ 0.8	2.4 $\pm$ 1	0.86	0.06

FR: Field referees; AR: Assistant referees; TD: Total distance; HIR: High intensity running; SPR: Sprinting; HIA: High intensity activities; Different letters (<sup>abc</sup>) indicate significant differences between categories.

## Discussion

The present study aimed to examine the impact of the attacking style of teams and match outcome on the high-intensity activities performed by FRs and ARs. Supporting our first hypothesis, CA was the predominant attacking style associated to HIA and elicited longer HIA in terms of distance and duration than other conditions. Additionally, our second hypothesis was partially accepted, since FRs covered longer TD in away win and GD 1 conditions, and experienced greater sprinting distances in draw matches (i.e., GD 0).

As expected, counterattacks (CA) presented the highest frequency of HIA (FRs: 60.7%; ARs: 50.6%) in our study. This attacking style leads to higher occurrence of HIA (Alhazmi, 2016; Gonçalves et al., 2021; Johansen & Erikstad, 2021), as CA occurs in a short period of time, with players performing high-intensity actions and prioritizing depth while the defense is unbalanced, seeking to take advantage of imbalance to score (Borges et al., 2019; Lago-Ballesteros, Lago-Peñas, & Rey, 2012; Tenga & Sigmundstad, 2011). These particular features of CA required our referees to cover longer distances (and longer effort durations) at high-intensity (i.e., above 18 km·h<sup>-1</sup>) (Table 2), probably to ensure proximity to plays and achieve optimal positioning and accuracy. These findings gain greater significance and practical support when considering the higher frequency of goals following counterattacks compared to elaborated attacks (Tenga et al., 2010) and the high prevalence of straight sprints and accelerations actions that often precede goals (Castro, 2017; Faude et al., 2012) or are performed during attacking and defensive transitions moments (Caldbeck & Dos'Santos, 2022). In addition, this study

showed that the greatest amount of HIA occurred during the first period of the match (0-15') (Figure 1). This finding may be due to the greater frequency of maximal intensity sprints experienced by the players in the first period of the match during football matches (Oliva-Lozano, Fortes, López-Del Campo, Resta, & Muyor, 2022). Regarding HIA distribution throughout the match, our data (agreeing with earlier studies in FRs and ARs) also showed reduction in the frequency of HIA during and towards the end of each half of the match (Da Silva et al., 2022; Ozaeta, Fernández-Lasa, Martínez-Aldama, Cayero, & Castillo, 2022; Weston et al., 2012).

The final GD significantly affected TD and distance at sprinting in FRs. Matches that ended in a draw (i.e., GD 0) had longer sprinting distances than GD 1. Nevertheless, final scores with GD 1 elicited greater TD. Therefore, the final GD appears to influence the dynamics of displacements of FRs, indicating that closer score-line (GD 1) induces higher total volume, while draws seem to provide more situations to perform sprints, probably associated with other variables not assessed in this study such as team formation, team level and match location (Aquino et al., 2020; Aquino, Munhoz Martins, Palucci Vieira, & Menezes, 2017).

In terms of final match outcome, only total distance (TD) was higher when the away team won the match. This finding can be attributed to psychological factors, particularly those associated with the influence of the home crowd (Buraimo, Forrest, & Simmons, 2010), indirectly affecting physical demands (Castagna et al., 2007; Weston et al., 2012). Specifically, the attention required and the need for increased movements might be intensified in cases of victory by the away team, potentially leading to disapproval

from the local crowd. In general, these results indicate that during most time of the match, other factors such as disciplinary control and accuracy are equally important as high-intensity displacements.

One of the primary limitations of this study is related to the sample used. Although a substantial number of observations were included, providing a robust dataset for analysis, the overall level of the referees was heterogenous and not as high as desired. Many of the referees in the sample were not from top-tier leagues, which may limit the generalizability of the findings to higher competitive levels. The physical and cognitive demands on referees at different competitive levels can vary significantly, and the running performance of lower-tier referees may not accurately reflect the demands experienced by referees in top-tier matches (Castagna et al., 2007; Castagna, Pérez Leguizamón, & Araújo Póvoas, 2022). Future research should aim to include referees from higher competitive levels to ensure that the findings are more representative of the elite refereeing population and to better understand the impact of attacking styles and situational variables on the performance of top-level referees.

In conclusion, this study showed that CA are the most physically demanding attacking style and often associated with HIA. From the practical standpoint, these findings have implications for prescribing training and testing protocols for referees (Castagna et al., 2022). Specifically, sprint endurance and high-intensity intermittent performance appear to be crucial physical abilities in FRs training and testing (Castagna et al., 2022). This research provides a better understanding of HIA actions and contributes to the selection of professionals for refereeing matches based on the offensive characteristics of teams and the physical attributes of referees. Moreover, the regional nature of the analyzed championships may influence the results, especially because the levels of FRs and ARs was heterogenous and not all were from elite or top-class tier, highlighting the need for further studies including national and international levels. Furthermore, only offensive actions were investigated, and it should be recognized that defensive behaviors may also influence the running performance of FRs and ARs.

### Practical Applications

Coaches and practitioners should prioritize training regimes that enhance sprint endurance and high-intensity intermittent performance for referees. Given that counterattacks (CA) are the most physically demanding attacking style associated with high-intensity activities (HIA), referees need to be prepared to keep pace with these fast-paced situations. Referees should focus on maintaining proximity to plays, ensuring optimal positioning and accuracy, especially during CAs, as these situations frequently lead to goals and critical decisions, also, it is essential that in CAs situations, referees quickly recognize and anticipate their running displacements. From a practical perspective, starting a movement 2 seconds earlier can

enable the FR to be closer in approximately 10 meter at end of counterattack. Training sessions should include drills simulating real game scenarios, emphasizing repeated or isolated HIA actions and fast decision-making under fatigue. This study provides valuable insights into the duration and distance of each type of attack, aiding in the design of more specific training according to game situations.

Matches ending in a draw or with a close goal difference (GD 1) may require different energy expenditure and movement patterns compared to matches where one team dominates. Training protocols should be tailored to prepare referees for varying match scenarios, as different games necessitate varying physical demands. It is also crucial for referees to adapt their pacing to effectively monitor actions throughout a match. Furthermore, the physical attributes of referees should be considered when selecting officials, particularly their sprint endurance and high-intensity intermittent performance capabilities. Referees with better physical conditioning may be better prepared to handle the demands of high-intensity match situations.

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### Conflict of Interest Statement

The authors report there are no competing interests to declare.

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