

# COMPARATIVE ANALYSIS OF THE PHYSICAL ACTIVITY OF RUGBY REFEREES IN INTERNATIONAL AND NATIONAL COMPETITIONS

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**Abstract:** *The study aimed to diagnose and compare the physical demands specific to rugby referees in international and national competitions, to support the integrated preparation of rugby referees. The research material included official matches from Rugby World Cup 2023, Rugby Europe Championship 2022–2023, and the Romanian National Rugby Championship. Data analysis was carried out through systematic observation and video analysis, recording speed-running sequences and gestural activity separately for the referee and the assistant referee. The results showed that the referee is predominantly required to perform repeated short- and medium-distance movements, whereas the assistant referee is characterised by a relatively stable frequency of long-distance running and signalling. The data obtained support the need for an integrated preparation model in which the physical and decision-making components are developed in a convergent manner and adapted to the actual demands of competition.*

**Key words:** *rugby referees, physical activity, video analysis, competitive demands.*

## 1. Introduction

Modern sports officiating requires efficient game observation, appropriate positioning, and the formulation of rapid and accurate decisions under conditions of high demand [5], [9]. In rugby, these requirements become even more pronounced because of the complexity of the game, the alternation between set phases and dynamic play, and the need to

remain constantly connected to the decisive phases of the match. In this context, referee performance cannot be explained solely by knowledge of the Laws of the Game or by general physical preparation, but requires an integrated form of preparation combining theoretical, physical, technical-tactical, and psychological components [5], [8].

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This perspective is also supported by the analysis of the World Rugby L1-L3 architecture, which shows that the current training model provides a solid instructional core, yet still leaves room for strengthening sport-specific physical preparation, perceptual-cognitive training, communication within the officiating team, and performance analysis [7, p. 216]. In the same sense, the quantitative profile of officiating in the Romanian championship highlighted a moderate but specific physical demand, as well as a pattern of intervention influenced by the particularities of the domestic competition [8, p. 915-916]. Consequently, the analysis of referee activity must be related not only to regulatory requirements, but also to the actual characteristics of the game and of the competitive context.

From a broader sport science perspective, recent literature supports the value of integrated training models adapted to the demands of the activity. Functional training programmes, structured according to movement and performance parameters, have been associated with significant improvements in agility, mobility, stability, and explosive capacity [1, pp. 23-24]. At the same time, research in judo and water polo shows that competitive performance and special physical preparation must be developed through continuous, holistic, and individualised approaches adapted to the specific requirements of the activity [2], [3]. These findings are also relevant to rugby officiating, where physical effort has not only a quantitative dimension, but also a functional one, since it conditions the maintenance of proximity to play, the preservation of an effective observation angle, and the execution of an appropriate decision-making intervention [5], [8].

At the same time, the specialised literature shows that the preparation and evaluation of referees must be related not only to the physical demands of the game, but also to the emotional, cognitive, and technological factors that influence the quality of performance. In football, it has been shown that emotional states may influence the referee's conduct during the game [11, p. 122-123], while digital technologies and video analysis contribute to the objectification of game situations and support evaluation and feedback processes [10], [13]. Moreover, a systematic review dedicated to the training of sports officials highlighted that their development frequently includes the use of sport-specific video tasks, although evidence regarding the direct transfer of training to actual competitive performance remains limited [4, p. 654]. Therefore, the preparation of the modern referee cannot be reduced to the development of a single component, but must aim at integrating physical, perceptual, and decision-making demands into a coherent training model.

Although important contributions already exist regarding the integrated preparation of referees, the World Rugby training model, and the profile of officiating in national competition [5], [7], [8], comparative analyses of the physical activity of rugby referees in international and national competitive contexts, conducted based on the same operational indicators, remain limited. In this context, the present study aims to diagnose and compare the level of physical demand imposed on rugby referees in international and national competitions, to support the individualisation of training and the calibration of performance standards specific to officiating activity.

## 2. Objectives

The aim of the study was to diagnose and compare the physical demands specific to rugby referees in international and national competitions, to outline useful reference points for the integrated preparation of the rugby referee.

In line with this aim, the following objectives were formulated:

- to identify and compare the mean match values of the main physical and gestural indicators specific to the referee and the assistant referee in the competitions analysed;
- to highlight the particularities of the demands in relation to the function performed during the match and to the competitive level;
- to highlight the implications resulting from the comparative analysis of physical demands for guiding the integrated preparation of the rugby referee.

## 3. Materials and Methods

### 3.1. Research material

The research material consisted of official matches belonging to three competitive contexts: Rugby World Cup 2023, Rugby Europe Championship 2022–2023, and the Romanian National Rugby Championship. The selection of matches aimed to ensure data that were as representative as possible of the actual demands of high-performance officiating. In this respect, matches with different dynamics were included, ranging from balanced contests to games with an evident imbalance in value, so that variations in the rhythm and intensity of officiating activity could be captured. At the same time, the inclusion of as many

referees as possible was pursued, so that the results obtained would reflect the particularities of the competition analysed and not exclusively the specificity of a single refereeing profile.

### 3.2. Video analysis procedure and operational indicators

To investigate the demands specific to rugby officiating, the method of video analysis through systematic observation was used, applied to the matches selected from the three competitions. The observation sheets were structured into two main blocks. The first block targeted the fixed moments of the game, by recording the occurrence and frequency of standardised phases, used as landmarks for organising and systematising the observation. The second block, intended for the actual investigation, targeted referee activity and included two distinct dimensions: the movement dimension and the gestural dimension.

The movement dimension was assessed through the number of speed-running sequences, classified by distance thresholds of  $\geq 10$  m,  $\geq 20$  m,  $\geq 30$  m, and  $\geq 50$  m, estimated in relation to pitch landmarks and the referee's position in the frame. The gestural dimension was quantified through the number of gestures observable during actual playing time. For the referee, basic gestures, secondary gestures, and advantage signals were recorded, whereas for the assistant referee only basic gestures performed in direct relation to the unfolding of play were counted. Forms of communication that were difficult to quantify through video analysis were not included, such as communication via radio system, verbal communication, gestures associated with

substitutions, or gestures used in organising players during set phases.

### 3.3. Statistical processing of the data

For each match, the values were summed by indicators and subsequently synthesised at the level of each competition. Statistical processing included the calculation of the arithmetic mean ( $\bar{X}$ ), the mean error of the mean ( $m$ ), and the coefficient of variation (CV), indicators used to describe the average level of demand, the stability of the estimate, and the degree of data variability. The results were expressed as  $\bar{X} \pm m$  and CV [%], which made it possible to compare systematically the physical and gestural indicators between competitions

and between the functions performed within the officiating team. In addition, to verify the stability of the analysis procedure, a measurement error of at most 5% between two codings of the same video material was considered acceptable.

### 4. Results and Discussions

Table 1 summarises the mean match values of the main physical and gestural indicators specific to the referee in the competitions analysed. These data provide the comparative framework necessary for highlighting the particularities of effort associated with this role.

Table 1  
*Mean match values of physical and gestural indicators for the referee across the analysed competitions*

Indicator	Rugby World Cup 2023		Rugby Europe Championship 2022–2023		Romanian National Championship 2022–2023	
	$\bar{X} \pm m$	CV [%]	$\bar{X} \pm m$	CV [%]	$\bar{X} \pm m$	CV [%]
Speed-running sequences (no.)	72.67 ± 2.27	10.83	59.25 ± 2.55	14.93	65.50 ± 2.38	12.58
Speed-running ≥10 m (no.)	31.58 ± 1.32	14.51	26.00 ± 1.75	23.37	25.67 ± 1.70	22.98
Speed-running ≥20 m (no.)	25.33 ± 1.43	19.51	22.25 ± 1.22	18.98	23.58 ± 0.94	13.82
Speed-running ≥30 m (no.)	12.42 ± 1.20	33.38	8.42 ± 0.82	33.78	12.33 ± 1.20	33.76
Speed-running ≥50 m (no.)	3.33 ± 0.48	50.09	2.58 ± 0.51	68.97	3.92 ± 0.77	68.39
Basic gestures (no.)	47.67 ± 1.61	11.71	50.00 ± 1.56	10.79	49.50 ± 2.39	16.76
Secondary gestures (no.)	74.92 ± 3.09	14.29	50.67 ± 1.71	11.70	63.92 ± 2.98	16.17
Advantage signals (no.)	14.67 ± 1.32	31.22	17.67 ± 1.59	31.13	23.67 ± 1.00	14.67

**Note:**  $\bar{X}$  = arithmetic mean;  $m$  = mean error; CV = coefficient of variation;  $n$  = 12 matches for each competition

The data in Table 1 show that the activity of the referee is built predominantly on repeated sequences of short- and

medium-distance movement, which confirms the intermittent and adaptive character of the effort specific to rugby

officiating. The mean total value of speed-running sequences is highest in the Rugby World Cup 2023, where it reaches  $72.67 \pm 2.27$  sequences per match, compared with  $65.50 \pm 2.38$  in the domestic championship and  $59.25 \pm 2.55$  in the Rugby Europe Championship. This distribution suggests that, at elite level, the referee is subjected to a more intense locomotor load, determined by the higher tempo of the game and by the need for rapid repositioning in relation to decisive phases.

The structure of the effort supports the same tendency. In all three competitions, the highest values are recorded at the  $\geq 10$  m and  $\geq 20$  m thresholds, which shows that the activity of the referee is based mainly on frequent positional adjustments performed over short and medium distances. In the World Cup, these

thresholds reach  $31.58 \pm 1.32$  and  $25.33 \pm 1.43$  sequences per match, values higher than those observed in the European and domestic competitions. At the  $\geq 30$  m and  $\geq 50$  m thresholds, the differences are more nuanced: for  $\geq 30$  m, the Rugby World Cup 2023 and the domestic championship show similar values, whereas at  $\geq 50$  m the domestic championship records the highest mean. This suggests that, although the referee is required mainly to perform short- and medium-distance repositioning, the domestic competition also includes situations that generate long high-speed movements more frequently.

For a clearer illustration of the differences between competitions, the comparative distribution of the main physical and gestural indicators specific to the referee is presented in Figure 1.

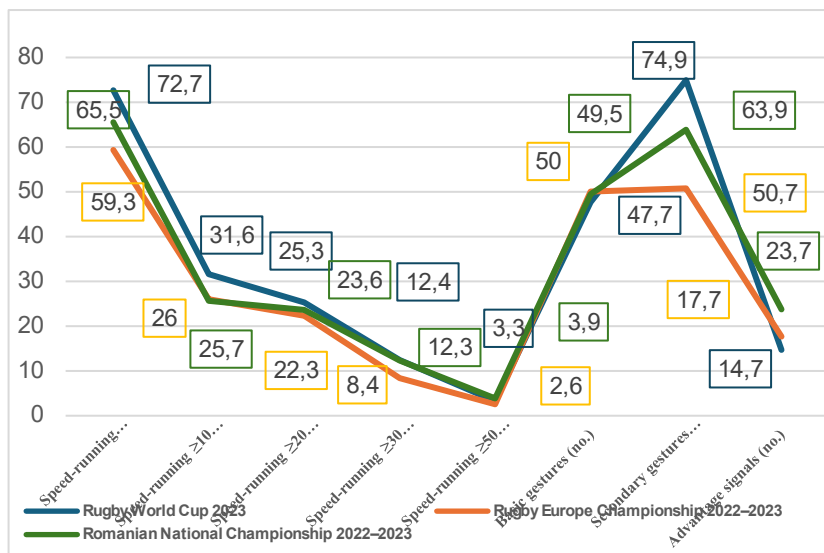


Fig. 1. *Physical and gestural profile of the referee across the analysed competitions*

The gestural activity complements the overall picture of the referee's performance. As can also be seen in Figure 1, basic gestures remain at relatively similar values across competitions, whereas secondary gestures reach their highest level in the Rugby World Cup 2023, and advantage signals are more numerous in the domestic championship. At the same time, the coefficients of variation show that the basic effort indicators, such as the total number of speed-running sequences and basic gestures, display low or moderate

variability, while CV values increase at the  $\geq 30$  m and  $\geq 50$  m thresholds, as well as for advantage signals. This indicates a greater sensitivity of these indicators to the specificity of each match and to the contextual dynamics of the game.

Table 2 summarises the mean match values of the main physical and gestural indicators specific to the assistant referee in the competitions analysed. These data make it possible to highlight the particularities associated with this role and the way in which they vary according to the competitive level.

Table 2  
Mean match values of physical and gestural indicators for the assistant referee across the analysed competitions

Indicator	Rugby World Cup 2023		Rugby Europe Championship 2022–2023		Romanian National Championship 2022–2023	
	$\bar{X} \pm m$	CV [%]	$\bar{X} \pm m$	CV [%]	$\bar{X} \pm m$	CV [%]
Speed-running sequences (no.)	59.42 ± 2.21	12.91	52.42 ± 2.38	15.70	42.92 ± 2.69	21.69
Speed-running $\geq 10$ m (no.)	18.42 ± 1.28	24.11	16.67 ± 1.02	21.15	14.42 ± 1.05	25.35
Speed-running $\geq 20$ m (no.)	19.00 ± 1.26	23.00	16.25 ± 1.20	25.59	11.92 ± 0.94	27.36
Speed-running $\geq 30$ m (no.)	9.50 ± 1.25	45.66	6.50 ± 0.93	49.74	4.75 ± 0.75	54.70
Speed-running $\geq 50$ m (no.)	12.50 ± 0.88	24.48	13.00 ± 0.88	23.42	11.83 ± 0.88	25.69
Basic gestures (no.)	31.50 ± 2.01	22.14	33.67 ± 1.51	15.53	32.17 ± 1.12	12.06

**Note:**  $\bar{X}$  = arithmetic mean; m = mean error; CV = coefficient of variation; n = 12 matches for each competition

The data in Table 2 show that the activity of the assistant referee is characterised by an effort profile distinct from that of the referee, determined mainly by the need to maintain permanent alignment with the phase of play and to control the touchline. Overall, the total number of speed-running sequences is lower than in the case of the referee, yet their internal distribution reveals an important share of long-distance movements, which confirms

the specificity of this role.

From a comparative point of view, the Rugby World Cup 2023 records the highest mean total value of running sequences, with 59.42 ± 2.21 sequences per match, followed by the Rugby Europe Championship, with 52.42 ± 2.38, and the domestic championship, with 42.92 ± 2.69. This hierarchy suggests that, as the competitive level increases, the activity of the assistant referee becomes more

intense and more dynamic, in line with the higher tempo of the game and the greater frequency of rapid transitions.

A defining aspect of the assistant referee's activity is the relative stability of long-distance running. While for the  $\geq 10$  m,  $\geq 20$  m, and  $\geq 30$  m thresholds a progressive decrease in values can be observed from elite competition to domestic competition, the  $\geq 50$  m threshold maintains similar values across all three competitive contexts. This result

suggests that long-distance movements represent a structural requirement of the assistant referee's activity, imposed by the need to maintain alignment and to cover efficiently the lateral space of the phase.

For a clearer illustration of the differences between competitions, the comparative distribution of the main physical and gestural indicators specific to the assistant referee is presented in Figure 2.

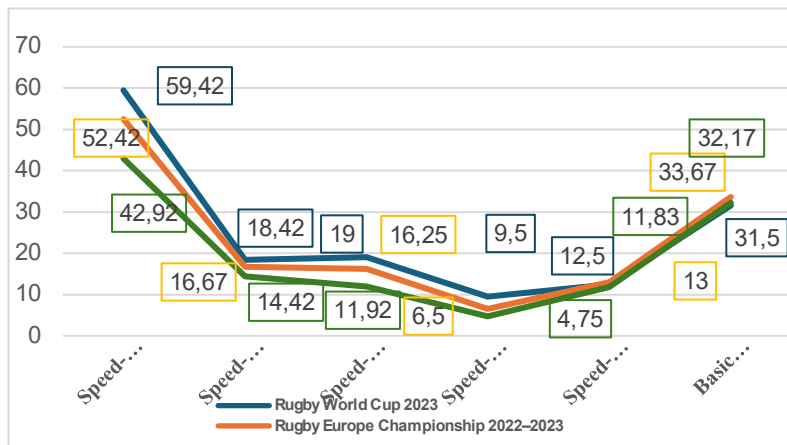


Fig. 2. *Physical and gestural profile of the assistant referee across the analysed competitions*

The gestural activity complements this picture through a relatively constant level across competitions. As can also be seen in Figure 2, the values of basic gestures remain within a narrow range, with small differences between the Rugby World Cup 2023, the Rugby Europe Championship, and the domestic championship. This constancy shows that the signalling activity of the assistant referee is more stable than the locomotor component and

preserves its functionality in all three analysed contexts. At the same time, the higher CV values at the  $\geq 20$  m and  $\geq 30$  m thresholds show that the intensity of certain movement sequences depends to a greater extent on the particularities of each match.

The results obtained show that physical activity in rugby officiating must be interpreted in direct relation to the actual demands of officiating. In all three

competitive contexts, the data highlight the link between movement, positioning, and the ability to maintain a favourable observation angle in relation to the decisive phases of the game. From this perspective, the recorded values reflect not only the volume of movement, but also the conditions under which the referee can sustain decision quality. This interpretation is consistent with the observations of Sant'Anna et al. [12], who highlighted the association between referee positioning and decision-making accuracy in rugby sevens.

The differences identified between the activity performed in the centre and that performed on the touchline reflect distinct demands within the same officiating role. The predominance of short- and medium-distance movement sequences in the referee indicates the importance of continuous repositioning for phase control, while the relatively stable frequency of long-distance running in the assistant referee suggests the role of maintaining alignment and controlling the lateral space. In this context, locomotor effort must be related to game dynamics, as also suggested by previous research on the systematic analysis of game actions in rugby [14].

At the same time, the results support the orientation of rugby referee training towards an integrated model, in which the physical and decision-making components are developed in a convergent manner. The frequency of repositioning, the need to maintain proximity to play, and the preservation of an effective observation angle show that locomotor effort has a direct role in supporting the observation, interpretation, and communication of refereeing interventions. In this respect, previous research on the integrated

preparation of rugby referees [6] supports the idea that physical development must be correlated with the maintenance of functional efficiency under conditions close to real game demands.

Overall, the research data argue for the need for an integrated preparation of the rugby referee, in which physical and decision-making development are permanently correlated, and training contents are adjusted according to the actual demands of competitive activity and the role performed during the match.

## 5. Conclusions

The comparative analysis of the physical activity of rugby referees highlighted different effort profiles according to the role performed during the match. The referee is required predominantly to perform repeated short- and medium-distance movements, whereas activity on the touchline is marked by the frequency of long-distance running and the stability of signalling.

The data obtained argue for the need for an integrated preparation of the rugby referee, in which physical and decision-making development are permanently correlated and adapted to the actual demands of competitive activity.

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