

QUANTIFYING WITHIN-MATCHES TACTICAL BEHAVIORS USING POSITION DATA AND NOTATIONAL ANALYSIS IN SOCCER: THE EFFECT OF GOAL SCORING

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Original scientific paper

DOI 10.26582/k.56.1.6

Abstract:

This study aimed to compare the collective and individual tactical positional behavior before the first goal was scored or conceded in official soccer matches. The sample comprised 50 players and 27 official matches played in Brazil during the 2020 and 2021 U-20 seasons. Global Positioning System devices were used to monitor the players' positional data. Collective – width, length, length per width ratio, and stretching index, and individual – spatial exploration index, variables were calculated and compared between the contextual scenarios by a one-way ANOVA. Results indicated a reduction in the width after scoring a goal ($p=.006$) and a lower spatial exploration after conceding a goal ($p<.001$) compared with the draw condition. Therefore, it is concluded that goal-scoring affects the tactical positional responses of the players. Specifically, a higher width concentration, characteristic of defensive tactical behavior, is observed after scoring a goal to keep the current match status. On the other hand, players present difficulties in exploring the space after conceding a goal. The knowledge of these intrinsic game dynamics is helpful for coaches in preparing the strategies to explore changes due to goal scoring in official matches.

Keywords: *football, youth sport, GPS devices, ecological dynamics*

Introduction

Match analysis in team sports, specifically tactical performance analysis, has evolved in recent years due to the number of available statistics and instruments. Current approaches to tactical performance analyses in soccer adopt position data (Low, et al., 2020; Memmert, Lemmink, & Sampaio, 2017; Rein & Memmert, 2016) which might be captured by electronic tracking position systems (ETPS) (Bastida-Castillo, Gómez-Carmona, de La Cruz Sánchez, & Pino-Ortega, 2019; Forcher, Altmann, Forcher, Jekauc, & Kempe, 2022; Linke, Link, & Lames, 2018), such as optical-based systems and global positioning system devices (GPS). Although data from these technologies were initially adopted almost exclusively to analyze the external load of game-based activities – the distance covered at different speed zones, for example – it has been

recently proposed that the position of the player on the pitch accounts for the tactical space management (Praça, Andrade, Bredt, Moura, & Moreira, 2021; Rein & Memmert, 2016). Therefore, positional data may be used to analyze how players and teams deal with spatial occupation to generate advantages that might increase the winning chance (Praça, Moreira, et al., 2021). Indeed, a recent study showed that positional data from GPS devices showed higher reliability than data provided by observational instruments (Praça, Abreu, Rochoael, & Moreira, 2022), which might indicate the potential of such an approach for match analysis in soccer. The current study will use positional data to describe tactical behavior within matches based on this rationale.

In previous studies, GPS devices have often been employed to analyze soccer matches, aiming to understand how contextual factors and player positions influence game outcomes. For instance,

research has indicated that older players exhibit different spatial positioning tendencies than younger players, especially when playing away (Praça, Moreira, et al., 2021). Another study showed that playing away – match venue effect – reduced the position of the offensive line (Santos, Lago-Peñas, & García-García, 2017). However, most of these studies have focused on collecting data for the entire match, overlooking the potential variations in behavior during different phases of the game. Recent research has highlighted that offensive and defensive tactical behaviors can differ significantly when considering specific game phases (Moura, Martins, Anido, de Barros, & Cunha, 2012; Praça, Moreira, et al., 2022). Therefore, considering the whole match in the tactical analysis might bias the interpretation as the reported pattern is usually the average pattern – that might not represent a specific moment within the game. The current study will shed light on this problem by splitting positional data before and after goal-scoring.

The literature extensively addresses the influence of goal scoring on players' behavior and outcomes in a match. For example, from a broader view, the simple occurrence of a goal might enhance the odds of another goal being scored over time (Nevo & Ritov, 2013). Also, scoring first might increase the winning probability, irrespective of the match venue (Caballero, García Rubio, & Ibáñez, 2017). Furthermore, when analyzing the players' behavior, another study suggested that the first goal influences teams' physical responses (O'Donoghue & Robinson, 2017). On the same topic, forwards were reported to have increased physical response in winning scenarios, while defenders showed higher distances covered at high speeds in the other match statuses. (Redwood-Brown, O'Donoghue, Robinson, & Neilson, 2017).

Regarding technical-tactical variables, it has also been shown that increasing the goal difference increases the passing accuracy (Redwood-Brown, O'Donoghue, Nevill, Saward, & Sunderland, 2019), which might indicate that winning teams tend to find more space due to the attempts of the opposing team to draw the match. Besides the abovementioned results on physical and technical-tactical variables, to our knowledge, no previous study examined the impact of scoring a goal on individual and collective tactics within a match. For example, teams might adopt a more defensive tactical positioning after scoring a goal to prevent conceding a goal. This hypothesis, however, has not been tested before.

Collecting data on how contextual factors affect players and teams throughout a match provides valuable insights for sports professionals. Firstly, this information can be instrumental in designing more effective training exercises that closely mimic the demands of real match situations. Additionally,

comprehending the dynamics of a match is essential for coaches to make strategic adjustments in response to anticipated influences of these contextual variables. For example, this understanding can help coaches prepare tactical alternatives for scenarios where the team either concedes a goal or scores. With this rationale in mind, the current study's primary objective was to compare individual aspects, such as spatial exploration, and collective factors, such as length, width, length-to-width ratio (LPW ratio), and the stretching index. These factors were examined in two distinct contexts: moments preceding a goal and moments following a goal in favor of the team or against the team.

Materials and methods

Participants

The sample of this study comprised the 27 matches played by a U-20 elite Brazilian soccer club over the 2020 and 2021 competitive seasons. All the matches were played in the national championship, the most relevant competition in the country. Over these matches, 50 U-20 players (19.08 ± 0.61 years, 71.13 ± 8.03 kg, 172 ± 0.03 cm, 9.61 ± 2.01 % of body fat) effectively participated. All the players consented to participate in the study. The local Ethics committee approved the study (CAAE 19596019.9.0000.5149).

Procedures

This study followed a cross-sectional retrospective design in which players' and teams' behaviors were analyzed throughout a competitive season. From an observational methodology perspective, the study is classified as follow-up, idiographic, and multidimensional (Anguera, Villaseñor, Mendo, & Lopéz, 2011). The data was collected throughout the competitive seasons of 2020 and 2021, which allowed a large sample to be collected (a total of 540 individual observations). Players wore GPS units (Polar®, Team Pro, Kempele, Finland) within a chest strap during every match. The chest strap was worn at the beginning of the warm-up to facilitate satellite identification and reduce missing data. After the match, the researchers collected the devices and analyzed the data using the Polar Team Pro online software. The devices were synced with the online system by positioning them into a dock station connected to a tablet (iPad 6th generation – Apple Inc. – California, USA).

A fifteen-minute threshold was set to assess how scoring a goal affected the behavior of both the players and teams. This approach is consistent with previous studies in the literature (Jones, Greig, Mawéné, Barrow, & Page, 2018; Mohr, Krustup, Andersson, Kirkendal, & Bangsbo, 2008) that used similar thresholds for analyzing key moments in a match. Consequently, whenever a goal was scored,

we divided the positional data into two time intervals, before and after the goal, within these fifteen-minute windows. If a goal was scored with less than fifteen minutes remaining until half-time or full-time, we adjusted the data to ensure a balance between the periods before and after the goal, even if the goal was scored early in the match (e.g., in the 12th minute). If a goal was scored within the final five minutes of a period, it was not included in the sample. Games without any goals were excluded as well. Ultimately, we focused exclusively on the moments before and after the first goal, as it is widely recognized that this initial goal tends to influence subsequent events in a match significantly.

To account for individual analysis, only the players who engaged in the whole fifteen-minute period were included. In case a substitution took place between these periods, the collective data was still collected, but the player was not included in the individual analysis. This procedure was required to avoid bias regarding changing the playing position of the substitute players on the reported responses.

After filtering out matches with late and early goals, our final sample consisted of 27 matches, representing 72.9% of all the available matches. The comprehensive analysis encompassed twenty-seven instances before a goal was scored, ten moments following a goal in favor of the team, and seventeen moments following a goal against the team. For individual player analysis, this study analyzed 270 instances before a goal, 100 instances after a goal in favor, and 170 instances after a goal against. We excluded one match from the sample due to poor GPS data quality, likely caused by a closed stadium environment. Player positions after the game were determined by the coaching staff, in accordance with the team's strategy.

Instruments and variables

Players' positional data responses during matches were collected using a GPS (global positioning system – Polar Team Pro) with a 10 Hz sampling rate. Athletes wore a chest strap designed by the manufacturer to carry the GPS units. This equipment's validity and reliability were tested in a previous study (Akyildiz, Yildiz, & Clemente, 2020). In addition, the reliability of GPS-based tactical variables has also been established in the literature (Praça, Abreu, et al., 2022).

The tactical behavior of players and teams was analyzed by processing the positional data provided by the GPS device, as previously adopted in the literature (Low, et al., 2020; Praça, Chagas, et al., 2021), using the software MATLAB R2010a (The MathWorks Inc., Natick, MA, USA). Each player's latitude and longitude data were synchronized and converted into meters using the Universal Transverse Mercator (UTM) coordinate system and a MATLAB routine (Palacios, 2006). The corners of the field were manu-

ally obtained by the researchers in every field and were adopted as the referential system for the positional analysis. The data were smoothed using a second-order 5 Hz Butterworth low pass filter. After converting the positional data into meters, a rotation matrix was calculated for each game with the positions of the field vertices, aligning the length of the playing field along the x-axis and the width along the y-axis. Then, the rotation matrix was applied to players' positional data to align with the referential playing field (Folgado, Duarte, Fernandes, & Sampaio, 2014). The following variables were calculated: width and length, determined by the distance between the furthest players in length and the rightmost and leftmost players in width (Clemente, Bernardo Sequeiros, Correia, Silva, & Martins, 2018); length-per-width (LPW) ratio (Folgado, et al., 2014); stretch index (Clemente, et al., 2018); and spatial exploration index (SEI), defined as the average difference between a player's average position and his actual position at each moment of the game (Clemente, et al., 2018). The LPW ratio indicates the preferential positional axis of the team, with higher values indicating a more in-depth positioning (Praça, Moreira, et al., 2021). The SEI indicates how a player explores the pitch, irrespective of the preferential axis, with higher values indicating a more exploratory behavior (Praça, Moreira, et al., 2021). The width, length, LPW ratio, and stretch index were collectively measured, while the SEI was individually analyzed.

Data analysis

The data were firstly checked for the assumptions of normality (Shapiro-Wilk's), homoscedasticity (Levene's) and sphericity (Mauchly's). Concerning the sphericity analysis, when the homoscedasticity analysis revealed p-values lower than 0.05, the Greenhouse-Geisser correction was used to adjust the degrees of freedom and reduce the type I error. One-way ANOVAs were used to compare the positional data between the three contextual contexts (before the goal, after the goal in favor, and after the goal conceded). Bonferroni's *post-hoc* tests were performed when the ANOVA indicated significant differences. The partial eta squared was calculated and classified as small effect ($0.02 < \eta^2_p < 0.13$), medium effect ($0.13 < \eta^2_p < 0.26$), or large effect ($\eta^2_p > 0.26$) (Pierce, Block, & Aguinis, 2004). All the analyses were conducted using the software IBM SPSS Statistics (version 19; SPSS, Inc., Chicago, IL, USA).

Results

Figure 1 shows the descriptive data regarding the collective variables. A significant effect of the context was observed in the width values ($F_{(2,53)}=5.584$, $p=.006$, $h^2_p=0.183$, medium effect).

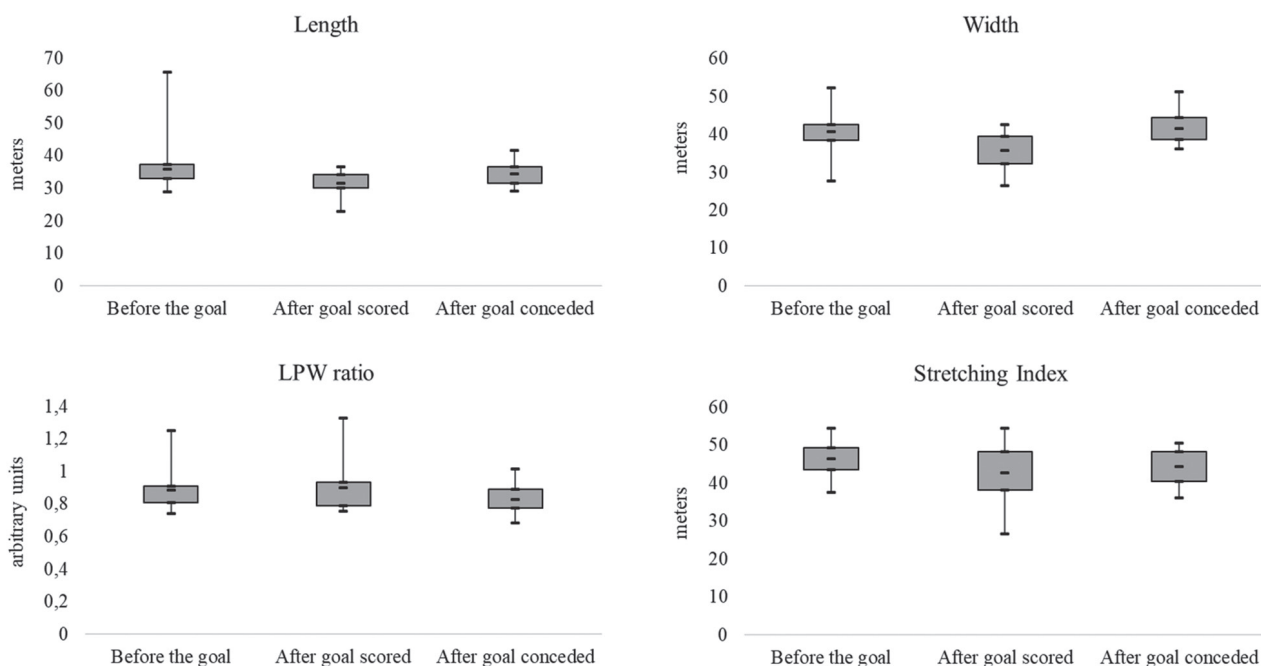


Figure 1. Boxplots of the collective variables.

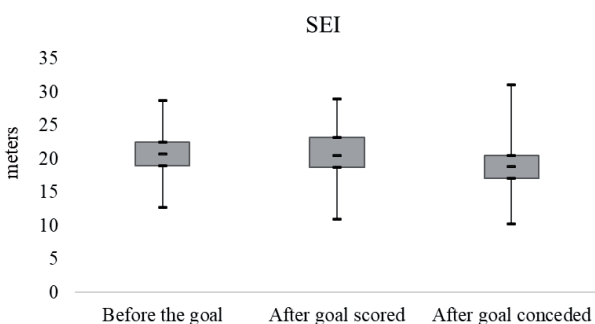


Figure 2. Boxplot for the spatial exploration index.

At this point, the after-goal-in-favor moment showed lower values than the other two situations. There were no significant differences in the length ($F_{(2,53)}=3.100$, $p=.054$, $h^2_p=0.110$, small effect), and stretching index ($F_{(2,53)}=1.806$, $p=.175$, $h^2_p=0.067$, small effect). Figure 1 also shows the descriptive data related to the LPW ratio. No significant differences were reported between the contexts ($F_{(2,53)}=1.162$, $p=.321$, $h^2_p=0.044$, small effect).

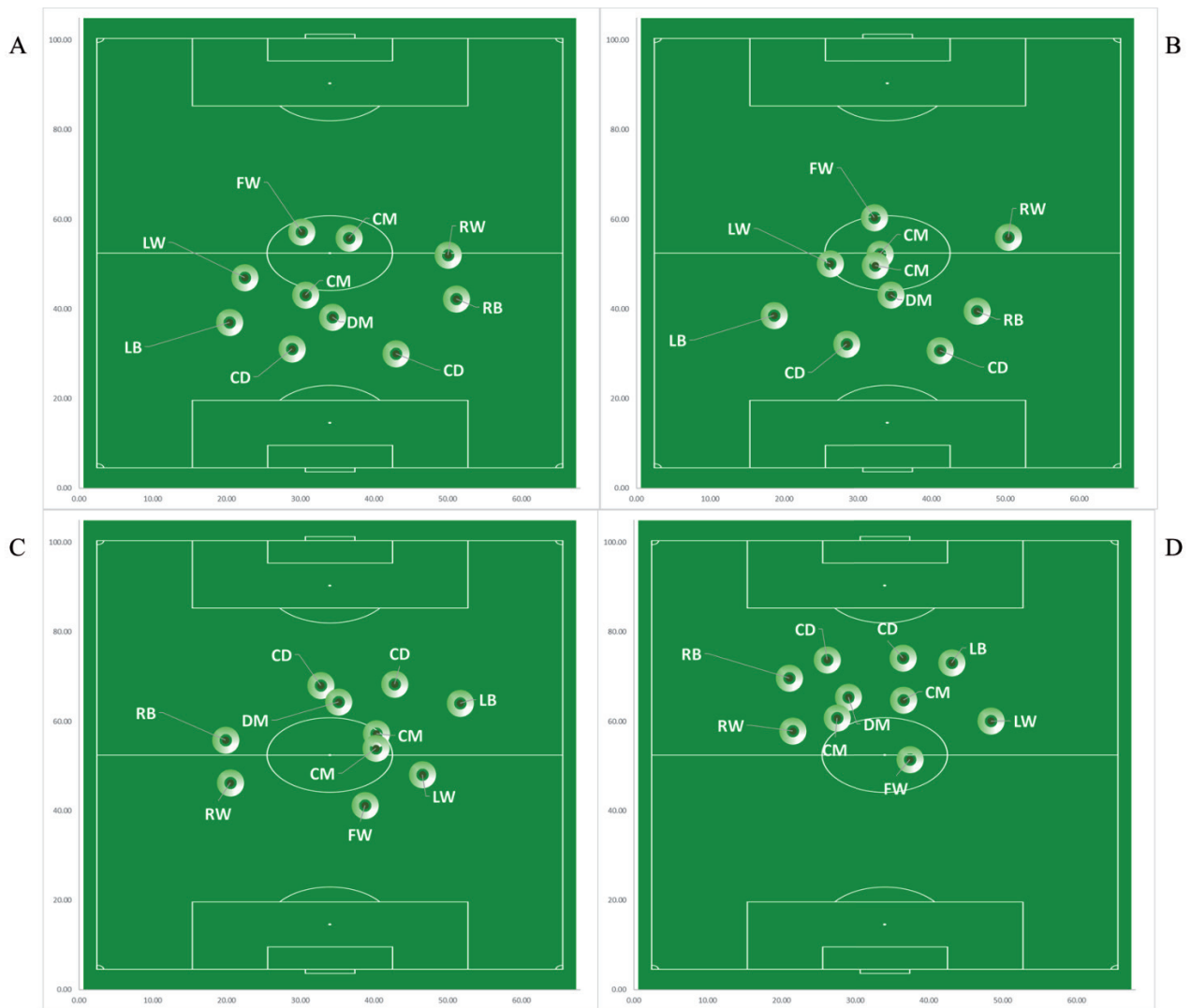
Figure 2 shows the SEI descriptive data, which indicates lower values for the after-goal-conceded condition compared with all the other contexts ($F_{(2,53)}=21.672$, $p<.001$, $h^2_p=0.075$, small effect).

Finally, Figure 3 shows the positional comparison between the moments from different matches as an example of positional changes due to a scored goal. It is possible to notice a higher proximity of the players in the midfield after the goal conceded (3B) than before the goal (3A), indicating reduced spatial exploration. Also, the reduction in the width (3D) is noticeable after scoring a goal compared to before the goal (3C).

Discussion and conclusions

The current study aimed to compare the tactical positional data of official U-20 soccer matches between three contextual situations: fifteen minutes before the first goal was scored, fifteen minutes after a goal in favor was scored, and fifteen minutes after a goal against was scored. The results indicate that a scored goal reduced the width positioning of the team. Besides, from an individual perspective, players tended to explore fewer pitch areas after their team conceded a goal.

Concerning the collective variables, a previous study indicated that final third entries were less frequent after the team scored a goal (Lago-Peñas & Gómez-López, 2014). Similarly, a 2018 FIFA World Cup study indicated that teams tended to adopt a more direct play style when winning (Praça et al., 2019), characterized by in-width positioning and a preference for long and forward passes. This result has been expanded recently in the investigation of the 2022 World Cup, in which reducing the width in the pitch's final third was assumed as a positive performance indicator for the teams (Praça, Brandão, de Oliveira Abreu, Oliveira, & de Andrade, 2023). Both results align with the current ones, which indicates a tendency to reduce width after scoring a goal. In addition, a previous study showed that, when defending, players tend to be closer to each other, reducing the possibility of the offensive team finding passing lanes (Moura et al., 2012). The strategy to protect the own goal, associated with the possibility of exploring counter-attacks due to the need of the opposing team to advance the defensive lines, might explain these results. In summary, both results confirm the orig-



Note. RB: right back; CD: central defender; LB: left back; DM: defensive midfielder; CM: central midfielder; FW: forward; LW: left-wing; RW: right-wing. Changes in tactical occupation can be observed when comparing after the goal conceded (B) with before the goal (A) moments and after the goal scored (D) with before the goal scored (C) moments.

Figure 3. Example of changes in positional responses due to changes in match status.

inal hypothesis that teams would adopt a more conservative tactical positioning after scoring a goal to avoid being scored.

Regarding the SEI, a previous study indicated that after scoring a goal, teams showed a higher percentage of successful passes (Redwood-Brown, et al., 2019). Similarly, a higher frequency of short passes was reported for winning teams compared to drawing and losing teams during the EURO 2016 (Konefał, et al., 2018). As reported in the literature, a higher difficulty in passing after conceding a goal might be explained by the current score. Specifically, we found lower values of spatial exploration after the team conceded a goal (the goal-against situation). Spatial exploration is a key to creating passing lanes and promoting unbalances in the opposing defensive system (Praça, Andrade, et al., 2021). Therefore, due to difficulties in dealing with the unfavorable score, players explored less available space, reducing their passing success.

The absence of previous studies on positional data before and after a goal scored hinders the discussion of the current study. Therefore, additional investigations are recommended at different playing levels and contexts. Also, the positional data was gathered from a single club, which requires caution when generalizing the results. Besides this caution, practical applications can be drawn. Firstly, training for moments in which the players experience conceding or scoring a goal must be addressed by coaches. This might be achieved by manipulating task constraints that elicit similar positional tactical behavior. For example, it has been shown that progression-to-the-target small-sided games led to a higher positional exploration, mainly in length, compared to regular games (Praça, Andrade, et al., 2021). Therefore, this seems an exciting task constraint to stimulate players to progress through the pitch when in possession, which seems relevant after conceding a goal. Also, floaters can be

used to replicate low-positioning defensive strategies (which seems to be the case after being scored) as they were reported to stimulate ball circulation (Castellano, Silva, Usabiaga, & Barreira, 2016; Padilha, Guilherme, Serra-Olivares, Roca, & Teoldo, 2017; Praça, Clemente, de Andrade, Morales, & Greco, 2017). Besides task constraints, informational constraints can be manipulated to lead to transferrable adaptations (Chow, 2013; Shafizadeh, Davids, Correia, Wheat, & Hizan, 2016). At this point, creating situations in which players have to start the task by losing or winning by one goal might elicit the emergence of patterns similar to those required in actual match-play.

Finally, match analysts and researchers might benefit from the results of the current study. Firstly, the mere information that scoring a goal impacts positional demands should be considered when elaborating game plans and interventions on the pitch. For example, designing *a priori* alternative strategies in case an early goal is conceded or scored might be interesting to facilitate the coaching process through matches. Also, as recently postulated, the whole match positional analysis likely hinders the complete comprehension of the sports performance phenomenon (Praça, Moreira, et al., 2022). Therefore, besides the already investigated

goal-scoring and game phase influence, researchers and practitioners are encouraged to open the black box of positional data and look at the detailed information instead of whole-match summaries. This will allow a deep comprehension of intrinsic match dynamics and likely increase the quality of training prescription and match planning.

The current study, besides being innovative, presents certain limitations. First, we observed all the matches of a single team. Although the number of matches and players was high, future studies with more diverse samples are recommended. Also, only linear position-based variables were adopted. Measures such as players' synchronization (Aguiar, Goncalves, Botelho, Lemmink, & Sampaio, 2015) might provide interesting insights into the within-game changes and should be explored in future studies.

In summary, it is concluded that positional tactical variables are affected by scoring or conceding a goal in official matches. Specifically, a more conservative tactical positioning, characterized by in-width concentration, will likely happen after scoring a goal. On the other hand, after conceding a goal, players tend to explore the pitch less.

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Submitted: March 14, 2023

Accepted: October 12, 2023

Published Online First: June 24, 2024

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