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Impact of match-related contextual variables on weekly training load in a professional soccer team: a full season study

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ABSTRACT: The purpose of this study was to analyse the impact of match-related contextual variables (match location, match outcome and level of the opponent) on the weekly training load in a professional soccer team throughout a full competitive season. Total distance, high-speed running distance (HSRD, > 18 km·h^{-1}), high-metabolic load distance (HMLD, > 25.5 W·kg^{-1}), player load and total number of impacts (above 3 G) were collected from training and match sessions in professional soccer players (n = 25) competing in LaLiga123. Comparisons of external load parameters by each match-related contextual variable were examined using a mixed-effect model. Differences between playing positions were found for total distance ($p < 0.05$; $r = 0.11–0.15$), HSRD ($p < 0.05$; $r = 0.13–0.19$), HMLD ($p < 0.05$; $r = 0.12–0.19$), player load ($p < 0.05$; $r = 0.11–0.19$) and impacts ($p < 0.05$; $r = 0.15–0.26$). However, no significant interaction was observed between match-related contextual variables and playing position for any variable ($p > 0.05$). In addition, a significant impact of match outcome ($p < 0.05$; $r = 0.11–0.15$), opponent level ($p < 0.05$; $r = 0.11–0.17$) and match location ($p < 0.05$; $r = 0.14–0.20$) on the weekly training load (before and after the match) was observed. In conclusion, match-related contextual variables seem to slightly affect weekly external training load. Thus, coaching and medical departments could consider the influence of these contextual variables when prescribing the training load relative to the match demands.

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INTRODUCTION

Training load monitoring has become one of the most common practices in high-performance soccer [1, 2]. The main purpose of this monitoring process is to analyse how each player is coping with daily load and how the player is adapting to the training stimulus [3]. The availability of this information, which may be collected by electronic performance tracking systems among other methods [4–6], may assist coaching and medical staff to minimize the injury risk or overtraining, and maximize fitness, readiness and performance [7, 8].

In consequence, coaches consciously prescribe training load seeking a balance between loading the players for adaptation purposes and avoiding fatigue accumulation as match day approaches [3, 9, 10]. Thus, it is important to understand external training loads (i.e., workload performed by the player in training sessions) relative to match demands, specifically when attempting to optimize position-specific loads [9, 11]. In this regard, several studies, which provide a comprehensive insight into the load monitoring process, have reported seasonal training loads from a variety of professional soccer leagues [9, 12–14]. However, the implementation of training programmes at such high-performance level is difficult given the practical constraints which are related to the competitive calendar in professional soccer [15].

Previous investigations have also suggested that match-related contextual variables (e.g., match location, opponent level, match outcome, length of the microcycle) may have a confounding effect on training load interpretation [16–20]. For instance, it is of interest for strength and conditioning coaches to know whether the players experience different training demands during the week after losing the match compared to the week after winning [20]. In this regard, a recent study reported that weekly training load increased after losing a match, and before and after playing against a top-level team [17]. Therefore, these investigations recommend coaches to consider these contextual variables when prescribing weekly training load [16–18, 21].

Currently, only a few studies have analysed the impact of match-related contextual variables on weekly training load in professional soccer teams during short competitive periods [17, 19, 20], so a full-season study is necessary. Similar investigations have been carried out to date, which included internal (e.g., heart rate recordings and rating of perceived exertion, RPE) [16, 17, 19, 20] and external load [17–20] variables. However, there are no data available concerning the relationship between contextual variables and weekly training load relative to peak match demands (i.e., training demands relative to match day). These considerations for quantifying training loads based on match demands may be a coaching strategy in the periodization training models [9]. Hence, this study aimed to analyse the impact of match-related contextual variables (match location, match outcome and level of the opponent) on the weekly training load in a professional soccer team throughout a full competitive season.

MATERIALS AND METHODS

Study design

A longitudinal study was designed to collect data from training and match sessions throughout the 2018/2019 competitive season of a Spanish professional soccer team in LaLiga123. The league consisted of a total of 42 matches (home, $n = 21$; away, $n = 21$) and the team started the matches with a standard 1–4–4–2 formation. However, this playing formation could vary depending on situational variables. For all external load variables, the maximum values registered by each player on match days were considered for the calculation of relative training load through the following formula: (training session external load / competitive-match external load) × 100 [9]. Thus, whereas match data were used to relativize training data, inferences were computed on training data only.

Since the length of the microcycle continually varied over the season from 5 to 9 days based on the league calendar, the seven-day length of the microcycle was selected given the greatest number of cases ($n = 879$). This also implies that microcycles which contained national cup (*Copa del Rey*) matches were not included in the analysis to avoid calendar congestion effects [22]. It has been suggested that at least 80 individual recordings are needed to remove the inter-individual variability in observational studies [23]. Our study included 879 individual files. Then, the players' training load was quantified weekly. Every training session was classified based on match-related contextual variables, which included: last match outcome, opponent level and match location, and next match outcome, opponent level and match location (Figure 1). Match location was defined as home or away. The opponent level was categorized as: a) top, from first to sixth position; b) medium, from seventh to fourteenth position; and c) bottom, from fifteenth to twenty-second position considering weekly ranking. Match outcome was defined as win, draw and loss.

Participants

Twenty-five professional soccer players (age: 26.1 ± 3.8 years; height: 1.8 ± 0.1 m; body mass: 75.5 ± 6.7 kg) participated in the study. The club provided consent to conduct the research and therefore anonymously use the data by ensuring anonymity and confidentiality of the participants once the season had finished. Only players who met the following inclusion criteria were considered for the study: i) each player had to complete a minimum of one microcycle (i.e., training days from a seven-day microcycle) from the competitive season; and, ii) each player had to complete at least one full match in order to calculate the relative training load and the effect of contextual variables. Players undergoing any rehabilitation process and goalkeepers were excluded from this study given the different nature of training and match demands profile [24, 25]. This study was designed and conducted in line with the Ethical Standards in Sports and Exercise Science Research [26]. In addition, it was approved by the Bioethics Committee at the University of Almeria (UALBIO2020/032).

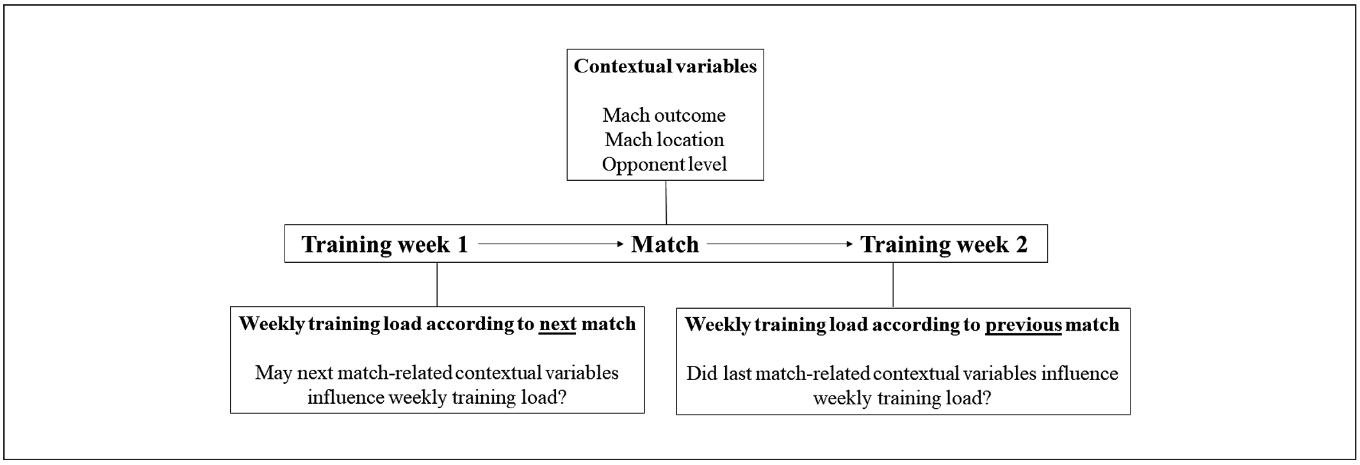

FIG. 1. Sample weekly structure for interpretation of the impact of match-related contextual variables on weekly training load.

Procedures

WIMU Pro (RealTrack Systems, Almeria, Spain) was the electronic performance tracking system used to collect the external load variables. These systems registered positioning-derived variables through the Global Positioning System (GPS) and inertial variables through four 3D accelerometers, three 3D gyroscopes, a 3D magnetometer, and a barometer. The validity and reliability of WIMU Pro for measuring soccer-specific external load variables have been successfully tested by previous investigations [27–29]. Based on previous studies [21, 28, 30], the sampling frequency of the units was set at 10 Hz for the GPS and 100 Hz for the inertial sensors. According to the manufacturer's instructions (RealTrack Systems, Almeria, Spain), the units had to be calibrated at the beginning of each data collection session. Therefore, the units had to be turned on and placed on a flat surface within the Smart Station (RealTrack Systems, Almeria, Spain) for 30 seconds. Then, the units started to record data and were vertically placed in the back pocket of a chest vest (Rasán, Valencia, Spain). The players wore always the same device in order to avoid inter-unit error [17]. Once the training or match session had finished, the data were transferred to SPro software for analysis (RealTrack Systems, Almeria, Spain) by activating "PC mode" on the Smart Station. This software provided a specific report which was stored on WIMU Cloud (RealTrack Systems, Almeria, Spain). Finally, full-season data were downloaded from the WIMU Cloud in order to run the statistical analysis.

Variables

Five external load variables were collected from training and competitive matches: total distance covered, high-speed running distance (HSRD, above 18 km·h^{-1}), high metabolic load distance (HMLD, above 25.5 W·kg^{-1}), player load (calculated through the vector sum of accelerometry-derived measures from vertical, anterior-posterior and medial-lateral movements) and the total number of body impacts (collisions registered by the accelerometers with a magnitude above 3G) [9, 31–34]. External training load was reported as the mean volume of work during the training days from the microcycle (i.e., training periods which count from the first training day of the period to the following match) [13, 21]. Weekly external training load was reported as the relative percentage to match training load, considering the highest match value recorded for each player.

Statistical analysis

The Shapiro-Wilk test revealed that external training load data were normally distributed in all weeks for all variables ($p > 0.05$). Considering the longitudinal nature of this study (i.e., each player was measured repeatedly at several points in time), comparisons in external load parameters by each match-related contextual variable were examined using a mixed-effect model with restricted likelihood, taking into account missing data (e.g., injured players or reconditioning sessions) and that players took part in a different number of practice sessions [35]. Match-related contextual variables were set as fixed effects, the individual player was set as a random effect, and external load parameters were set as dependent variables. When a significant effect was found, pairwise comparisons were examined using a Bonferroni post-hoc test. To describe the magnitude of differences, the *t* statistics derived from the mixed model were converted to effect sizes' correlations (*r*) and associated 95% confidence intervals (95% CIs) [36]. Effect sizes were qualitatively interpreted

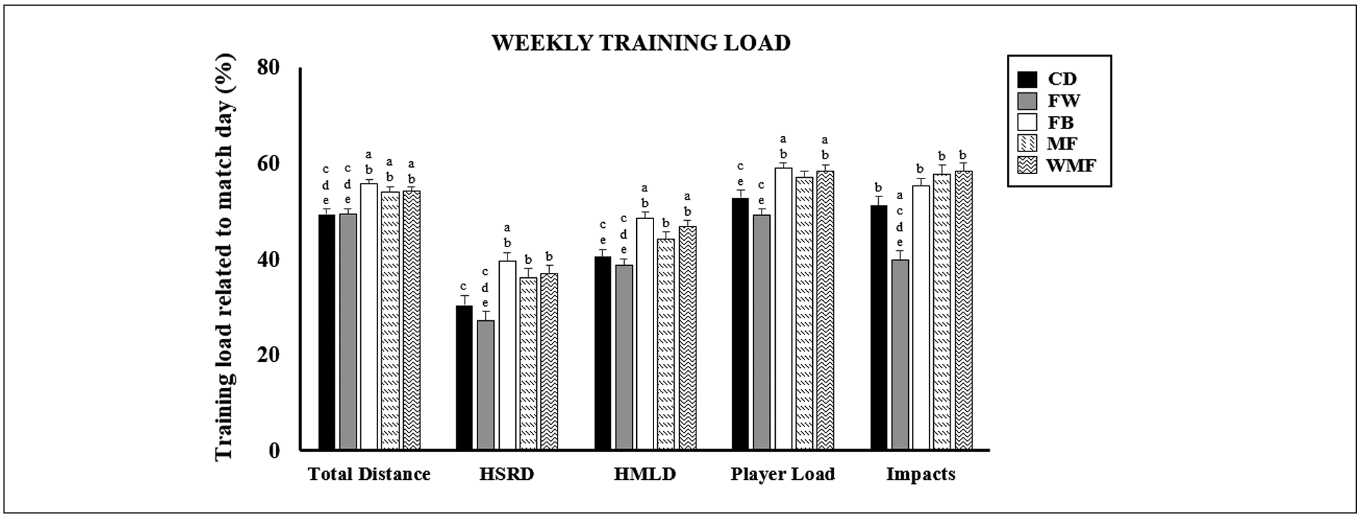

FIG. 2. Differences between playing position in the mean weekly training load of total distance, high-speed running distance (HSRD), high-metabolic load distance (HMLD), player load and impacts. [a]Significant differences compared to central defenders (CD); [b]Significant differences compared to forwards (FW); [c]Significant differences compared to full backs (FB); [d]Significant differences compared to midfielders (MF); [e]Significant differences compared to wide midfielders (WMF).

using the following criteria: trivial ($r \leq 0.1$), small ($r = 0.1–0.3$), moderate ($r = 0.3–0.5$), large ($r = 0.5–0.7$), very large ($r = 0.7–0.9$) and almost perfect ($r \geq 0.9$) [37, 38]. Descriptive statistics are presented as mean and 95% CIs unless otherwise stated. Statistical significance was set at $p < 0.05$. Data analyses were performed using SPSS software (IBM SPSS Statistics for Windows, Version 25.0; IBM Corp., Armonk, NY).

RESULTS

Figure 2 shows descriptive statistics of the mean weekly training load of total distance, HSRD, HMLD, player load and impacts by playing position. Statistically significant differences between playing positions with a small effect size were found for total distance ($p < 0.05$; $r = 0.11–0.15$), HSRD ($p < 0.05$; $r = 0.13–0.19$), HMLD ($p < 0.05$; $r = 0.12–0.19$), player load ($p < 0.05$; $r = 0.11–0.19$) and impacts ($p < 0.05$; $r = 0.15–0.26$). In this regard, full backs (FB), wide midfielders (WMF), and midfielders (MF) showed greater total distance, HSRD, HMLD, player load and impacts than CD and FW during the training sessions.

Weekly training load by match outcome

Regarding match outcome, player load was significantly greater in the training weeks after winning (~4.5%; $p < 0.05$; $r = 0.11–0.13$). Also, the results showed a greater training load with a small effect as well during the training weeks after winning compared to the training weeks after losing for total distance (~4.4%; $p < 0.01$; $r = 0.13$) and HMLD covered (~4.1%; $p < 0.01$; $r = 0.10$). However, weekly training load was slightly greater for the training weeks before winning than before losing in total distance (~3.1%; $p = 0.02$; $r = 0.10$) and HSRD (~7.5%; $p < 0.01$; $r = 0.14$). In addition, no significant interaction was observed between match outcome and playing position for any variable ($p > 0.05$) (Figure 3).

Weekly training load by opponent level

Weekly training load of HSRD and impacts after playing against bottom-level teams were slightly greater than in weeks after playing top-level (mean difference: ~12.5%; $p < 0.01$; $r = 0.17$) or medium-level teams (mean difference: ~6.4%; $p < 0.01$; $r = 0.14$). However, the training weeks before playing against bottom-level teams showed the greatest total distance (~55.4%; $p < 0.01$; $r = 0.11–0.14$), impacts (~58.5%; $p < 0.01$; $r = 0.15–0.16$) and player load (~59.2%; $p < 0.01$; $r = 0.13–0.15$). In addition, slightly greater HSRD (mean difference: ~7.4%; $p < 0.01$; $r = 0.15$) and HMLD (mean difference: ~5.7%; $p < 0.01$; $r = 0.15$) were observed before playing bottom-level teams compared to medium-level teams. No significant interaction was observed between opponent level and playing position for any variable ($p > 0.05$) (Figure 4).

Weekly training load by match location

Regarding the effect of match location, there was no difference ($p > 0.05$) in weekly training load after playing at home or away. However, significantly higher values of total distance (mean difference: ~4.6%; $p < 0.01$; $r = 0.17$), impacts (mean difference: ~7.6%; $p < 0.01$; $r = 0.16$), player load (mean difference: ~7.1%; $p < 0.01$; $r = 0.20$) and HMLD (mean difference: ~4.5%; $p < 0.01$; $r = 0.14$) were observed in the training weeks before playing away, with a small effect size (Figure 5). In addition, no significant interaction was observed between match location and playing position for any variable ($p > 0.05$).

DISCUSSION

The purpose of this study was to analyse the impact of match-related contextual variables (match location, match outcome and level of the opponent) on the weekly training load during a full season study. The main finding of this study was that despite the positional differences observed in training load, match-related contextual variables (match outcome, opponent level and match location) had a significant effect on weekly training load before and after the match regardless of the playing position.

This study found that professional soccer players experienced positional differences in training load, which have also been reported in previous investigations [9, 19, 39, 40]. However, a further novel finding of this study was that the interaction between match-related contextual variables and playing position was not significant for any external training load variable. Although only four studies have investigated the impact of match-related contextual variables on weekly training load [16–19], our study adds evidence to the literature by concluding that match-related contextual variables had a significant impact on weekly training load independently of the playing position. In this regard, weekly tactical strategies, which depend on match characteristics, may explain these results. For example, coaches may decide to decrease the volume of tasks with high-intensity actions in order to have more time to prepare corner kicks because the upcoming team is good in these strategic actions. In consequence, the whole team is affected by a match-related contextual variable while playing position does not determine the training load.

Specifically, one of the match-related contextual variables which had an impact on training load was match outcome. Contrary to previous findings [16–19], which showed lower external and internal training load (e.g., distance covered, average speed, HSRD, RPE) in the training weeks after winning in comparison with losing or drawing, our study observed greater training load in training weeks after winning (e.g., total distance, high-metabolic load distance and player load). This finding suggests that despite the effect of match-related contextual variables on the training load, the coaching strategies applied by each team are different [17]. However, in our study training load (e.g., total distance and HSRD) was significantly greater when preparing for wins. This is in line with a recent investigation which reported that internal training load (i.e., session RPE) increased too [16]. Furthermore, a recent study also showed that the training load parameters were specifically greater the day before winning the match (i.e., MD-1) [20]. Nevertheless, future research should be conducted in

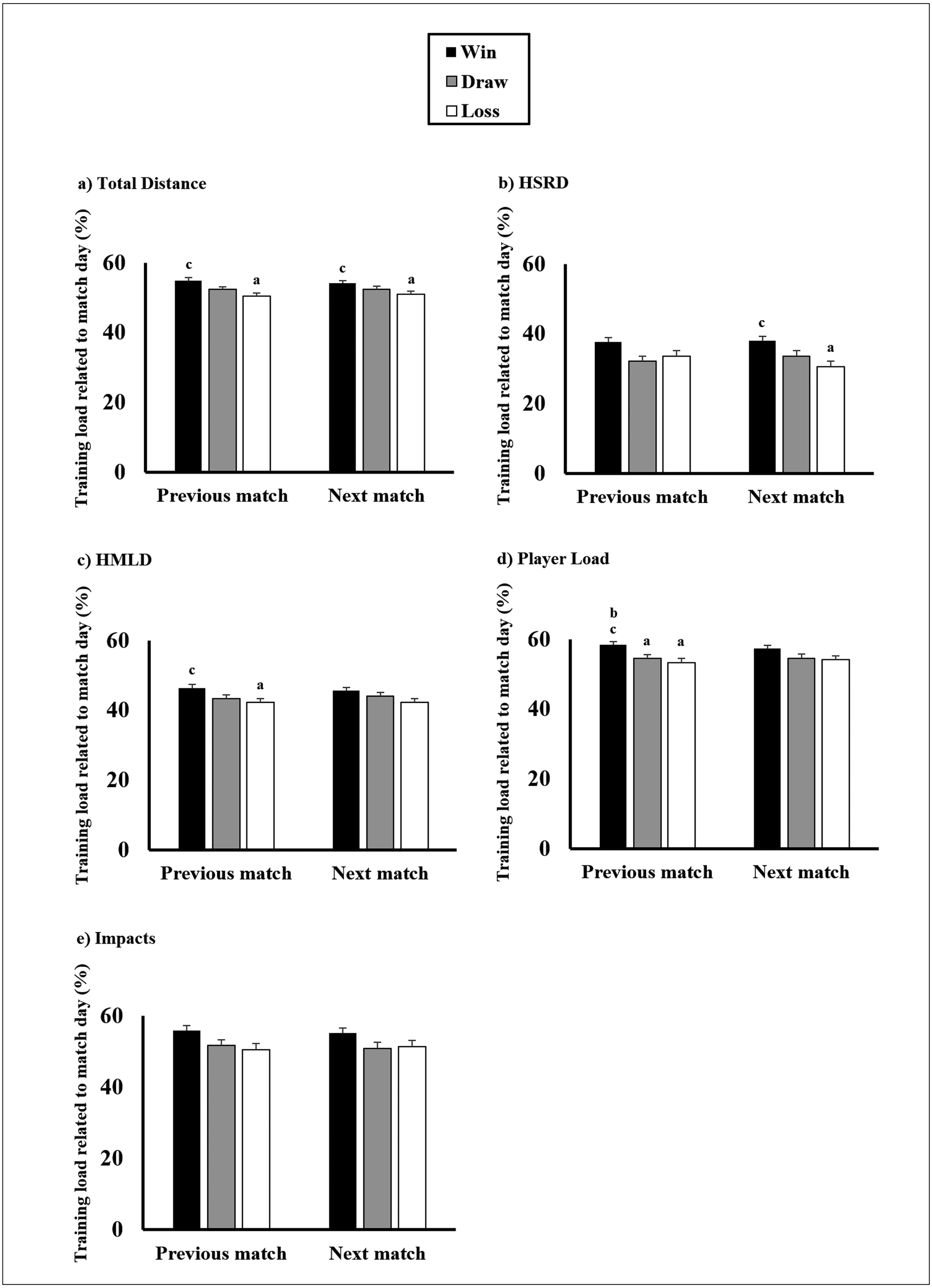

FIG. 3. Weekly training load according to match outcome (% of the match).

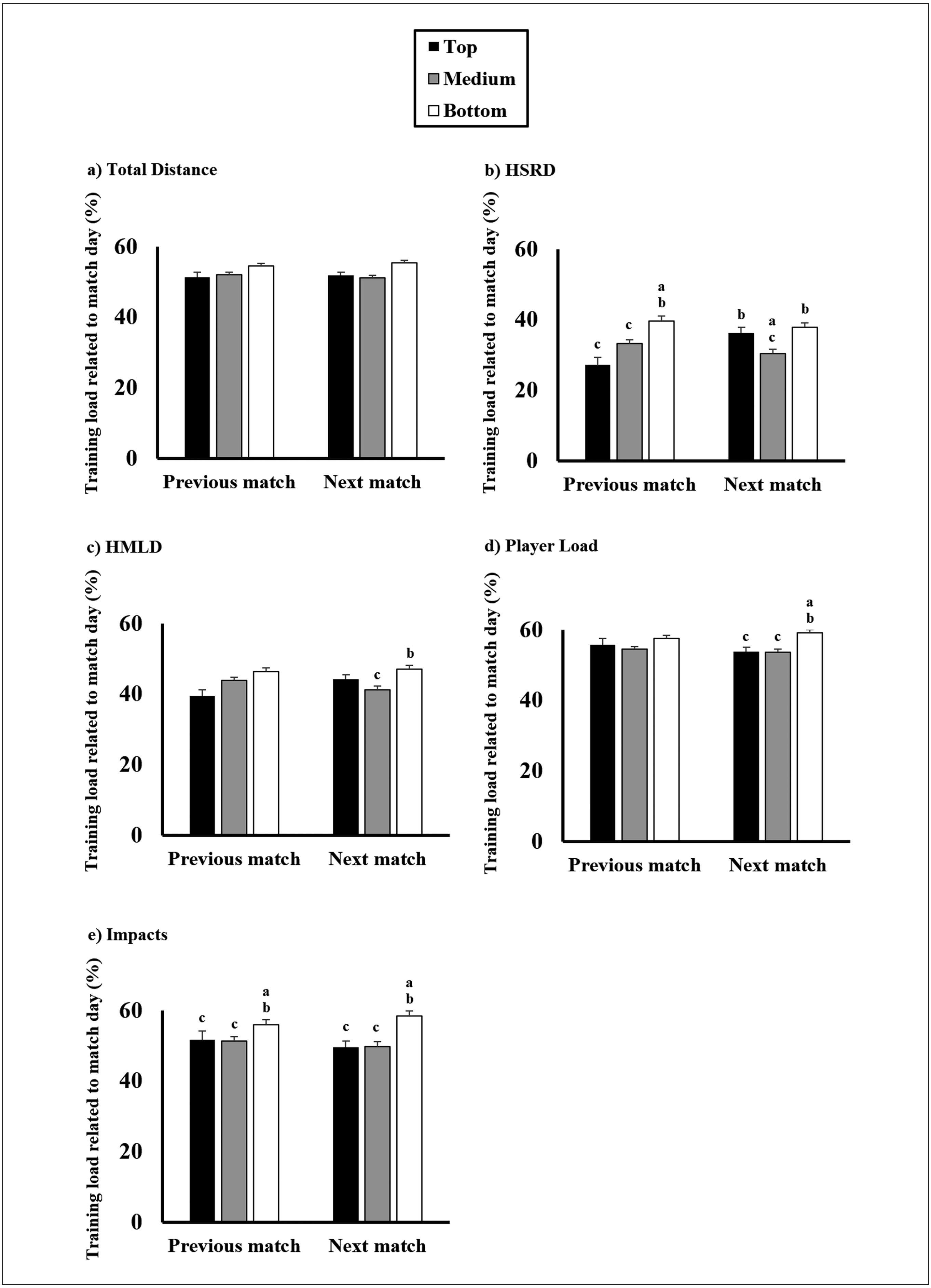

FIG. 4. Weekly training load according to opponent level (% of the match).

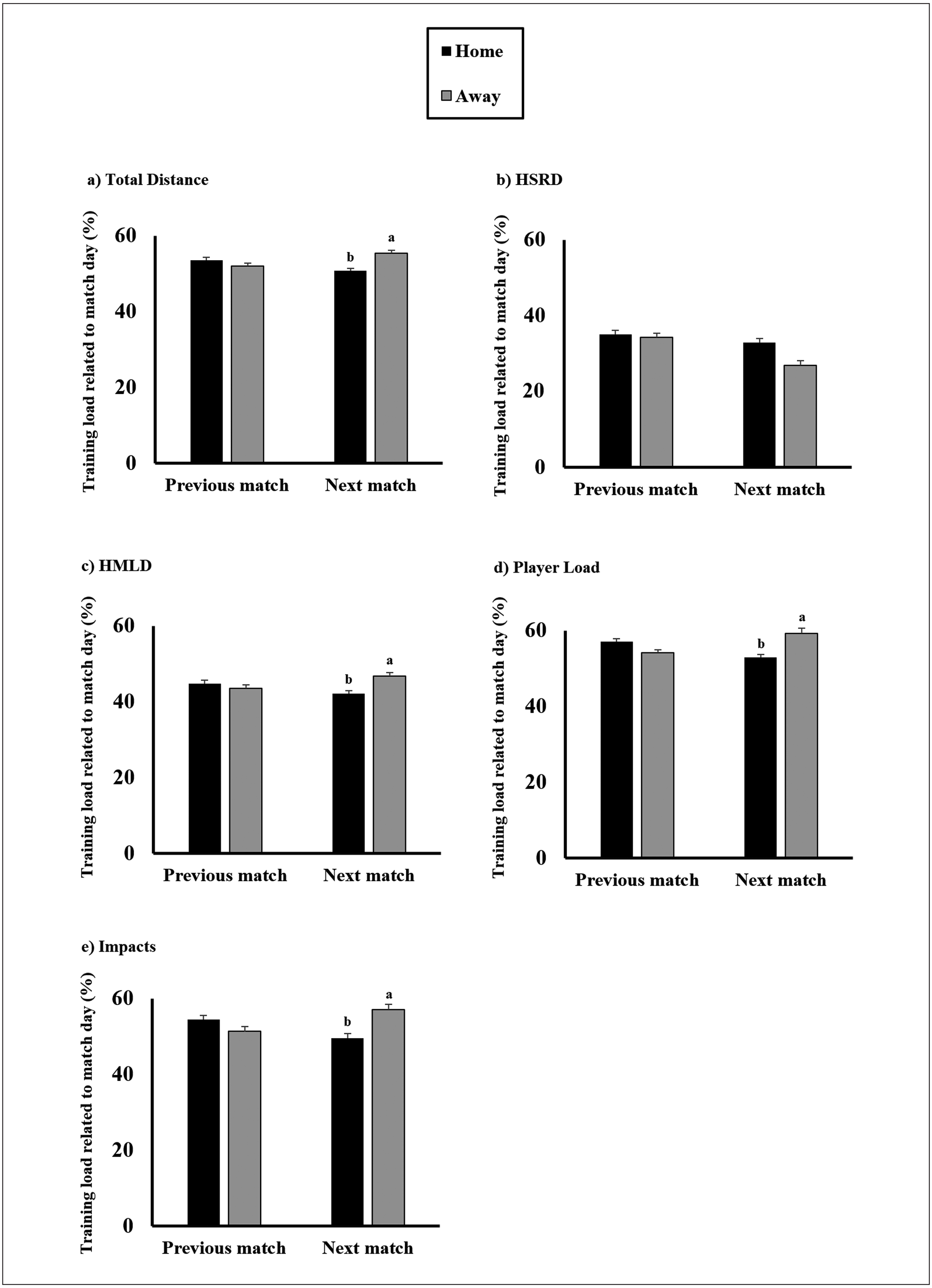

FIG. 5. Weekly training load according to match location (% of the match).

order to investigate the effect of match outcome on both external and internal training load in professional soccer.

A further novel finding was that weekly training load varied based on opponent level. The highest values of number of impacts and HSRD covered were observed after playing against bottom-level teams. Several studies concluded that playing against weaker teams resulted in lower high-intensity match demands (e.g., HSRD, high-intensity accelerations or decelerations) [41–44], which suggests that degree of neuromuscular fatigue may be lower too during the following week. Nevertheless, this may also be dependent on the training day [20]. Additionally, the results showed that volume-related training load variables such as total distance, impacts and player load were the greatest when preparing for bottom-level teams [45]. The team tactical behaviour in match play may explain these results since weaker teams require lower high pressure or direct style of play than top-level teams, which suggests that weaker teams keep players closer together by increasing the density of players per area [45]. However, it should be highlighted that our results are inconsistent with previous research on professional soccer players [17]. Although the same study also found an impact of this match-related contextual variable on weekly training load [17], the coaching strategies of each team may have been different regarding opponent level.

Finally, the results concerning the impact of match location on training load partly support the findings from a recent study [17, 19]. This study found that there were no significant changes in weekly training load (e.g., total distance, HSRD, mean heart rate, RPE) after playing home matches or away matches [17], which is in line with our results. Since there are studies which found that the overall match demands did not significantly vary based on match location [44, 46], these results may explain why the training load in the following week is not significantly affected [17]. However, the training load may be significantly influenced when preparing for the upcoming match [16, 17]. In this regard, our study found that training load increased the week before playing away matches. This may be a coaching strategy to prepare the players for the competitive demands since home teams tend to look for a dominant style of play (e.g., by increasing ball possession) [45, 47], which implies that the away team may need to maximize the physical output. This may not be the case for all the training days since a recent study showed that the players experienced lower external and internal training load before playing away compared to playing at home during MD-5 training sessions (i.e., five days before the match) [20]. Although these results did not replicate those previously reported in the literature, the conclusion is similar given the significant impact of match location on weekly training load [16, 17, 20].

However, several limitations need to be considered. For example, data were collected from one professional soccer team, so adding more teams to the analysis would be of interest to increase the power of the analysis. In this regard, although there were significant differences, the magnitude of the effect sizes was usually small, which implies that there may be additional contextual variables that should be considered [17]. Although a total of five external training load variables were included in the study, internal load variables were not included [16, 17]. Also, the mean weekly training load was scaled to the match demands, which implies that there is a lack of consideration for the specificity of each training day within the microcycle (e.g., higher loads are usually concentrated in the middle of the microcycle to prevent excessive loading immediately before the match) [16, 17]. In addition, some of the variables included in the study were collected by GPS and the limitations associated with this technology (e.g., satellite connection variability) need to be acknowledged [48]. Although most measurements from training and match days were taken in the same stadium, away matches implied different stadiums and geographical locations [49]. Nonetheless, the growth of local positioning systems for load monitoring purposes implies that future studies may include local positioning systems (e.g., ultrawideband technology) to improve the accuracy of the data during professional soccer matches [28].

CONCLUSIONS

Match-related contextual variables, which included match outcome, opponent level and match location, had an impact on the subsequent weekly training load. This study also found that professional soccer players experienced positional differences in training load, which have also been reported in previous investigations. However, the interaction between match-related contextual variables and playing position was not significant for any variable of the weekly training load. In consequence, strength and conditioning coaches need to consider match-related contextual variables when planning and prescribing the weekly training load. Gaining knowledge of external training loads relative to the match is important for applied practitioners, particularly when attempting to optimize individualized loads. In this regard, this study allows coaches to understand the weekly training load experienced by professional soccer players. Specifically, load quantification relative to the match may be an advantageous strategy to be used by coaches within the training periodization models. In addition, this full season study may serve as a source of data and comparison for future investigations on the effect of match-related contextual variables on the weekly training load.

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Conflict of Interest Disclosure

The authors declare no conflicts of interest.

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