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Integrated technical and tactical demands during peak match demands in soccer players

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Abstract

This study examined the integrated external, technical, and tactical demands of peak match demands (PMD) across playing positions in semi-professional soccer. External load for 20 players (Tier 2) was monitored across 10 matches using 10-Hz GNSS. PMDs for total distance (PMD_{TD} ; 1-min and 3-min rolling averages) were synchronized with video to analyze play phases, technical actions, and tactical outcomes. Results showed position-dependent external loads, with center backs exhibiting significantly lower total distance and high metabolic load distance. PMDs occurred most frequently during defensive organization (31–33%) and transitions. Large positional associations ($V=0.25$ – 0.42) were observed for tactical actions: center backs and central midfielders predominantly engaged in “pushing up the line” and “on-ball defense,” whereas wide midfielders and forwards performed more “runs-in-behind” and “breaking into the box.” Position-specific technical fingerprints (e.g., fullbacks' crosses, wide midfielders' tricks) were more prominent during the 3-min window. In conclusion, when identified via total distance (PMD_{TD}), PMD represents a peak in tactical responsibility rather than just locomotion. Practitioners should shift from generic physical replication toward integrated, position-specific drills that couple peak locomotor output with relevant technical-tactical requirements to better reflect the integrated reality of the most demanding match periods.

Key words: Football; Worst-case scenarios; External load; Performance, Contextual factors.

Introduction

Soccer is an acyclic team sport characterized by intermittent, multidimensional efforts, in which performance results from the interaction of physical, technical, tactical, and psychological components (Bradley, 2020). In recent years, modern styles of play, characterized by increased pressing intensity, faster ball circulation, and more frequent transitional phases, have led to a progressive intensification of the physical demands imposed on players (Barnes et al., 2014; García-Calvo et al., 2025). Consequently, there has been an increased focus on conditioning-based training approaches aimed at replicating match demands and preparing players to tolerate these heightened physical requirements (Riboli, 2022; Riboli et al., 2023). Several studies have proposed that training should be based on the demands of match play (Bradley & Noakes, 2013; Harper et al., 2019). However, recent studies have suggested that relying solely on average match data may underestimate the peak match demands (PMD) experienced during competition (Oliva-Lozano, Gómez-Carmona, et al., 2022; Rodríguez-Fernández et al., 2024), potentially limiting the effectiveness of training strategies. Specifically, these averages may obscure the peak match demands of a game, thereby limiting their value in informing accurate training prescriptions (Cunningham et al., 2018). Consequently, recent research has focused on identifying PMD, defined as brief periods that represent the most intense load occurring during a match (Oliva-Lozano et al., 2020), to design training tasks that better replicate match realities (Oliva-Lozano, Riboli, et al., 2023).

PMD analysis provides a more refined understanding of match intensity by capturing transient spikes in workload that are critical for performance (Oliva-Lozano, Riboli, et al., 2023). These periods are typically assessed through short rolling time windows (e.g., 1, 3, 5, or 10 min) using high-frequency Global Navigation Satellite System (GNSS) data, allowing the quantification of physical metrics such as total distance, high-speed running

distance, sprint distance, and the frequency of accelerations and decelerations (Oliva-Lozano et al., 2020; Rico-González et al., 2022). Importantly, peak demands identified through one metric do not necessarily coincide with peak demands derived from others, as total distance, high-speed running, accelerations, and metabolic power may reach their maxima during different time windows and match phases (Novak et al., 2021). This multivariable nature of PMD underscores the importance of specifying the metric used when interpreting peak periods, as each variable captures a distinct dimension of the physical stressor imposed on the player. Methodologically, the utilization of moving or rolling averages represents a critical refinement over traditional discrete fixed epochs; previous research has demonstrated that fixed-window analyses systematically underestimate peak match demands (Fereday et al., 2020). Notably, these demands are highly position-dependent, with midfielders and wide midfielders frequently exhibiting higher distances per minute (Martin-Garcia et al., 2018). In addition, other contextual variables—such as match status, team venue, or opposition quality—significantly influence peak demands across different positions (Rico-González et al., 2022; Romero-Rodríguez et al., 2024). Furthermore, a player's substitution status represents a critical contextual factor; while substitute players often achieve greater relative high-speed running distances per minute due to more aggressive pacing strategies, they consistently fail to replicate or supersede the PMD achieved by starting and full-match players (Sydney et al., 2023). Nonetheless, the conceptual validity of using PMD as a universal benchmark for training has been questioned, since these peak demands appear to be highly individualized, variable, and context-specific (Novak et al., 2021). While PMD research has expanded, to our knowledge, no studies have integrated the technical and tactical actions players perform during these periods, despite their importance in influencing match outcomes.

In line with the limited integration of technical and tactical actions within PMD research, this gap reflects a broader tendency to analyze physical outputs independently of their tactical determinants (Ade et al., 2016). Yet, peak physical demands tend to emerge as a consequence of specific tactical behaviors rather than isolated physiological events. For example, Caldbeck and Dos'Santos (Caldbeck & Dos'Santos, 2023) found that 58% of sprints occurred out of ball possession, with clear position-specific differences in sprint types and contexts. Similarly, Oliva-Lozano et al (Oliva-Lozano, Fortes, et al., 2022) reported that most sprints during match play are non-linear and occur out of ball possession, with distinct tactical purposes depending on the player's role (e.g., central defenders: interceptions; midfielders: recovery runs; fullbacks, wide midfielders, and forwards: running into space). These findings highlight the need to go beyond physical outputs when evaluating PMD and to integrate technical and tactical complexities into training planning. As Bradley & Ade (2018) argued, a combined approach—balancing physical, technical, and tactical metrics—offers a more holistic representation of soccer performance. However, current practice often treats these dimensions in isolation, limiting the ecological validity of performance profiling and reducing the transfer from training to match performance. Bridging this gap could enable practitioners to replicate not only the physical intensities of PMD but also the associated technical and tactical behaviours, thereby enhancing training specificity and efficacy.

Therefore, the aim of this study was to provide an integrated characterization of PMDs by simultaneously examining external load and the technical and tactical actions performed during these periods across playing positions. This novel approach seeks to redefine PMD as context-dependent scenarios rather than isolated physical peaks, offering a more meaningful framework for informing training design and “periodization” in elite football. The study hypothesized that player position would influence not only

locomotor outputs but also technical and tactical demands, as previously suggested (Ade et al., 2016; Caldbeck & Dos'Santos, 2023; Oliva-Lozano, Fortes, et al., 2022).

Material and Methods

Experimental design

Match data were collected from a semi-professional soccer team during the 2023–2024 season. Similarly to previous studies (Caldbeck & Dos'Santos, 2022, 2023), a total of ten official matches (5 home, 5 away) were analyzed. The selected matches resulted in five wins, three draws, and two losses, with the team scoring 13 goals and conceding eight. External demands were monitored using GNSS devices (10 Hz; accelerometer: 100 Hz; APEX, STATSports®, Northern Ireland), while all matches were simultaneously recorded using a fixed multi-angle video system (Veo Sports Camera®). The GNSS data were synchronized with the match video recordings to enable the contextual and tactical coding of player behavior. The team's formation during the analyzed matches was a 1-3-4-3 system in the offensive phase and a 1-4-4-2 system in the defensive phase, with contextual and individual tactical variability across matches. Importantly, specific contextual variables such as match status (winning, losing, or drawing), opponent quality, or match-by-match dynamic tactical adaptations were not controlled or included as independent factors in the core analysis. For each match, the external demands, technical, and tactical actions performed during the total-distance peak match demands (PMD_{TD}) were identified using rolling time windows of 1 and 3 min, following previous procedures (Oliva-Lozano, Martín-Fuentes, et al., 2021). Only players who played for at least 60 minutes were included in the analysis for each match. Goalkeepers were excluded from the analysis due to the distinct nature of their physical and tactical profiles. Prior to the data collection period, all players completed a 6-week preseason during which they

trained and competed using the same GNSS devices, ensuring full familiarity with the technology and procedures.

Participants

A total of 20 semi-professional male soccer players (age: 21.2 ± 1.4 years; height: 175.2 ± 10.3 cm; body mass: 73.2 ± 6.7 kg) participated in this study. Based on the performance and competition-level classification in Sports Science, participants were categorized as Tier 2 (Trained/Developmental) athletes (McKay et al., 2022). Players were categorized as center backs (CB), fullbacks (FB), central midfielders (CM), wide midfielders (WM), and central forwards (CF) (Ade et al., 2016; Caldbeck & Dos'Santos, 2023). Importantly, fullbacks and wide midfielders were strictly treated as independent positional roles rather than being grouped into a single generic flank-player category. Throughout the competitive period, players followed a training schedule of 4–5 field sessions and 2 strength training sessions per week, in addition to one official match. As players were semi-professionals and data collection was part of their routine performance monitoring, formal ethical approval was not required (Winter & Maughan, 2009). Nonetheless, the study was conducted in accordance with the principles outlined in the Declaration of Helsinki. In addition, the study was approved by the Ethics Committee of University of León (Code: ETICA-ULE-004-2021). All participants were informed about the aims of the study and provided written informed consent prior to participation. No personal or identifiable data were disclosed.

Defining Peak Match Demands

The PMDs were quantified using GNSS units (10 Hz GNSS; 100 Hz accelerometer; APEX, STATSports®, Northern Ireland). These tracking devices have demonstrated high levels of validity and reliability in previous research, with error rates below 5% for peak speed and total distance measurements (Beato et al., 2018), and have been employed in

prior studies for PMD determination (Thoseby et al., 2022). Prior to the start of each match, all GNSS units were powered on and calibrated in accordance with the manufacturer's guidelines. The devices were positioned on the upper back of each player, inserted into a custom vest provided by the manufacturer. Accelerometer-derived data such as high-intensity accelerations and decelerations possess higher inherent variability and inter-unit reliability limitations during intense multi-directional drills. To eliminate potential inter-unit variability, each player consistently wore the same GNSS device across all matches (Rodríguez-Fernández et al., 2023). After the match concluded, Raw GNSS positional data were processed using the manufacturer's proprietary software (Viper STATSports®, version 4.3.8), which applies an internal smoothing algorithm to the velocity-time signal prior to the calculation of derived metrics. No additional external filtering or smoothing was applied by the research team beyond the default parameters established by the manufacturer. The software employed a rolling average method to calculate and identify the PMD of each player in 1-min (PMD_{TD-1}) and 3-min (PMD_{TD-3}) windows. From this, the peak match demand for total distance covered (PMD_{TD}) was identified and selected for subsequent synchronization with video footage and for the integrated technical-tactical analysis. This choice was justified because TD offers the most stable and reliable metric to capture overall locomotor volume across all playing positions. It should be noted that the PMD periods identified in this study represent TD-driven peak scenarios and do not necessarily coincide with peak demands for other load dimensions such as high-speed running, accelerations, or metabolic power. The selection of TD as the criterion variable was further supported by its comparatively lower intra-individual variability relative to other candidate metrics (Novak et al., 2021). In addition to total distance (TD), high-speed running distance (HSD, $>5.83 \text{ m}\cdot\text{s}^{-1}$ / $>21 \text{ km}\cdot\text{h}^{-1}$), sprint distance (SPD, $>7.00 \text{ m}\cdot\text{s}^{-1}$ / $>25.2 \text{ km}\cdot\text{h}^{-1}$), high metabolic load distance (HMLD,

25.5 W·kg⁻¹), number of high-intensity accelerations (ACC, >3 m/s⁻²) and decelerations (DDC, >-3 m/s⁻²) were registered (Gualtieri et al., 2023; Martin-Garcia et al., 2018). Acceleration and deceleration events were defined using absolute thresholds. Additionally, Player Load (PL) was calculated as $\sqrt{((aca_{t=i+1} - aca_{t=i})^2 + (acl_{t=i+1} - acl_{t=i})^2 + (acv_{t=i+1} - acv_{t=i})^2)}$ as previously described (Bowen et al., 2017). All data corresponded to the total playing time, excluding the halftime interval. Finally, the data were exported into Microsoft Excel (Microsoft Corporation, USA) for additional calculations across all peak intensity periods.

Peak match demands, technical and tactical classification

To classify the tactical context associated with each PMD, the data extracted by the Viper software (Viper Statsports version 4.3.8) were first synchronized with time-stamped video footage of the corresponding match. Subsequently, two independent observers with expertise in sport science and prior experience in soccer performance analysis reviewed each PMD_{TD} sequence. These observers categorized the PMDs according to the “phase of play”, defined as the four main phases of play commonly described in soccer performance analysis (Caldbeck & Dos’Santos, 2023): (1) offensive transition, (2) offensive organization, (3) defensive transition, and (4) defensive organization. Each PMD_{TD} could include one or more of these phases, depending on the team’s ball possession and tactical context. In addition, each PMD_{TD} was further categorized based on its technical and tactical content (offensive and defensive) (Table 1), following the criteria established in previous literature (Ade et al., 2016; Bradley & Ade, 2018; Caldbeck & Dos’Santos, 2023). In cases of disagreement between the two observers, a third experienced member of the research group served as an arbitrator to determine the final classification. Observers were not blinded to player position, as positional information was necessary to apply the classification criteria consistently.

Table 1 near here

Statistical analysis

Linear mixed models were used to examine differences in each of the external metrics (TD, HSD, SPD, HMLD, ACC and DCC) in PMD_{TD} between playing positions. Separate models were constructed for each individual physical variable to avoid generic clustering. Player identity (Player_ID) was included as a random effect to account for repeated measures of individual players across matches, while playing position was included as a fixed factor. Estimated marginal means were calculated for each positional group, and subsequent Bonferroni-adjusted pairwise comparisons were conducted to identify significant differences between positions whenever the global F-statistic yielded significance. Adopting an exploratory approach, a series of Pearson's Chi-square (χ^2) tests were performed to examine the association between playing position and the frequency of occurrence of each game phase (offensive transition, offensive organization, defensive transition, and defensive organization) and offensive and defensive technical and tactical actions during the PMD_{TD} periods. A global Chi-square analysis was conducted using a single categorical variable representing the types of technical and tactical actions to determine whether the overall distribution of technical actions differed across playing positions. Subsequently, individual Chi-square tests were performed for each specific phase of play and each technical and tactical action to identify which actions showed significant positional differences. Each test compared the observed and expected frequencies across positional groups (positions). Whenever a Chi-square test yielded a significant global association, adjusted standardized residuals were calculated to identify which specific categories drove the differences. Adjusted residuals with an absolute value greater than 1.96 were considered statistically significant, indicating that the observed frequency was significantly higher or lower than expected by chance. Effect sizes for the

Chi-square tests were quantified using Cramer's V , interpreted as small ($V = 0.10$), medium ($V = 0.30$), or large ($V \geq 0.50$) effects (Cohen, 1988). All analyses were carried out using the Crosstabs procedure in IBM SPSS Statistics (version 25, IBM Corp., Armonk, NY, USA). For each test, Pearson's Chi-square value, degrees of freedom (df), and the asymptotic two-tailed significance level (p) were reported. The level of statistical significance was set at $p < 0.05$.

Results

External demands

Separate linear mixed models conducted for each physical metric revealed a significant main effect of playing position during the PMD_{TD-1} for TD ($F = 4.094, p = 0.006$), HSD ($F = 3.998, p = 0.022$), and HMLD ($F = 9.837, p < 0.001$). Specifically, pairwise comparisons for TD showed that CB covered significantly less distance than CM (mean difference = -24.39 m, 95% CI [-47.79, -0.92]) and WM (mean difference = -27.98 m, 95% CI [-50.11, -5.84]). For HSD, WM exhibited significantly greater outputs compared to CB (mean difference = 22.17 m, 95% CI [1.84, 42.51]). Regarding HMLD, CB recorded significantly lower values than CM (mean difference = -24.92 m, 95% CI [-43.06, -6.78]), WM (mean difference = -29.81 m, 95% CI [-47.03, -12.60]), and CF (mean difference = -18.71 m, 95% CI [-37.29, -0.14]). Conversely, no significant effects were observed for SPD ($F = 1.081, p = 0.381$), ACC ($F = 1.669, p = 0.181$), DCC ($F = 0.865, p = 0.496$), or PL ($F = 0.964, p = 0.449$). For the PMD_{TD-3} , the independent models showed significant positional effects were found for HSD ($F = 6.677, p = 0.002$) and HMLD ($F = 5.278, p = 0.003$), where post-hoc analyses indicated that WM maintained higher HSD outputs than CB (mean difference = 40.83 m, 95% CI [8.93, 72.74]) and FB (mean difference = 26.67 m, 95% CI [1.89, 51.45]), while CB displayed lower HMLD totals than WMs (mean difference = -49.95

m, 95% CI [-85.93, -13.97]). Whereas no significant differences were observed for TD ($F = 1.909, p = 0.134$), SPD ($F = 1.600, p = 0.188$), ACC ($F = 2.764, p = 0.059$), DCC ($F = 1.475, p = 0.230$), or PL ($F = 1.047, p = 0.385$) (Table 2).

Figure 1 near here

Table 2 near here

Phase of the game

A total of 641 periods were identified and analyzed for the phase of play variable (offensive transition: $n=201, 31.4\%$; defensive organization: $n=184, 28.7\%$; defensive transition: $n=173, 27.0\%$; offensive organization: $n=81, 12.6\%$) in PMD_{TD-1}. For PMD_{TD-3} 1431 periods were identified and analyzed (offensive transition: $n=327, 22.7\%$; defensive organization: $n=238, 16.6\%$; defensive transition: $n=399, 27.7\%$; offensive organization: $n=467, 32.5\%$). When evaluating the overall distribution of tactical behaviors across the entire match sample, independently of playing position, results showed that during the PMD_{TD-1} periods, the offensive transition phase represented 29.0% of all categorized game phases, the defensive transition accounted for 27.0%, the offensive organization comprised 12.8%, and the defensive organization constituted 31.2%. During the PMD_{TD-3} periods, the offensive transition accounted for 22.8% of the total phase observations, the defensive transition 27.8%, the offensive organization 16.8%, and the defensive organization 32.7%.

A global Pearson's Chi-square test revealed a significant association between playing position and the distribution of game phases during both PMD_{TD-1} ($\chi^2 (12) = 31.490, p = 0.002$, Cramer's $V = 0.128$, *small*) and PMD_{TD-3} ($\chi^2 (12) = 60.172, p < 0.001$, Cramer's $V = 0.118$, *small*) periods. In PMD_{TD-1}, CM (32.3%), CB (34.8%), and FB (33.7%) players were more involved in defensive transition and defensive organization. In

contrast, WM players had a higher proportion of offensive transition (32.4%). During PMD_{TD-3}, CB (38.8%) and CM (38.0%) players remained more engaged in defensive phases, while WM players again showed greater involvement in offensive transition (27.1%). CF players showed increased involvement in both offensive transition and defensive organization.

Individual Chi-square test results for each phase revealed significant positional effects. Specifically, significant positional differences were found for defensive transition during PMD_{TD-1} and for offensive transition, offensive organization, and defensive transition during PMD_{TD-3} (Table 3).

Table 3 near here

Technical actions

A total of 131 and 261 technical actions were successfully coded and analyzed during PMD_{TD-1} and PMD_{TD-3} respectively. A global Pearson's Chi-square test revealed a significant association between playing position and the frequency of technical actions during PMD_{TD-3} ($\chi^2 (28) = 62.709, p < 0.001$, Cramer's $V = 0.245$, *small*), with no association observed in PMD_{TD-1} ($\chi^2 (28) = 37.945, p = 0.099$, Cramer's $V = 0.277$, *medium*) periods. Individual Chi-square test analyses revealed significant positional effects for the trick action in both PMD_{TD-1} and PMD_{TD-3}, with WM players performing the highest frequency of tricks during PMD_{TD-3} (18%) compared to other positions. Additionally, significant differences were observed for cross and pass actions during PMD_{TD-3}, with FB players performing a significantly higher number of crosses (15.9%) than other positions, and CB players exhibiting a higher frequency of passes (56.7%) compared to WM players (Table 4).

Table 4 near here

Tactical actions

A total of 631 tactical actions (260 offensive and 371 defensive) and 1429 tactical actions (567 offensive and 862 defensive) were successfully coded and analyzed during PMD_{TD-1} and PMD_{TD-3} respectively. A global Pearson's Chi-square test revealed a significant association between playing position and the frequency of offensive tactical actions in both PMD_{TD-1} ($\chi^2(32) = 190.727, p < 0.001$, Cramer's $V = 0.421$, *large*) and PMD_{TD-3} ($\chi^2(32) = 294.512, p < 0.001$, Cramer's $V = 0.361$, *large*) periods. Individual Chi-square tests of offensive tactical actions are shown in Table 5. Notable differences included CF players, who were more involved in offensive transition, particularly in actions like "run-in-behind" and "break into the box". In contrast, FB players performed a significantly higher number of crosses during the PMD_{TD-3} period (15.9%).

Table 5 near here

A global Pearson's Chi-square test revealed a significant association between playing position and the frequency of defensive tactical actions in both PMD_{TD-1} ($\chi^2(28) = 95.684, p < 0.001$, Cramer's $V = 0.254$, *large*) and PMD_{TD-3} ($\chi^2(28) = 214.984, p < 0.001$, Cramer's $V = 0.250$, *large*) periods. Individual Chi-square tests of defensive tactical actions are shown in Table 6. CB players demonstrated a higher frequency of recovery runs (25.5%) and cover actions in both periods, while WM players showed a significantly higher frequency of on-ball defence actions during PMD_{TD-3} (45.3%).

Table 6 near here

Discussion

The primary objective of this study was to analyze the integrated external (i.e., locomotor and mechanical), technical, and tactical (i.e., phase of play and tactical outcome) demands during PMD across different playing positions in soccer, providing a holistic understanding of these scenarios. The findings demonstrate that external demands during PMD are position-dependent, with CBs exhibiting the lowest TD and HMLD in PMD_{TD-1} compared with CM and WM, and lower HMLD than CF, while relative intensity, as expected, was higher in the PMD_{TD-1} window compared to the PMD_{TD-3} window. A novel and critical finding of this research is that PMD periods are predominantly characterized by defensive phases (organization and transition); however, positional analysis revealed that while CB, FB, and CM are primarily involved in defensive duties, WM and CF show significantly greater engagement in transition phases during these high-intensity bouts. Furthermore, significant positional differences were identified for technical actions (e.g., tricks, crosses, and passes) and tactical outcomes, with offensive and defensive actions showing a strong association with playing position. These results suggest that PMD in soccer is not merely a physical phenomenon but a context-specific demand in which tactical roles dictate the nature of the high-intensity efforts.

There is a broad consensus in the literature that physical match performance is highly dependent on the positional roles of soccer players (Bradley, 2024; Di Salvo et al., 2007). In a recent systematic review, Rico-González et al. (Rico-González et al., 2022) reported that WM typically exhibit the highest locomotor demands (135–233 m/min), while CBs consistently record the lowest values (115–179 m/min). It is important to acknowledge, however, that the PMD periods analyzed in this study were identified using TD as the criterion variable, meaning they capture TD-driven peak scenarios rather than absolute PMD across all load dimensions simultaneously. As highlighted by Novak et al. (2021), peak periods defined by different metrics are not temporally coincident, and the intra-

positional variance remains substantial regardless of the locomotor variable employed, ranging from 6.5-6.9% for TD-based, 21.0%-30.6% for HSD -based and 35.0-56.1% for SPD-based scenarios. In line with these observations, our results indicate that CB covered significantly less TD than CMs and WM, and displayed lower HMLD compared to CM, WM, and CF during PMD_{TD-1} . These findings align with previous research (Delaney et al., 2017; Martin-Garcia et al., 2018; Oliva-Lozano et al., 2020) characterizing the CB as the position with the lowest locomotor output, due to its specific tactical requirements centered on defensive positioning and spatial control rather than expansive running (Mohr et al., 2003). Furthermore, HSD, a key metric in modern soccer performance (Akenhead & Nassis, 2016), showed significantly higher values for WM compared to CB in both PMD_{TD-1} and PMD_{TD-3} . Interestingly, while the lower HSD values for CB are consistent with existing data (Delaney et al., 2017), our findings partially diverge from studies identifying FB as the position with the highest HSD (Martin-Garcia et al., 2018; Oliva-Lozano et al., 2020). These discrepancies may be attributed to specific tactical instructions from the coaching staff or, fundamentally, to the methodological approach of using TD as the criterion variable for identifying PMD. As suggested by Novak et al. (2021), a true PMD is likely a multifactorial phenomenon. Relying on a single locomotor metric may not capture the complex interactions of sprinting, accelerations, decelerations, and technical involvements that define maximum match exigency, particularly when these demands are uncoupled from total load (Novak et al., 2021). This methodological focus on TD as the primary indicator could also explain the lack of significant positional differences observed in other high-intensity variables, such as sprint SPD, ACC, DCC, or PL, which may peak independently of total volume. Methodologically, it is critical to contextualize these integrated physical-tactical findings within the specific competitive level of the analyzed sample. This study evaluated semi-professional players categorized

as Tier 2 (Trained/Developmental), a cohort that possesses distinct tactical maturities, tactical structures, and physical capacities compared to other populations.

The analysis of game phase revealed that PMD periods occurred most frequently during defensive organization (31-32%) and transitions (defensive: 27-28%; offensive: 23-29%). This finding aligns with integrated studies that have analyzed sprint (Caldbeck & Dos'Santos, 2023; Oliva-Lozano, Cuenca-López, et al., 2023; Oliva-Lozano, Fortes, et al., 2021) and high-intensity efforts (Ade et al., 2016), confirming that high-intensity activities often occur out of ball possession and are defensive in nature, such as recovery runs or pressing. Our results, defensive organization as the phase with the highest number of occurrences during PMDs are consistent with the literature that finds that the majority of sprint efforts occur when the team is settled into a defensive structure, with up to 60% of high-intensity efforts occurring during defensive phases (organization and transition) (Caldbeck & Dos'Santos, 2023). The low proportion of PMD in the offensive organization phase (12.8%) is also consistent with the literature, which reports that this phase is statistically the least common for high-intensity running (Ade et al., 2016), likely because the opposing team is typically settled into a strong defensive structure (Delgado-Bordonau & Mendez-Villanueva, 2012). The defensive nature of these PMD periods is further reinforced by the high frequency of defensively minded tactical actions observed in this study, such as cover or recovery runs, which have been identified as the most common tactical outcomes associated with PMD in match play. This emphasizes the importance of high-intensity, reactive, and out-of-possession movements in defining the critical moments of a match. Our position-specific breakdown further refines this understanding, showing that CB, FB and CM are more involved in defensive phases (organization and transition), while WM and CF demonstrate greater involvement in offensive transitions. This distinct distribution reflects the core functional responsibilities

of each position. CB and CM operate as the structural core, where their PMD is dominated by continuous, short-burst actions (accelerations and decelerations) required for closing down spaces, marking, and maintaining shape during sustained defensive pressure. Conversely, WM and CF are positioned to capitalize on newly won possession; their high PMD during offensive transition is likely driven by the requirement for maximal running speed over longer distances to exploit wide/central corridors and generate immediate offensive momentum, directly supporting the tactical objective of the transition phase (Dellal et al., 2011; Mohr et al., 2003).

The results regarding technical actions further emphasize that PMD in soccer is not solely locomotor challenges but requires the maintenance of technical proficiency under high physiological strain (Ade et al., 2016; Bradley & Ade, 2018). Our findings reveal that the global association between playing position and technical execution reached a small-to-moderate magnitude in the 3-min ($\text{PMD}_{\text{TD-3}}$; $V = 0.245$, $p < 0.001$) while remaining weaker in the 1-min window. Following recent methodological recommendations on workload and tactical analysis in court and team sports (Qarouach et al., 2024, 2025), this non-significant global result suggests that the overall distribution of technical actions does not fundamentally differ by position within such a brief, restricted timeframe. This suggests that while a 60-second burst may be dominated by explosive locomotor actions (Gualtieri et al., 2025), the 3-min window likely encompasses more complete tactical sequences, allowing position-specific technical roles to manifest more clearly. Notably, WMs exhibited the highest frequency of tricks in both windows (20.7% and 18% in $\text{PMD}_{\text{TD-1}}$ and $\text{PMD}_{\text{TD-3}}$, respectively), reflecting their specific tactical requirement to solve one-on-one situations and progress the attack during high-intensity transitions (Caldbeck & Dos'Santos, 2023). Similarly, crosses were significantly associated with FBs and WMs during $\text{PMD}_{\text{TD-3}}$, which aligns with the functional role of wide players in generating goal-

scoring opportunities following high-speed overlapping runs or wing-play sequences (Oliva-Lozano et al., 2021). Interestingly, CB and CM showed the highest percentage of passes during the 3-min peak period (56.7% and 44.9%, respectively). Given that our previous phase-of-play analysis identified defensive organization and transitions as the predominant contexts for PMD, this high passing frequency suggests that these players must immediately transition from peak physical defensive efforts—such as interceptions or recovery runs—to effective ball circulation and offensive initiation. This “mixed-demand” highlights the need for training drills that do not just replicate the distance of a PMD (Rico-González et al., 2022), but also the technical accuracy required immediately following or during the effort. The lack of significant differences in actions like shots or tackles may be due to their low frequency of occurrence, as these are highly discrete events that might not consistently align with the specific window identified by TD (Novak et al., 2021). Consequently, these findings suggest that coaches should periodize technical-tactical drills that reflect these specific positional requirements (e.g., crossing for FB or high-pressure passing for CB) to better simulate the technical reality of the match's most demanding periods.

The most substantial finding of this study is the moderate effect sizes observed in the association between playing position and both offensive ($V = 0.361\text{--}0.421$) alongside small-to-moderate effects for defensive actions ($V = 0.250\text{--}0.254$) tactical actions during PMD. Although these effect sizes fall within the small-to-medium range according to traditional benchmarks, they reflect meaningful positional trends within the highly homogeneous context of semi-professional soccer. This confirms that PMD is not merely a peak in locomotor output, but a peak in tactical demands, where the specific role of the player dictates the nature of the effort. Regarding offensive actions, our data reveal distinct positional fingerprints. CB and CM predominantly engaged in “pushing up the

line/advancing the team” (50% and 26.9% in PMD_{TD-1}, respectively), suggesting that their PMD often occurs when they are driving the team forward or maintaining the block’s height during offensive organization. In contrast, WM and CF exhibited a high frequency of “breaking into the box” and “runs-in-behind” (e.g., CF: 23.1% in PMD_{TD-1}), which aligns with previous research identifying these high-speed movements as the most crucial for creating scoring opportunities (Caldbeck & Dos’Santos, 2022, 2023). Furthermore, the high prevalence of “wide runs” exclusively in FB and WM (42.9% and 16.7%) reinforces the idea that wide players achieve their peak demands through expansive, lane-stretching efforts (Oliva-Lozano, Cuenca-López, et al., 2023; Oliva-Lozano, Fortes, et al., 2021, 2022).

Defensively, the results provide critical insights into the modern game’s demands. A striking finding was that “on-ball defense” (pressing) was the most frequent tactical action for CB and WM (above 40% in PMD_{TD-1}), confirming that for these players, PMD are often driven by high-intensity, proactive defensive transitions to disrupt the opposition’s build-up (Ade et al., 2016). For the defensive line, “cover” actions were significantly more prevalent in CB and FB, highlighting the reactive and structural nature of their peak efforts. Interestingly, “recovery runs” were identified as a universal demand across all positions (22–27%), supporting the notion that high-intensity tracking back is a non-negotiable physical requirement in soccer, regardless of tactical role (Ade et al., 2016). From a methodological perspective, although the global Chi-square test for defensive tactical actions during PMD_{TD-1} was highly significant ($p < 0.001$), our follow-up analysis indicates that this global significance is primarily driven by a specific subset of position-dependent actions (such as “interception” or “defending a ball over the defensive line”). In contrast, other critical duties like “cover” or “recovery runs” showed more homogeneous distributions across certain roles. These findings suggest that the physical

load of a PMD is a vehicle for a specific tactical purpose. Therefore, practitioners should move away from generic high-intensity drills and instead design scenarios where, for example, a CF achieves their PMD through repeated pressing (on-ball defense) or a CB through a combination of pushing the line and recovery runs.

To effectively prepare players for the PMD, practitioners should design position-specific training drills that replicate both the locomotor intensity and the specific technical-tactical fingerprints identified. Based on our findings, the following contextualized tasks are proposed: CB: we suggest implementing integrated physical-tactical drills where these players must execute repeated clearance or covering runs, immediately followed by pushing up the defensive line to initiate an organized offensive build-up through high-volume passing under accumulative fatigue; FB: Practitioners should design high-intensity linear overloads where FBs perform a maximal recovery run to defend a ball to the side of the defense, followed by an immediate counter-attacking wide run to deliver a cross under high cardiovascular stress; CM: We recommend small-sided games or positional games with a high density of repeated high-intensity switch-of-play movements, forcing these players to perform continuous on-ball defense/pressing and immediate central penetrative driving or forward line advancement upon recovery; WM: These wingers should be exposed to counter-attacking transition drills starting with a maximal sprint, where they must immediately engage in a 1v1 duel using technical tricks to break into the box or make a wide run under time-pressure constraints; CF: Coaches should implement repeated sprint ability protocols where CFs perform a maximal run-in-behind to finish, immediately followed by a high-intensity post-turnover pressing or on-ball defensive action to disrupt the opponent's counter-attack.

Despite the novel integrated approach of this study, several limitations should be acknowledged. First, the identification of PMD was based on TD as the primary criterion

variable. While TD is a robust measure of overall volume (Akenhead & Nassis, 2016), it may not perfectly coincide with the peaks of other high-intensity variables such as accelerations, decelerations, or high-speed running. As previously suggested (Novak et al., 2021), PMD is a multifactorial phenomenon, and different high-intensity periods may emerge depending on the metric selected. Second, the sample consisted of players from a semi-professional club, meaning the findings are inherently team- and context-specific. These technical-tactical patterns are heavily influenced by the team's specific formation, playing style, competition level, skill level, and physical capacity (Calder & Gabbett, 2022) and cannot be directly generalized across the wider soccer ecosystem. Third, this study did not account for contextual variables such as match status (winning, losing, or drawing), opponent quality, or pitch dimensions, all of which are known to influence both locomotor demands and tactical behaviour (Savoia et al., 2024). Future research should consider a multi-metric approach to defining PMD and explore how external contextual factors modulate the technical-tactical requirements during these critical periods. Fourth, the frequency-based technical-tactical data were analyzed using Chi-square tests; because multiple demanding events were nested within the same players and matches, a potential inflation of statistical significance due to repeated observations must be considered, although we mitigated this locally by utilizing strict adjusted standardized residuals. Additionally, it must be noted that certain discrete tactical actions (e.g., overlap/underlap, drive inside) occurred with low baseline frequencies in the peak windows. Consequently, the statistical power of the Chi-square tests for these specific low-occurrence variables may be limited, and their position-specific trends should be interpreted with caution. Fifth, formal inter- and intra-observer reliability statistics were not calculated for the technical-tactical coding procedure. Although disagreements between observers were resolved through arbitration, the subjective nature of tactical classification and the

absence of quantified reliability metrics (e.g., Cohen's Kappa) represent a methodological limitation of the present study. Future research should systematically assess and report observer reliability for each coding category—phase of play, technical actions, and tactical actions—to strengthen the methodological rigor of integrated physical and tactical analyses.

Conclusions

In conclusion, this study establishes that PMD are associated with position-specific and multifactorial phenomenon where tactical roles dictate physical and technical requirements. Rather than representing isolated peaks in physical output, PMD appear to emerge as properties of broader game dynamics, embedded within tactical contexts that vary systematically according to positional function. The specific trends observed in tactical actions, along with the prevalence of defensive phases, highlight these PMD tend to occur predominantly in reactive, out-of-possession scenarios. Consequently, these findings advocate for a paradigm shift in training design: practitioners may consider moving beyond generic physical replication toward integrated, position-specific drills that replicate the precise technical and tactical objectives of the most demanding match periods. This approach may help ensure players are prepared not only for the physical load but also for the specific functional demands of the game, achieved by designing training scenarios that carefully couple peak locomotor demands with the tactical objectives observed during these critical match periods.

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Author Contributions

All authors contributed equally to the conception, design, data collection, analysis, and writing of the study. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Figure 1. Phase of play peak match demands total distance observed during soccer match play in 1-min (A) and 3-min (B) windows.

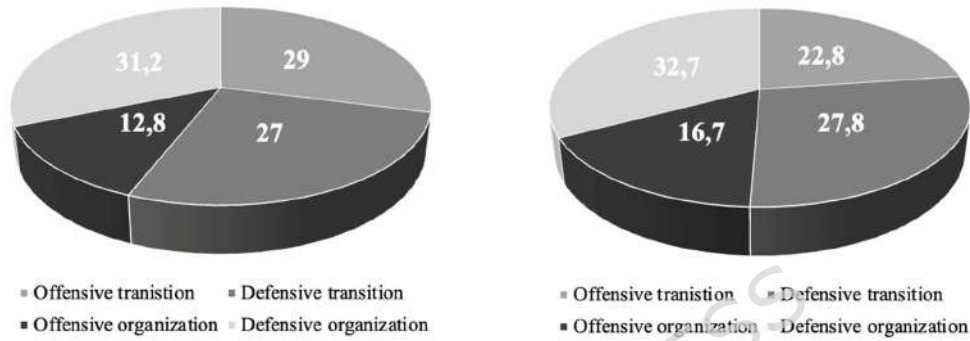


Figure 1. Phase of play peak match demands total distance observed during soccer match play in 1-min (A) and 3-min (B) windows.

Table 1. Categorization of technical and tactical actions performed during PMD. Adapted from previous research (Ade et al., 2016; Bradley & Ade, 2018; Caldbeck & Dos'Santos, 2023).

Phase	Type	Action	Description
Offensive	Technical	Long pass	The player attempts to pass the ball to a teammate over a defensive line
		Trick	The player performs a feint or deceptive technical maneuver with the ball to evade defensive pressure or bypass an opponent in 1v1 situations
		Short Pass	The player attempts to pass the ball to a nearby teammate

		Dribble	The player performs a skill with the ball before, during, or after dribbling or carrying it
		Cross	The player attempts to deliver the ball into the opponent's penalty area from either attacking flank in the final third
		Shot	The player attempts a shot on goal
		Header	The player makes contact with the ball using the head
		Other	Any other technical action performed with the ball not included in the listed categories

	Tactical	Break into the box	The player run into the opponent's penalty area
		Over/underlap	The player run from behind to ahead of the teammate with or about to receive the ball
		Push up the line / advance the team	The player runs forward to push the offside line higher (in possession) or to collectively advance with teammates into attack
		Wide run	The player (with or without the ball) runs down the wing to attack.
		Run-in-behind	The player run to attack space behind, unbalances the

			opposition defense, and run through onto the opposition goal
		Drive inside	The player run with/without the ball from the external flank into the central area.
		Drive through the middle	The player run with/without the ball through the middle of the pitch.
		Run with ball	Player moves with the ball either dribbling with small touches or sprinting with the ball with bigger touches
		Other	Any other offensive tactical action not covered in the above categories

Defensive	Technical	Tackle	The player attempts to dispossess the opponent who has the ball
		Other	Any other technical defensive action not included in the listed categories
	Tactical	On-ball defense	The player directly defends the opponent in possession
		Interception	The player run to cut out pass
		Cover	The player marks an off-ball opponent or protects a specific area of the pitch
		Recovery run	Player sprinted back towards his own goal to be goal side when out of position

		Defending a ball over the defensive line	The player defends against an aerial ball played behind the defensive line
		Defending a ball to the side of the defense	The player defends a pass played to the side of the defensive line
		Persecution run	The player makes an effort after the opposing player with the ball to steal it or make the game difficult
		Other	Any other defensive tactical action not covered in the above categories

Table 2. Mean and 95% confidence interval of external load variables by playing position during Peak Match Total Distance periods.

		CB (n=24)	FB (n=23)	CM (n=31)	WM (n=39)	CF (n=28)
TD (m)	PMD_{TD-1}	169.1 (156.4-181.79)	188.0 (178.2-197.8)	193.5 (183.4-203.6) *	197.1 (188.5-205.6) *	191.3 (181.2-201.3)
	PMD _{TD-3}	398.5 (360.0-437.0)	438.1 (406.3-469.9)	450.2 (419.0-481.3)	422.5 (396.0-449.0)	451.4 (420.4-482.4)
HSD (m)	PMD_{TD-1}	20.6 (10.2-31.0)	36.1 (26.8-45.4)	33.0 (24.4-41.5)	42.8 (35.3-50.2) *	30.6 (21.7-39.6)
	PMD_{TD-3}	27.1 (9.8-44.3)	56.3 (42.0-70.5)	41.4 (27.5-55.4)	67.9 (56.1-79.8) *†	41.2 (27.3-55.1)
SPD (m)	PMD _{TD-1}	10.0 (0-23.1)	22.1 (11.4-32.8)	14.0 (3.4-24.6)	23.2 (14.2-32.2)	15.8 (5.1-26.5)
	PMD _{TD-3}	12.0 (0-31.4)	33.0 (18.5-47.6)	18.7 (3.3-34.0)	33.9 (21.0-47.0)	21.6 (6.9-36.4)
ACC (n°)	PMD _{TD-1}	1.03 (0.40-1.67)	1.35 (0.78-1.92)	1.98 (1.45-2.51)	1.65 (1.20-2.11)	1.48 (0.93-2.03)
	PMD _{TD-3}	2.41 (1.40-3.43)	3.09 (2.2-3.97)	3.18 (2.35-4.02)	4.17 (3.45-4.89)	3.56 (2.72-4.41)
DCC (n°)	PMD _{TD-1}	1.44 (0.62-2.26)	1.84 (1.16-2.51)	2.17 (1.51-2.84)	2.21 (1.65-2.78)	2.01 (1.34-2.69)
	PMD _{TD-3}	3.05 (1.62-4.47)	4.05 (2.9-5.19)	4.09 (2.94-5.24)	4.78 (3.81-5.75)	4.90 (3.77-6.03)

HMLD (m)	PMD_{TD-1}	48.0 (31.17-56.83)	65.2 (57.11-73.257)	72.9 (65.57-80.28) *	77.8 (71.40-84.23) *	66.7 (59.00-74.43) *
	PMD_{TD-3}	87.6 (67.6-107.5)	118.3 (102.3-134.3)	124.0 (108.0-140.0)	137.5 (124.0-151.1) *	117.7 (101.9-133.5)
PL (AU)	PMD _{TD-1}	2.44 (2.0-2.89)	2.84 (2.51-3.18)	3.15 (2.8-3.5)	2.87 (2.58-3.17)	2.82 (2.48-3.17)
	PMD _{TD-3}	5.78 (4.91-6.67)	6.46 (5.81-7.11)	6.80 (6.10-7.50)	5.96 (5.38-6.55)	6.36 (5.70-7.02)

CB = center backs; FB = full backs; CM = central midfielders; WM = wide midfielders; CF = central forwards; PMD_{TD-1} = peak match demands in total distance epoch in 1-min; PMD_{TD-3} = peak match demands in total distance epoch in 3-min; TD = total distance; HSD = high-speed running distance (>21 km·h⁻¹); SPD sprint running distance (>25.2 km·h⁻¹); HMLD = high metabolic load distance (>25.5 W·k⁻¹); ACC = accelerations (>3 m/s⁻²); DCC = decelerations (>-3 m/s⁻²); PL = Player load. * = differences with CB; † differences with CF. Bold values indicate statistically significant results.

Table 3. Chi-square results for positional differences in the frequency of game phases during the 1-min and 3-min Peak Match Total Distance periods.

Phase	Period	CB	FB	CM	WM	CF	X ²	p	ES
Offensive	PMD _{TD-1}	20 (22.5%)	17 (20.48%)	46 (29.1%)	57 (32.4%)	46 (34.1%)	7.43	0.115	0.108
transition	PMD_{TD-3}	26 (11.6%)	36 (16.9%)	71 (21.8%)	107 (27.1%)	86 (31.4%)	35.95	0.000	0.158
Offensive	PMD_{TD-1}	14 (15.7%)	11(13.3%)	6 (3.8%)	32 (18.2%)	19 (14.1%)	16.94	0.002	0.163
organization	PMD_{TD-3}	58 (25.9%)	35 (16.4%)	37 (11.4%)	62 (15.7%)	47 (17.2%)	20.55	0.000	0.120
Defensive	PMD_{TD-1}	27 (30.3%)	27 (32.5%)	51(32.3%)	44 (25%)	24 (17.8%)	10.21	0.037	0.126
transition	PMD_{TD-3}	63 (28.1%)	74 (34.7%)	91 (28%)	114 (28.9%)	56 (20.5%)	16.77	0.033	0.077
Defensive	PMD _{TD-1}	28 (31.5%)	28 (33.7%)	55 (34.8%)	43 (24.4%)	46 (34.1%)	5.49	0.241	0.093
organization	PMD _{TD-3}	77 (34.4%)	68 (31.9%)	126 (38.8%)	113 (28.6%)	84 (30.7%)	9.31	0.054	0.081

CB = Center back; FB = full back; CM = central midfielder; WM = wide midfielder; CF = central forward; PMD_{TD1} = peak match demands in total distance epoch in 1-min; PMD_{TD3} = peak match demands in total distance epoch in 3-min. Bold values indicate statistically significant results.

Table 4. Chi-square results for positional differences in the frequency of technical actions the 1-min and 3-min Peak Match Total Distance periods.

Phase	Period	CB	FB	CM	WM	CF	X ²	p	ES
Long pass	PMD _{TD-1}	4 (21.1%)	3 (12.5%)	2 (4.7%)	1 (3.4%)	1 (5%)	6.658	0.155	0.222
	PMD _{TD-3}	6 (9.0%)	3 (6.8%)	4 (5.8%)	4 (5.8%)	1 (3.2%)	3.026	0.553	0.108
Trick	PMD _{TD-1}	0 (0%)	0 (0%)	3 (7%)	6 (20.7%)	1 (5%)	11.080	0.026	0.286
	PMD _{TD-3}	0 (0%)	2 (4.5%)	1 (1.4%)	9 (18.0%)	1 (3.2%)	23.457	0.000	0.300
Cross	PMD _{TD-1}	0 (0%)	3 (12.5%)	1 (2.3%)	3 (10.3%)	3 (15%)	6.092	0.192	0.212
	PMD _{TD-3}	0 (0%)	7 (15.9%)	1 (1.4%)	4 (8%)	1 (3.2%)	17.598	0.001	0.260
Shot	PMD _{TD-1}	0 (0%)	1 (4.2%)	2 (4.7%)	2 (6.9%)	1 (5%)	1.138	0.858	0.099
	PMD _{TD-3}	1 (1.5%)	2 (4.5%)	2 (2.9%)	2 (4%)	2 (6.5%)	1.877	0.758	0.085
Header	PMD _{TD-1}	3 (15.8%)	0 (0%)	5 (11.6%)	2 (6.9%)	3 (15.0%)	4.495	0.343	0.182

Tackle	PMD _{TD-3}	8 (11.9%)	4 (9.1%)	8 (11.6%)	1 (2.0%)	7 (22.6%)	8.804	0.066	0.184
	PMD _{TD-1}	1 (5.3%)	3 (12.5%)	5 (11.6%)	2 (10.0%)	2 (10.0%)	0.726	0.948	0.073
	PMD _{TD-3}	4 (6%)	8 (18.2%)	9 (13.0%)	7 (14.0%)	3 (9.7%)	4.353	0.360	0.129
Pass	PMD _{TD-1}	5 (26.3%)	3 (12.5%)	16 (37.2%)	11 (37.9%)	5 (25.0%)	11.920	0.155	0.210
	PMD _{TD-3}	38 (56.7%)	11 (25%)	31 (44.9%)	18 (36%)	12 (38.7%)	12.282	0.015	0.217
Other	PMD _{TD-1}	5 (26.3%)	3 (18.8%)	7 (17.1%)	1 (3.6%)	4 (20.0%)	5.687	0.224	0.205
	PMD _{TD-3}	10 (14.9%)	7 (15.9%)	13 (18.8%)	8 (16.0%)	4 (12.9%)	0.688	0.953	0.051

CB = Center back; FB = full back; CM = central midfielder; WM = wide midfielder; CF = central forward; PMD_{TD1} = peak match demands in total distance epoch in 1-min; PMD_{TD3} = peak match demands in total distance epoch in 3-min. Bold values indicate statistically significant results.

Table 5. Chi-square results for positional differences in the frequency of offensive tactical actions in the 1-min and 3-min Peak Match Total Distance periods.

Phase	Period	CB	FB	CM	WM	CF	X ²	p	ES
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Break into the box	PMD _{TD-1}	2 (5.9%)	3 (10.7%)	2 (3.8%)	23 (25.6%)	14 (21.5%)	16.169	0.003	0.245
	PMD _{TD-3}	1 (1.2%)	6 (8.8%)	3 (2.8%)	25 (14.6%)	27 (20%)	29.770	0.000	0.229
Over/underlap	PMD _{TD-1}	0 (0%)	1 (3.6%)	1 (1.9%)	3 (3.3%)	0 (0%)	3.399	0.493	0.112
	PMD _{TD-3}	0 (0%)	3 (4.4%)	3 (2.8%)	9 (5.3%)	4 (3%)	5.263	0.261	0.096
Push up the line / advance the team	PMD _{TD-1}	17 (50%)	4 (14.3%)	14 (26.9%)	5 (5.6%)	3 (4.6%)	47.531	0.000	0.420
	PMD _{TD-3}	34 (40.5%)	15 (22.1%)	43 (39.4%)	11 (6.4%)	7 (5.2%)	80.025	0.000	0.394
Wide run	PMD _{TD-1}	0 (0%)	12 (42.9%)	0 (0%)	15 (16.7%)	0 (0%)	54.629	0.000	0.451
	PMD _{TD-3}	0 (0%)	20 (29.4%)	2 (1.8%)	39 (22.8%)	4 (3%)	73.705	0.000	0.361
Run-in-behind	PMD _{TD-1}	0 (0%)	0 (0%)	1 (1.9%)	6 (6.7%)	15 (23.1%)	27.718	0.000	0.306
	PMD _{TD-3}	0 (0%)	2 (2.9%)	3 (2.8%)	16 (9.4%)	34 (25.2%)	55.557	0.000	0.313
Drive inside	PMD _{TD-1}	0 (0%)	2 (7.1%)	0 (0%)	9 (10%)	0 (0%)	15.121	0.004	0.237
	PMD _{TD-3}	0 (0%)	3 (4.4%)	1 (0.9%)	8 (4.7%)	1 (0.7%)	10.012	0.040	0.133
Drive through the middle	PMD _{TD-1}	1 (2.9%)	0 (0%)	11 (21.2%)	12 (13.5%)	13 (20%)	12.367	0.015	0.214
	PMD _{TD-3}	1 (1.2%)	1 (1.5%)	11 (10.1%)	27 (15.8%)	18 (13.3%)	20.330	0.000	0.189
Run with ball	PMD _{TD-1}	7 (20.6%)	0 (0%)	3 (5.8%)	0 (0%)	0 (3.7%)	34.714	0.000	0.359

Other	PMD _{TD-3}	9 (10.7%)	0 (0%)	3 (2.8%)	0 (0%)	0 (0%)	38.271	0.000	0.260
	PMD _{TD-1}	7 (20.6%)	6 (21.4%)	20 (38.5%)	17 (18.9%)	20 (30.8%)	8.148	0.086	0.174
	PMD _{TD-3}	39 (46.4%)	18 (26.5%)	40 (36.7%)	36 (21.1%)	40 (29.6%)	19.794	0.001	0.187

CB = Center back; FB = full back; CM = central midfielder; WM = wide midfielder; CF = central forward; PMD_{TD1} = peak match demands in total distance epoch in 1-min; PMD_{TD3} = peak match demands in total distance epoch in 3-min. **Bold values indicate statistically significant results.**

Table 6. Chi-square results for positional differences in the frequency of defensive tactical actions in the 1-min and 3-min Peak Match Total Distance periods.

Phase	Period	CB	FB	CM	WM	CF	X ²	p	ES
On-ball defense	PMD _{TD-1}	4 (7.3%)	12 (22.2%)	30 (28.3%)	35 (40.7%)	29 (41.4%)	24.412	0.000	0.257
	PMD _{TD-3}	18 (12.9%)	32 (22.4%)	66 (30.6%)	85 (37.9%)	63 (45.3%)	45.167	0.000	0.229
Interception	PMD _{TD-1}	5 (9.1%)	2 (3.7%)	13 (12.3%)	2 (2.3%)	0 (0%)	15.505	0.004	0.204
	PMD _{TD-3}	12 (8.6%)	16 (11.2%)	19 (8.8%)	10 (4.5%)	3 (2.2%)	12.738	0.013	0.122

Cover	PMD _{TD-1}	13 (23.6%)	15 (27.8%)	23 (21.7%)	12 (14%)	9 (12.9%)	6.959	0.138	0.137
	PMD _{TD-3}	42 (30%)	27 (18.9%)	58 (26.9%)	35 (15.7%)	23 (16.5%)	16.720	0.002	0.139
Recovery run	PMD _{TD-1}	14 (25.5%)	15 (27.8%)	24 (22.6%)	22 (25.6%)	18 (25.7%)	0.575	0.966	0.039
	PMD _{TD-3}	17 (12.1%)	39 (27.3%)	40 (18.5%)	59 (26.3%)	25 (18%)	15.481	0.004	0.134
Defending a ball over the defensive line	PMD _{TD-1}	5 (9.1%)	3 (5.6%)	0 (0%)	0 (0%)	8 (2.2%)	21.267	0.000	0.239
	PMD _{TD-3}	20 (14.3%)	5 (3.5%)	3 (1.4%)	0 (0%)	28 (3.2%)	68.861	0.000	0.283
Defending a ball to the side of the defense	PMD _{TD-1}	8 (14.5%)	2 (3.7%)	1 (0.9%)	0 (0%)	0 (0%)	32.012	0.000	0.294
	PMD _{TD-3}	17 (12.1%)	3 (2.1%)	0 (0%)	0 (0%)	0 (0%)	73.386	0.000	0.292
Persecution run	PMD _{TD-1}	6 (10.9%)	4 (7.4%)	13 (12.3%)	14 (16.3%)	14 (20%)	5.174	0.270	0.118
	PMD _{TD-3}	11 (7.9%)	17 (11.9%)	26 (12%)	35 (15.6%)	23 (16.5%)	6.521	0.163	0.087
Other	PMD _{TD-1}	1 (1.8%)	1 (1.9%)	2 (1.9%)	1 (1.2%)	0 (0%)	1.405	0.843	0.062
	PMD _{TD-3}	3 (2.1%)	4 (2.8%)	4 (1.9%)	0 (0%)	2 (1.4%)	0.586	0.232	0.080

CB = Center back; FB = full back; CM = central midfielder; WM = wide midfielder; CF = central forward; PMD_{TD1} = peak match demands in total distance epoch in 1-min; PMD_{TD3} = peak match demands in total distance epoch in 3-min. Bold values indicate statistically significant results.