

Contextual factors affect match sprinting demands and effective playing time in Spanish professional football

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ABSTRACT: Sprinting demands are a key factor in football. While effective playing time seems to affect them, there is a lack of information related to contextual factors. The present study aimed to compare effective playing time according to the level of the opponent and competition division, and to compare sprinting distance and the number of sprints, accounting for effective playing time, in relation to contextual variables such as match location, match final outcome, and match difficulty across the First and Second Spanish Divisions. All matches from the 2021/22 season in the First ($n = 380$) and the Second ($n = 462$) Spanish Divisions were analysed. Two variables were used to determine the physical performance: the total distance covered at speeds above 24 km/h and the number of efforts made at speeds above 24 km/h relative to effective playing time ($m \cdot \min^{-1}$ and $\text{sprints} \cdot \min^{-1}$). Difficulty-4 matches (teams qualified 1st to 5th) exhibited higher effective playing time than all other difficulty levels in both the First ($p < 0.001$; $ES > 0.71$) and the Second Division ($p < 0.004$; $ES > 0.30$). The sprint demands showed a significant effect of difficulty ($p < 0.001$), with lower sprint activity recorded in level-4 matches, a significant effect of match outcome ($p < 0.001$), with winning teams performing a greater sprint activity and a significant effect of location ($p < 0.001$), with teams performing a greater sprint activity in home matches. Effective playing time and sprinting demands show variation according to when top-tier teams (1st to 5th) are involved. Finally, winning and playing at home may be related to slightly superior sprinting demands.

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INTRODUCTION

Football is a physically demanding and complex sport, involving intermittent high-intensity actions such as jumps, changes of direction, and sprints [1]. Over the past two decades, physical performance in competition has been widely examined through external load metrics, including total distance covered and distance across different speed ranges [2]. Several contextual factors—such as playing style, score, match location, and match difficulty—can influence these distance-based performance indicators in different ways [3]. Moreover, evidence suggests that variables associated with high-intensity external load have increased in professional football during the last decade in the Spanish and English Premier League [4, 5]. In this regard, it is suggested that running demands are closely related to team's competitive level, as top-class players from an elite Italian First-Division team covered greater distances at high-speed during than moderate-class players from a Danish team [6]. Thus, understanding contextual variables and team classification may help sport scientists and coaches to design the most appropriate drills to cover their team's demands.

Sprint distance is a key high-speed running variable, as many goals and decisive actions are preceded by sprinting [7]. Its relevance is further supported by a ~50% increase over the past 15 years in both the Spanish and English Premier League and the higher injury risk associated with increased cumulative sprint distance [8, 9]. As a result, maintaining sprint capacity is considered essential for professional football performance [10]. Beyond quantifying how much players run during matches, it is also necessary to understand how they run, particularly the frequency of sprint actions, to obtain a complete and actionable picture of high-intensity external load. On the other hand, although the number of sprints performed during a match has been examined as an indicator of players' external load according to their specific positional roles [11], this variable has received limited attention from researchers. Nevertheless, despite the limited available evidence, it is known that the number of sprints performed may be associated with match importance, as higher sprint counts were observed in the later rounds of the 2014 FIFA

World Cup [10]. Contextual variables such as match location, opponent level, and match outcome can influence players' sprinting external load during competition [12–14]. In this regard, teams competing in the Spanish First Division have been shown to cover greater sprinting distances when playing at home compared to away matches [12]. Additionally, match difficulty affects sprint distance, since First-Division teams covered greater sprint distances when facing high-ranked opponents in the English Premier League [15]. However, it remains unclear whether this response in sprint running distance is consistent across all team levels or competitive divisions (i.e., First vs. Second Division).

Effective playing time is a key variable that clearly distinguishes not only the level of the team between divisions but also the performance level of teams within the same competition division. It is defined as the total match duration after subtracting periods when the ball is out of play (e.g., substitutions, goals, fouls, or injuries) [16]. In this regard, it has been observed that matches between higher-level teams present greater effective playing time compared to those involving lower-level teams [16]. Specifically, some teams tend to exhibit longer stoppages when leading the score, aiming to slow down the game's pace and preserve their advantage until the end of the match [17]. A recent and novel study showed that, when effective playing time is considered, sprinting distance appears to be similar between teams from the Spanish First and Second Divisions [16]. However, it is essential to note that this study classified First Division teams into distinct performance levels, whereas it grouped all Second Division teams into a single division. The absence of a performance-based categorization for Second Division teams limits the interpretability of the findings. Specifically, it constrains the ability to determine whether the differences in effective playing time identified in the First Division manifest similarly in the Second Division as a function of team performance level.

Most evidence on effective playing time and sprinting activity comes from top-tier leagues, where contextual factors clearly influence match dynamics. However, it is uncertain whether these relationships operate similarly in the Second Division, where teams generally present lower technical–tactical proficiency. These differences may alter game flow, ball continuity, and sprinting demands, with these variables being affected differently from what is observed in the First Division. Clarifying this linkage is therefore essential to justify the comparative approach and to interpret performance patterns appropriately across competitive levels. Given that effective playing time is not considered in many studies, which typically rely on absolute sprint values or metrics relative to total match duration, despite evidence suggesting that effective playing time offers a more accurate representation of sprint activity, it is important to integrate this parameter into match-demand analyses. Therefore, the aims of the present study were: (1) to compare effective playing time according to the level of the opponent and competition division, and (2) to compare sprinting distance and the number of sprints, accounting for effective playing time, in relation to contextual variables such as

match location, match final outcome, and match difficulty across the First and Second Spanish Divisions.

MATERIALS AND METHODS

Participants/sample

All matches from the 2021/22 season in First ($n = 380$) and Second ($n = 462$) Divisions were analysed. Two observations were made for each match, one per team. A total of 1394 observations were included across First and Second Divisions. Playoff matches for promotion from the Second to the First Division were not included in the analysis. One hundred ninety-one observations were excluded because they contained at least one red card for one of the two teams before the 90th minute of the match. If the red card was issued after the 90th minute, the observation was included for both teams. Five observations were excluded due to a technical failure of the data collection system.

The use of this data was authorized by La Liga (Spain), and in accordance with its ethical guidelines, no information that could identify the players involved was included. The study was conducted in accordance with the principles of the Declaration of Helsinki. It was approved by the Ethics Committee of the [blinded for peer-review].

Procedures

All external load variables included in this study were provided by the Mediacoach System (*Mediapro & LaLiga, Madrid, Spain*), which consists of eight Super 4K High Dynamic Range cameras based on a TRACAB positioning system (*ChryronHego VID, New York, NY, USA*) [18]. This system records X and Y positions for each player from different angles, providing real-time three-dimensional tracking (acquisition frequency = 25 Hz). The validity and reliability of the Mediacoach® system have been previously studied [19]. The generated reports were exported to Microsoft Office Excel (Microsoft Corporation, Washington, USA), creating a data matrix for later analysis.

Two variables were used to determine the physical performance: the total distance covered at speeds above 24 km/h (sprint distance) and the number of efforts made at speeds above 24 km/h (number of sprints). These variables were calculated based on effective playing time and normalized to meters and effort per unit of time ($m \cdot \text{min}^{-1}$ and $\text{sprints} \cdot \text{min}^{-1}$). Effective playing time refers to the time the ball is in play, which corresponds to the duration of the match minus time lost during play (stops, substitutions, goals, or injuries) [20]. These variables were presented as totals per team, including all players who participated in the match (starters and substitutes). Mediacoach® detected effective playing time using a sophisticated multi-camera optical tracking system and advanced artificial intelligence and machine learning algorithms. It processed the data to automatically identify when the ball is “in play” and when the action stops. Interruptions in play (fouls, throw-ins, corner kicks, goals, substitutions, etc.) were detected with pinpoint accuracy. The system calculated the total time of a match and automatically subtracts the duration of all these interruptions to determine the effective playing

time during which the ball was in motion and the action was actively taking place.

To determine the team division, the total sample was divided into First Division teams ($n = 20$) and Second Division teams ($n = 22$). The qualifying position obtained by each team at the end of the season was used to group them into four groups in the First Division (group 1 – from 1st to fifth ranked; group 2 – from 6th to 10th ranked; group 3 – from 11th to 15th ranked; and group 4 – from 16th to 20th ranked) and four groups in the Second Division (group 1 – from 1st to sixth ranked; group 2 – from 7th to 11th ranked; group 3 – from 12th to 16th ranked; and group 4 – from 17th to 22nd ranked). Based on each team's league ranking, the opponent's difficulty level was established: difficulty 1, when a team faced an opponent from league group 4, difficulty 2, when a team faced an opponent from league group 3, difficulty 3, when a team faced an opponent from league group 2, and difficulty 4, when a team faced an opponent from league group 1. Whether the match was played at home or away was also included in the data collection matrix. Finally, one variable related to the outcome was recorded. As such, the result, with two possible options: win or loss.

Statistical analysis

Given the hierarchical and longitudinal nature of the data, with repeated observations nested within teams, linear mixed-effects models were used to analyse the data. This approach allows for the appropriate handling of non-independence of observations and intra-team variability. Separate models were fitted for each dependent variable: relative playing time, sprint distance, and number of sprints. In all models, team was included as a random intercept to account for clustering of observations within teams. Random slopes were initially explored; however, they did not improve model fit and were therefore not retained in the final models. In the first set of models, division (First vs. Second) and match difficulty (ranging from 4 = "very difficult" to 1 = "easy") were included as fixed effects. In subsequent models, match location (Home vs. Away) and match final outcome (Win vs. Loss) were analyzed together with division as fixed effects. Potential interactions between fixed effects were tested. Model selection was conducted using likelihood ratio tests and information criteria to ensure the most parsimonious model. Statistical significance was set at $p < .05$. In the case of statistically significant fixed effects, post-hoc comparisons were performed using estimated marginal means, with Bonferroni adjustment for multiple comparisons. We examined the relationship between sprint metrics and effective playing time using Pearson's coefficients (r). The correlation values were qualitatively interpreted as follows: < 0.1 (trivial); ≥ 0.1 (small), ≥ 0.3 (moderate), ≥ 0.5 (large), ≥ 0.7 (very large) and ≥ 0.9 (nearly perfect) [21]. Finally, Cohen's d effect size was calculated and interpreted as follows: ≤ 0.2 (trivial), > 0.2 (small), > 0.5 (moderate), and > 0.8 (large) [21]. Statistical analyses were performed using JASP software (JASP Team 2019, Version 0.11.1, University of Amsterdam).

RESULTS

Effective playing time according to match difficulty and division.

Regarding effective playing time in relation to division and match difficulty, we found a significant division \times difficulty interaction ($p < 0.001$), with higher effective playing times in the First Division ($p = 0.040$), and higher effective playing times in level-4 difficulty matches ($p < 0.001$). Difficulty-4 matches exhibited higher effective playing time than all other difficulty levels in both the first ($p < 0.001$; $ES > 0.71$) and the Second Division ($p < 0.004$; $ES > 0.30$). Level-1 matches in the First Division showed lower effective playing time than all other difficulty levels ($p < 0.003$; $ES > 0.34$).

No correlation was found between effective playing time and sprint distance or the number of sprints in the First Division. In the Second Division, however, there was a significant correlation between effective playing time and sprint distance ($p = 0.011$; $r = 0.09$), as well as between effective playing time and the number of sprints ($p < 0.001$; $r = 0.12$).

Sprinting according to match difficulty and division.

Regarding sprint distance, we found a significant division \times difficulty interaction ($p = 0.002$). Lower sprint distances were recorded in level-4 matches ($p < 0.001$). Sprint distance was similar in both divisions ($p = 0.313$). In the First Division, level-4 matches showed

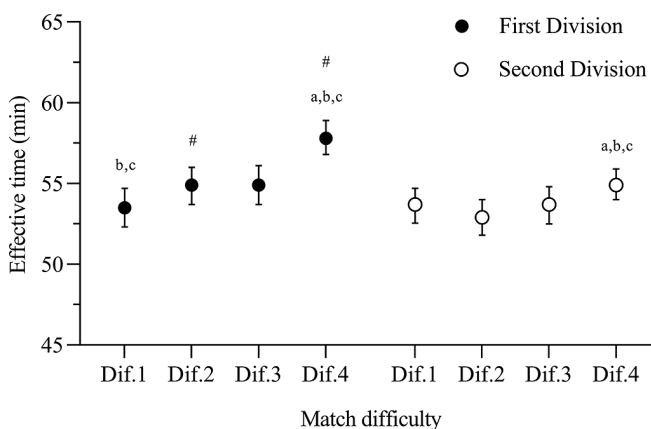


FIG. 1. Data are presented as estimated marginal means with 95% CI per match as a function of category and match difficulty level, where level 4 represents the highest difficulty and level 1 the lowest, including all matches from the 2021/22 season in the First ($n = 380$) and Second ($n = 462$) Divisions. Superscripts indicate significant differences ($p < 0.05$) with other divisions and match difficulty levels. Diff: Difficulty; a: significant differences with difficulty-1 matches within the same division; b: significant differences with difficulty-2 matches within the same division; c: significant differences with difficulty-3 matches within the same division; d: significant differences with difficulty-4 matches within the same division; #: significant differences with matches of the same difficulty in the Second Division.

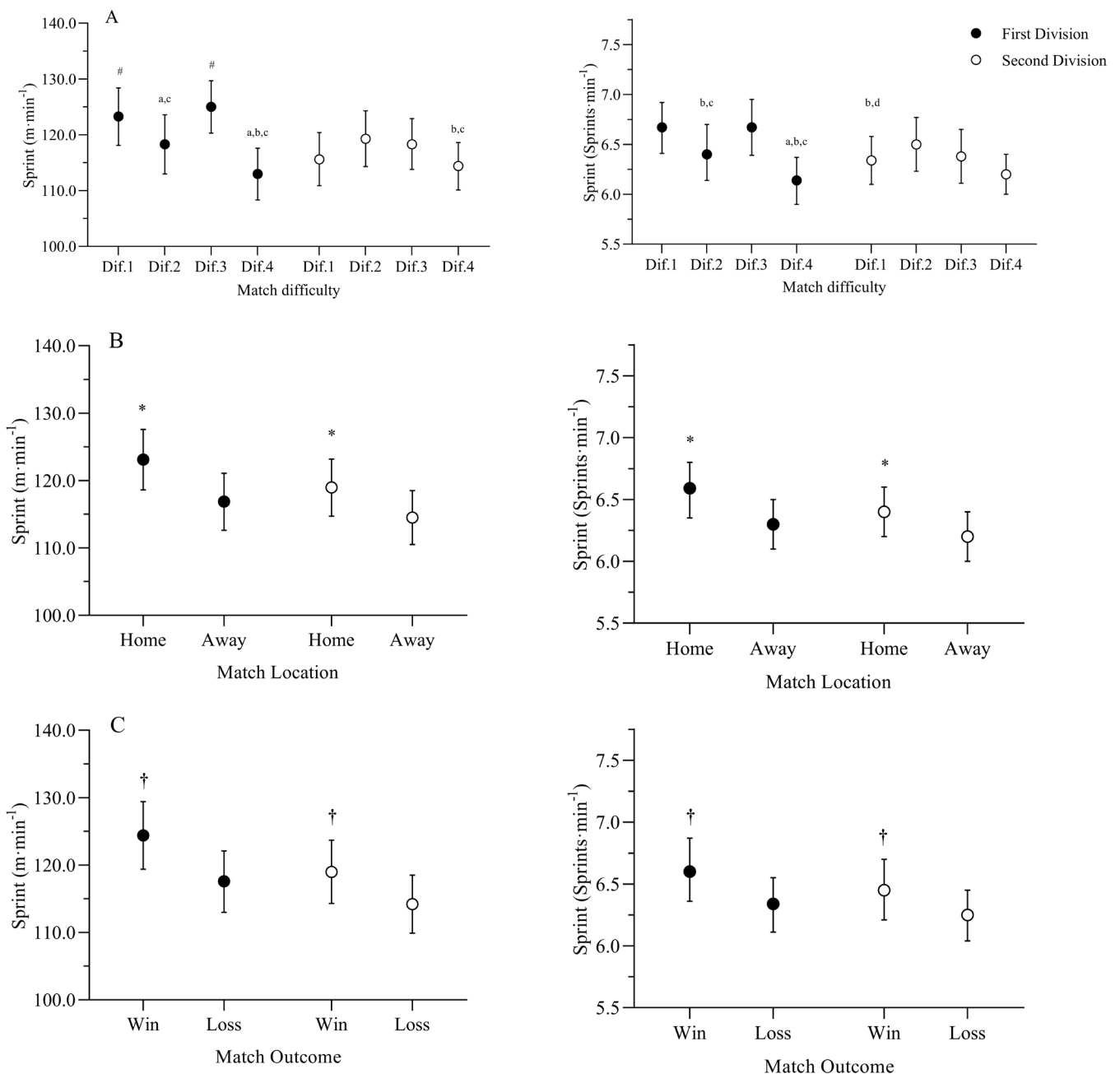


FIG. 2. Data are presented as estimated marginal means with 95% CI for distance covered at speeds > 24 km/h and the number of sprints relative to match time, as a function of division and (a) match difficulty, (b) match location, and (c) final match outcome, including all matches from the 2021/22 season in the First ($n = 380$) and Second ($n = 462$) Divisions. The figures in the left column represent the total distance covered at > 24 km/h, adjusted for effective playing time. The figures in the right column represent the number of sprints, also adjusted for effective playing time. Superscripts indicate significant differences ($p < 0.05$). Diff: Difficulty; a: significant differences with difficulty-1 matches within the same division; b: significant differences with difficulty-2 matches within the same division; c: significant differences with difficulty-3 matches within the same division; d: significant differences with difficulty-4 matches within the same division; #: significant differences with matches of the same difficulty in the Second Division; *: significant differences with away matches within the same division; †: significant differences with losing matches within the same division.

lower sprint distances than all other difficulty levels ($p < 0.020$; $ES > 0.27$). Level-2 matches also exhibited reduced sprint distances compared with level-1 and level-3 matches ($p < 0.026$; $ES > 0.25$). In the Second Division, sprint distance was lower in level-4 matches compared with level-2 and level-3 matches ($p < 0.048$; $ES > 0.20$). The number of sprints showed a significant division \times difficulty interaction ($p < 0.001$). Regarding the number of sprints, fewer sprints were performed in level-4 matches ($p < 0.001$), with no differences observed between divisions ($p = 0.582$). In the First Division, level-4 matches showed a lower number of sprints than all other difficulty levels ($p < 0.017$; $ES > 0.28$). Level-2 matches displayed fewer sprints than level-1 and level-3 matches ($p < 0.003$; $ES > 0.25$). In the Second Division, the number of sprints was higher in level-2 matches than in level-1 and level-4 matches ($p < 0.041$; $ES > 0.21$).

Sprinting according to match location and division.

Sprint distance was significantly higher when teams played at home ($p < 0.001$). Regardless of the division, sprint distance was higher when teams played at home ($p < 0.002$; $ES > 0.22$). Similarly, the number of sprints was significantly higher when teams played at home ($p < 0.001$), with teams performing a higher number of sprints in home matches ($p < 0.009$; $ES > 0.20$), regardless of the competitive division.

Sprinting according to the match final score and division.

The sprint distance showed a significant effect of outcome ($p < 0.001$), with winning teams covering greater distances. Winning teams accumulated more sprint distance ($p < 0.006$; $ES > 0.24$), regardless of the division. The number of sprints showed a significant effect of outcome ($p < 0.001$), with winning teams performing a higher number of sprints ($p < 0.011$; $ES > 0.23$), irrespective of the division.

DISCUSSION

The aims of the study were twofold: (1) to compare effective playing time according to the level of the opponent and competition division, and (2) to compare sprinting distance and the number of sprints, accounting for effective playing time, in relation to contextual variables such as match location, match final outcome, and match difficulty across the First and Second Spanish Divisions. The main findings of the study revealed that effective playing time was higher in the First Division compared to the Second Division, particularly when teams competed against level-4 opponents in the First Division. Regarding contextual variables, sprint-related metrics were slightly higher when teams won their matches and when they played at home, irrespective of whether they belonged to the First or Second division. Moreover, when playing at home, First-Division teams may cover greater sprint distances than Second-Division teams. Finally, sprint activity was associated with lower values when facing level-4 opponents.

Effective playing time is an often-overlooked factor that may distinguish teams across leagues and divisions when comparing

external load variables in soccer matches [16]. This study shows that First-Division teams achieve a greater effective playing time compared to Second-Division teams. Moreover, effective playing time is influenced by match difficulty (Figure 1). While effective time remains generally consistent across difficulty levels in the Second Division (except when playing against level-4 teams), level-4 First-Division effective time is significantly higher than in all other matches. These results reinforce the hypothesis that matches at the highest competitive levels are more fluid than lower-level ones [16]. These results may be explained by the substantially higher technical-tactical proficiency of top First-Division compared to the remaining First- and Second-Division teams, which likely enables a more continuous and less interrupted style of play [16].

Regarding sprint activity as a function of division and match difficulty, our results show that, when effective playing time is taken into account, sprint metrics are similar among the First and Second Divisions. Furthermore, match difficulty may influence high-speed metrics, as sprint activity may reflect lower values when match difficulty is highest in both divisions ($ES > 0.27$; Figure 2A) [15]. In line with our results, when sprint distance was normalized by effective playing time, no significant differences were observed between the First and Second Divisions [16]. Additionally, a previous study found that, in contrast to our results, sprint distance remains relatively unchanged regardless of match difficulty in the English Second Division. However, First-Division teams covered greater sprint distances when facing high-ranked opponents [15, 16, 22]. Besides, a previous study showed that very-high-speed running activity during matches is unrelated to the level of the opponent [15]. The discrepancies between these findings may be attributed to contextual factors, such as the minimum speed threshold used to define sprinting, comparisons with other European competitions, or the characteristics of the sample studied (e.g., data of a single team throughout the season vs. data from every team). Despite the slightly greater sprinting activity in level-4 matches, it is possible that lower-level teams, when facing top teams, may adopt a series of tactical strategies aimed at slowing down the game's pace and preserving their advantage until the end of the match [13, 17]. Moreover, although direct comparisons of our results regarding the number of sprints performed are not possible and evidence on this parameter is limited, the available study suggests that it may be influenced by factors such as match importance [10].

Contextual variables such as match location and match outcome may also influence players' sprinting distance during competition [12, 14]. In both divisions, sprint activity was slightly higher during home matches ($ES > 0.20$; Figure 2B). Match outcome also influenced sprint load, with teams performing a somewhat higher number of sprints and covering somewhat longer sprint distances when they won ($ES > 0.23$; Figure 2C). There is evidence supporting increased sprint activity when Spanish First-Division teams play at home compared to away matches [13]. Our findings suggest that a similar trend occurs in the Second Division. Factors proposed to

underlie this phenomenon include crowd effects, travel-related fatigue, familiarity with the playing environment, territoriality, and psychological influences [23]. Conversely, the literature suggests that winning teams may exhibit lower sprint activity [13, 14]. However, it is important to take two considerations into account: first, our results are based exclusively on sprint activity during effective playing time, whereas the two cited studies used absolute values or metrics relative to total match duration. Secondly, sprint demands are inherently position-dependent [13, 14], since central defenders tend to perform more sprints when losing while central midfielders, and forwards cover greater sprint distances when their team wins. Finally, comparisons with other studies regarding the number of sprints performed are limited. While this variable has been examined as an indicator of players' external load according to their specific positional roles [4], it has received limited attention in the literature.

Several limitations can be considered. Firstly, the current data may only apply to Spanish football players, as each league exhibits distinct external load characteristics. Secondly, multiple variables concurrently interact and can have a global impact on sprinting responses. However, the current study analyses each variable separately, which can limit understanding of the combined effects. For example, while we assess the sprinting distance based on the game's result, the opponent's level, or match location, we do not consider the interaction between variables. Thirdly, we did not assess those moments running above 24 km/h, comparing with and without the ball. It would be interesting to evaluate in further studies. Furthermore, there is no positional analysis, team-level clustering, non-independence of observations or use of absolute sprint

thresholds. Finally, sprinting variables per team may distort load interpretation. Reporting the sprint distance and number of sprints as totals for the entire team (including substitutes) introduces potential bias because substitution patterns differ between teams and divisions.

CONCLUSIONS

Effective playing time is greater in top-tier teams (1st to 5th) in the Spanish First Division compared to the rest of the teams. It is worth noting that sprinting metrics were normalized per minute of effective playing time. Furthermore, there may be tactical adjustments when competing against teams of the highest level (level 4), and it seems that the sprinting demands ($m \cdot \text{min}^{-1}$ and sprints $\cdot \text{min}^{-1}$) decrease. Finally, contextual variables may also affect the sprinting demands. Home games were associated with slightly greater sprinting distance covered in the First and Second Divisions. Winning First Division teams covered more sprint distance than Second Division teams regardless of match result.

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