External load of soccer players in the moments before and after a goal

Carga externa en jugadores de fútbol en momentos previos y posteriores al gol

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Abstract

Introduction: Research has explored factors linked to scoring goals in soccer, but little is known about teams' external load when a goal occurs.
Objective: This study aimed to analyze differences in external load before and after a goal, depending on whether it was scored or conceded.
Methodology: The research focused on a Spanish youth semi-professional soccer team. The study examined player movement dynamics before (Pre5 and Pre10) and after (Post5 and Post10) goals were scored, using the minute of the match as a reference point. Data were collected on various performance metrics including total distance (DC), DC at high-speeds, player load (PL), accelerations ($Acc_{2\text{-}3}$ & $Acc_{>3}$) and decelerations ($Dec_{2\text{-}3}$ & $Dec_{>3}$).
Results: Regardless of the goal was conceded of scored, DC, PL, $Acc_{2\text{-}3}$, and $Dec_{>3}$ decreased at Post10 compared to Post10 ($p< 0.05$), along with lower values of $Acc_{2\text{-}3}$ and $Dec_{>3}$ at Post5 vs. Pre5 ($p< 0.029$). When scoring, DC and $Dec_{2\text{-}3}$ decreased in Post5 vs. Pre5 ($p< 0.049$), while when conceding, DC was lower at Post10 vs. Pre10 ($p= 0.017$).
Discussion: The external load of soccer players decreases when goal happens during the game. The number of studies comparing players' running responses after goals is scarce, highlighting the need for more research to analyze players' running activity once the goal occurs.
Conclusions: Once a team scores, it can be inferred that they have achieved their aim and that they may adopt a more conservative strategy, reducing their efforts.

Keywords

External load; football; goal; monitoring; time-motion.

Resumen

Introducción: La investigación ha explorado factores relacionados con la aparición del gol en fútbol. Sin embargo, se sabe poco sobre la carga externa de los equipos cuando ocurre un gol.
Objetivo: El objetivo del estudio fué analizar las diferencias en la carga externa de jugadores de fútbol antes y después de un gol, dependiendo de si este fue anotado o recibido.
Metodología: La investigación se centró en un equipo semiprofesional de futbol español. El estudio examinó las dinámicas de movimiento de los jugadores antes (Pre5 y Pre10) y después (Post5 y Post10) del gol, utilizando el minuto del partido como punto de referencia. Se recopilaron datos sobre diversas métricas de carga externa, como la distancia total (DC), DC a alta velocidad, Player load (PL), aceleraciones ($Acc_{2\text{-}3}$ y $Acc_{>3}$) y desaceleraciones ($Dec_{2\text{-}3}$ y $Dec_{>3}$).
Resultados: Independientemente de si el gol fue anotado o recibido, DC, PL, $Acc_{2\text{-}3}$ y $Dec_{>3}$ disminuyeron en Post10 en comparación con Pre10 ($p< 0.05$), junto con valores más bajos de $Acc_{2\text{-}3}$ y $Dec_{>3}$ en Post5 vs. Pre5 ($p< 0.029$). Al anotar un gol, DC y $Dec_{2\text{-}3}$ disminuyeron en Post5 vs. Pre5 ($p< 0.049$), mientras que al recibir un gol, la DC fue menor en Post10 vs. Pre10 ($p= 0.017$).
Discusión: La carga externa de los futbolistas disminuye tras la ocurrencia de un gol. Existe una falta de investigación que compare las respuestas de carrera de los jugadores después de los goles, lo que destaca la necesidad de más investigación.
Conclusiones: Tras anotar un gol, los jugadores pueden entender que se ha alcanzado el objetivo, esto puede adoptar una estrategia más conservadora, reduciendo sus esfuerzos de desplazamiento.

Palabras clave

Carga externa; fútbol; gol; monitorización; time-motion.

Introduction

Sports performance is multifaceted, complex, and often unpredictable (Hughes & Franks, 2005). Football is especially susceptible to randomness, to the extent that some authors view football matches as a stochastic process (Mackenzie & Cushion, 2013). In recent decades, there has been a notable increase in performance analysis research in football, aiming to mitigate its unpredictability (Hughes & Franks, 2005). This unpredictability is significantly influenced by the multitude of factors that affect players' performance (Aquino et al., 2020; Dellal et al., 2011). External parameters such as match venue, congested fixtures, or the respective league can affect match performance components (Dellal et al., 2011). In the same way, game-related aspects such as effective playing time have also been shown to be an important element influencing the demands on players (Altmann et al., 2023; Tojo et al., 2023) Simillarlly, individual characteristics such as anthropometry or physical capacities influence the physical, technical, and tactical output of players on the pitch (Aquino et al., 2020).

On the other hand, one of the aspects that has the most influence on the behavior of soccer teams is the score-line of the match (Castellano et al., 2014). It has been demonstrated that most goals (+70%) come after sequences of short passes; more than 70% of goals are scored from within the penalty area; and approximately 30% of goals are scored from set plays (Wright et al., 2011). In terms of the times at which most goals occur, studies indicate that goal-scoring patterns are time-dependent. In fact, a recent study showed that more goals are scored as time progresses through soccer games, with the last 15-min period of the game showing significant differences to the other periods (Armatas et al., 2007). Finally, (Bell-Walker et et al., 2006) observed that successful teams exhibit a higher likelihood of scoring from set plays, with a ratio of 1:7.5, compared to unsuccessful teams, which have a ratio of 1:14. Likewise it is know that, after a goal, teams typically adjust their tactical strategies(Moreira-Praça et al., 2024), with this event also having a significant impact on the mental aspect of the players, particularly in areas related to their well-being and morale (Vansteenkiste et al., 2010). Considering that scoring more goals than the opponent is the primary objective of football (Schulze et al., 2022), some scholars argue that soccer coaches and technical staff must give greater attention to identifying goal-scoring trends. Such insights could prove instrumental in formulating strategies for optimizing team performance (Kubayi & Toriola, 2019). The pivotal factor that often decides the outcome of a football match, and consequently the success of a team, is scoring goals. Previous authors have discovered a significant correlation between goals scored and obtaining a higher number of points at the conclusion of the league competition in the Spanish LaLiga during the 2013 to 2015 seasons (Castellano et al., 2011).

From a tactical standpoint, a recent study of a German professional soccer league found a significant correlation between shooting accuracy variables and team success by the end of the season (Konefal et al., 2019; Lepschy et al., 2020). Similarly, a systematic review determined that the most influential technical-tactical variables included goals per shot, shots on goal and successful passes (Lepschy et al., 2018). After studying two full seasons of a professional soccer team, it was found that team success depended not only on goals scored but also on factors such as creating scoring opportunities near the opponent's goal (e.g., shots on target or set pieces) and the number of goals conceded (Oliva-Lozano et al., 2023). As can be seen, most tactical parameters studying success in football are related to the scoring of goals. The scientific literature has also attempted to elucidate, from a physical standpoint, the aspects associated with scoring goals (Faude et al., 2012; O'Donoghue & Robinson, 2016; Schulze et al., 2022). Faude et al. (2012) showed that straight sprints most often preceded a goal, and that running behavior was related to the effectiveness of goal scoring opportunities. Another study found that the attacker's running behavior 1 min immediately preceding the attempt was more important than their performance over a longer period (5 min prior) in creating a goal-scoring opportunity, and was positively correlated with success (Schulze et al., 2022). A notable correlation was discovered regarding the overall distance traveled during the minute preceding an attempt, with defenders covering a greater distance, as they typically initiate attacks from further away from the opponent's goal. However, no significant correlations were observed between playing positions and physical exertion before successful attempts, suggesting that the heightened running activity is unrelated to player positioning (Schulze et al., 2022). In addition, after scoring, teams generally run shorter distances and perform fewer sharp path changes (O'Donoghue & Robinson, 2016).

Despite efforts to elucidate the motoric processes involved when a goal is scored, information about the external load of teams before and after a goal attempt remains exceedingly limited. Therefore, the aim of the current study was (i) to analyze differences in teams' external load in the moments before and after a goal is scored in the match, and (ii) to compare the differences in external load in the moments before and after the goal, distinguishing between whether the goal is scored or conceded. The authors hypothesized that in the moments prior to scoring a goal, there are higher values of external load compared to after scoring it. Conversely, when a goal is conceded, players' external load demands are lower in the moments preceding the goal compared to those afterward.

Method

Participants

The research was carried out on a Spanish youth professional soccer team throughout the 2019/2020 season. The team comprised 22 football players with an average age of 20.6 ± 1.8 years, weight of 73.0 ± 7.1 kilograms, and height of 1.80 ± 7.4 meters. These individuals competed at a semi-professional level in a Spanish third division football club. All players had a minimum of 10 years of soccer experience, with some regularly participating with the first team in the Spanish First Division during both training and competitive events. For analysis, only data from players who completed the full match were included, excluding those who were substituted or injured. All players were briefed on the protocol and research objectives, and their involvement was voluntary, anonymous, and confirmed through the signing of an informed consent form. Given the nature of the study, which did not necessitate typical ethics committee authorization (Winter & Maughan, 2009), the research adhered to ethical standards outlined in the Declaration of Helsinki. The study was reviewed and conducted in accordance with these ethical standards.

Procedure

The research used a descriptive and retrospective approach to thoroughly investigate and analyze the external load experienced by soccer players in the periods leading up to and following a goal. External load was tracked using a GPS system (WIMU Pro, RealTrack Systems, Almería, Spain) operating at a sampling rate of 10 Hz. This device is reliable and valid for measuring various physical activities and movements, including accelerations, decelerations, with good agreement and consistency compared to other systems (Pons et al., 2019, 2021). Validity and reliability for collecting time-motion variables have been evaluated, making it a suitable tool for football-related purposes. (Bastida-Castillo et al., 2017, 2018). The variables recorded were total distance covered (DC), DC above 21 km·h−1 (DC> 21 km·h−1), DC> 24 km·h−1, player load (PL) accelerations and decelerations between 2 and 3 m·s-2 (Acc2-3; Dec2-3;) and above 3 m·s-2 (Acc>3; Dec>3). These variables have been utilized in previous research (Akenhead et al., 2013; Asian-Clemente et al., 2024; Asian-Clemente et al., 2021; Asín-Izquierdo et al., 2023). A formula previously proposed in literature was used to calculate the PL of the players (Gómez-Carmona et al. 2020).

The study encompassed 23 official matches (15 wins, 3 draws and 5 losses) in the season during which participants were closely monitored. A total of 79 goals were analyzed, with the team under study scoring 56 goals and conceding 23. The acquired data formed part of the daily monitoring process for the players, making them highly accustomed to the tools used in this study. The design, procedure, and operation of the data registers were monitored by an external evaluator, independent of the technicians, to ensure optimal conditions during their execution. When a goal was scored, the minute of the match served as the reference point, and players' external load were recorded during the previous 10- and 5-minute periods (Pre10 and Pre5 respectively), as well as during the following 5- and 10-min periods (Post5 and Post10 respectively). For example, if a goal occurred in the 25th minute, Pre10 consisted of the external load of players during the 15 to 25-minute period; Pre5, from the 20 to 25-minute period; Post5, from the 25 to 30-minute period, and Post10 from the 25 to 35-minute period. If a goal was scored during minutes that did not fall within any of these periods (for example, the first or last 5 or 10 min of each half), the corresponding period was excluded from the analysis. Additionally, the data were categorized based on whether the goal was scored by the studied team (scoring goals) or the opposing team (conceded goals). For this study, 5-minute and 10-minute time windows before and after the goal were

used, considering that they could represent an adequate period of time to explain the players' external workload. Taking into account that in the specialized literature, the most commonly considered time periods were 1-, 3-, 5-, and 10-minute time windows (Rico-González et al., 2022), the first two were discarded as they were considered too short to explain the external workload demands of the entire team in these situations.

The regular weekly training regimen at the club's facilities involved five sessions lasting around 90 min each, following a consistent structure on Monday, Wednesday, Thursday, Friday, and Saturday. Additionally, one match per week was typically scheduled for Sunday, except when matches occurred on Saturday. In such cases, only four training sessions took place on Monday, Wednesday, Thursday, and Friday. The GPS-GNSS waistcoats were distributed 30-min before the warm-up, coinciding with the footballers passing through the technical room for weigh-in. Following each match, the principal investigator retrieved the devices, recording and analyzing the data from each measurement individually.

Data analysis

The normality of each dataset was assessed using the Kolmogorov-Smirnov test, Q-Q plots of residuals, and histograms of random coefficients. Data that did not follow a normal distribution were transformed prior to further analysis. Mixed model analyses were employed to examine the effects of time intervals around goals scored and conceded (Pre10, Pre5, Post5, Post10) on the dependent parameters. For each dependent parameter, the model included the time intervals around goals scored or conceded as the independent fixed factor, with random intercepts assigned to individual goals conceded. The goodness of fit for the models was evaluated using a log-likelihood ratio test. Planned contrasts were specified to assess the differences between Pre5 and Post5 and between Pre10 and Post10 times around all the goals, and the goals scored or conceded, and p-values were adjusted using Bonferroni's correction. Statistical significance was set at $\alpha < 0.05$. Unless otherwise stated, all values are presented as estimated marginal mean ± SE. The data analysis was performed using JAMOVI for Mac (version 2.3.21; The Jamovi project and the jamovi module GAMLj: General analyses for linear models). The planned contrasts were performed using JASP for Mac (version 0.16.4, JASP Team).

Results

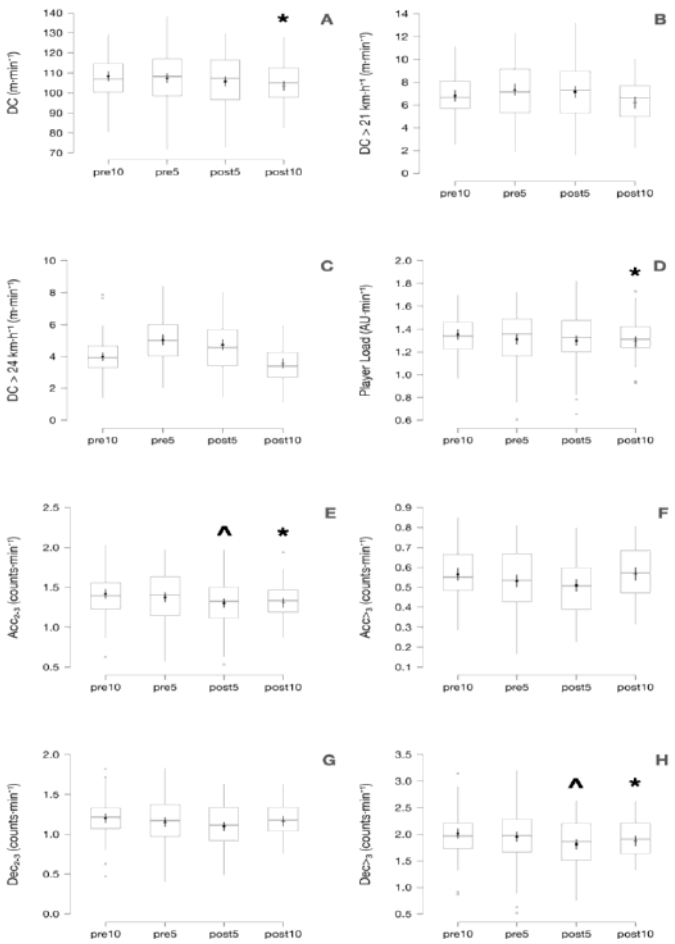
The comparison of the external load in the periods before and after the goal is presented in Table 1 and Figure 1. The results indicated that, regardless of the team scoring the goal, during Pre10 there were significantly more DC (MD = -4.86 m·min-1 95% CI [-6.66, -3.05], p < 0.001, d = -0,13 95% CI (-0,17, -0,08) , Trivial), PL (MD = -0.06 AU·min-1 95% CI [-0.10, -0.02], p = 0.003, d = -0,07 95% CI (-0,12, -0,03) , Trivial), Acc2-3 (MD = -0.11 counts·min-1 95% CI [-0.18, -0.05], p = 0.001, d = -0,08 95% CI (-0,13, -0,03) , Trivial) and Dec>3 (MD = -0.14 counts·min-1 95% CI [-0.23, -0.06], p = 0.001, d = -0,08 95% CI (-0,13, -0,03) , Trivial) than during Post10. Similarly, during the Pre5 period there were significantly higher Acc2-3 (MD = -0.07 counts·min-1 95% CI [-0.13, -0.01], p = 0.029, d = -0,06 95% CI (-0,1, -0,01) , Trivial) and Dec>3 (MD = -0.14 counts·min-1 95% CI [-0.22, -0.07], p < 0.001, d = -0,09 95% CI (-0,13, -0,04) , Trivial).

Table 1. Relative external load of the team when a goal occurs in the match, regardless of whether the goal is scored or conceded.

Variable	Pre10	Pre5	Post5	Post10
DC (m·min^{-1})	108.33 ± 1.27	107.41 ± 1.26	105.71 ± 1.27	103.47 ± 1.30*
DC > 21 km·h^{-1} (m·min^{-1})	6.80 ± 0.26	7.34 ± 0.27	7.16 ± 0.27	6.20 ± 0.27
DC > 24 km·h^{-1} (m·min^{-1})	3.99 ± 0.14	5.04 ± 0.17	4.74 ± 0.18	3.57 ± 0.16
Player Load (AU·min^{-1})	1.35 ± 0.02	1.31 ± 0.02	1.30 ± 0.02	1.29 ± 0.02*
Acc_{2-3} (counts·min^{-1})	1.42 ± 0.03	1.37 ± 0.03	1.30 ± 0.03^	1.31 ± 0.03*
$Acc_{>3}$ (counts·min^{-1})	0.56 ± 0.02	0.53 ± 0.02	0.51 ± 0.02	0.57 ± 0.02
Dec_{2-3} (counts·min^{-1})	1.20 ± 0.03	1.15 ± 0.03	1.10 ± 0.03	1.16 ± 0.03
$Dec_{>3}$ (counts·min^{-1})	2.02 ± 0.05	1.95 ± 0.05	1.81 ± 0.05^	1.87 ± 0.05*

Pre 10: the 10 minutes before a scored goal; Pre 5: the 5 minutes before a scored goal; Post 5: the 5 minutes after a scored goal; Post 10: the 10 minutes after a scored goal. DC: total distance covered; DC > 21 km·h^{-1}: distance covered above 21 km·h^{-1}, DC > 24 km·h^{-1}: distance covered above 24 km·h^{-1}; Acc_{2-3}: Accelerations between 2 to 3 m·s^{-2}; $Acc_{>3}$: Accelerations above 3 m·s^{-2}, Dec_{2-3}: Decelerations between 2 to 3 m·s^{-2}; $Dec_{>3}$: Decelerations above 3 m·s^{-2}; *: $p \leq 0.05$ statistically significantly different from Pre 10; ^: $p \leq 0.05$ statistically significantly different from Pre 5.

Figure 1. Comparative analysis between different times regardless of whether the goal is scored or conceded.



Each box plot represents the data distribution at a specific time point. For each box plot, the line inside the box represents the median, the box edges represent the first and third quartiles, and the whiskers extend from the box to the most extreme values within 1.5 times the interquartile range. Points outside the whiskers represent outliers. The symbol inside each box represents the mean and the 95% confidence interval (CI). A) Total distance covered, B) Distance covered above 21 km·h^{-1}, C) Distance covered above 24 km·h^{-1}, D) Player load, E) Accelerations between 2 to 3 m·s^{-2}, F) Accelerations above 3 m·s^{-2}, G) Decelerations between 2 to 3 m·s^{-2} and H) Decelerations above 3 m·s^{-2}. Pre 10: the previous 10 minutes before scoring a goal; Pre 5: the previous 5 minutes before scoring a goal; Post 5: the 5 minutes after scoring a goal; Post 10: the 10 minutes after scoring a goal. *: $p \leq 0.05$ statistically significantly different from Pre 10; ^: $p \leq 0.05$ statistically significantly different from Pre 5. See the text for further explanation.

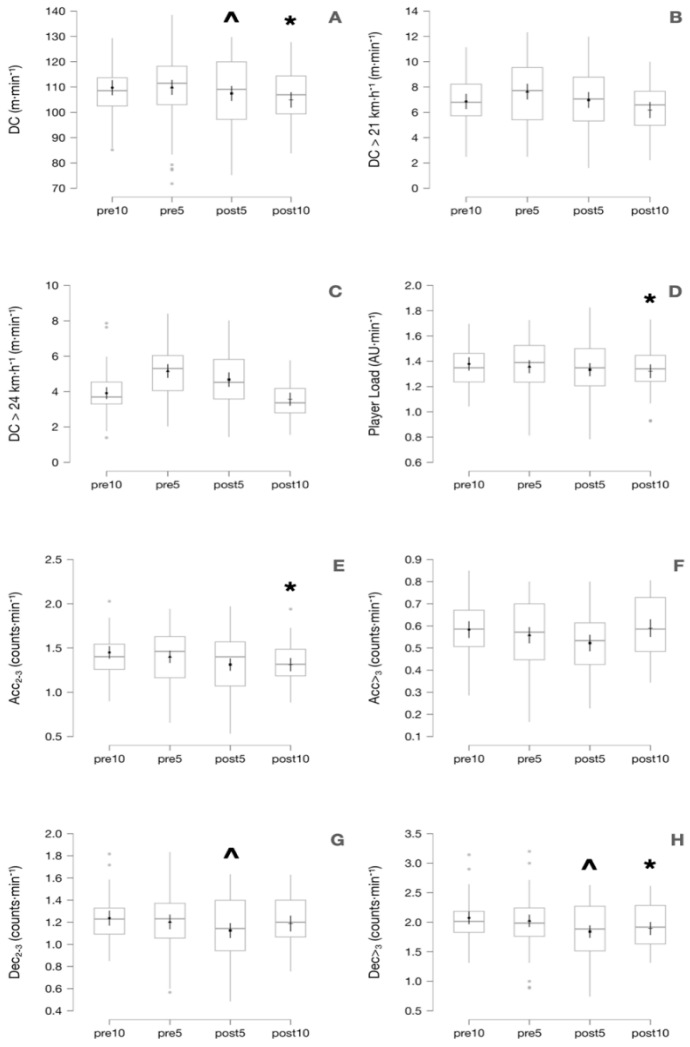
The comparison of the external load in soccer players in the moments preceding and following the achievement of a goal is illustrated in Table 2 and Figure 2. Analysis revealed that when the team scored a goal, there were significant differences during the Post10 and Pre10 period, with lower values observed in DC (MD = -4.82 m·min-1 95% CI [-6.89, -2.75], p < 0.001, d = -0,13 95% CI (-0,18, -0,07) , Trivial), PL (MD = -0.06 AU·min-1 95% CI [-0.10, -0.01], p = 0.028, d = -0,07 95% CI (-0,13, -0,01) , Trivial), Acc2-3 (MD = -0.14 count·min-1 95% CI [-0.22, -0.06], p < 0.001, d = -0,1 95% CI (-0,15, -0,04) , Trivial) and Dec>3 (MD = -0.18 count·min-1 95% CI [-0.28, -0.08], p < 0.001, d = -0,1 95% CI (-0,15, -0,04) , Trivial) during Post10. Furthermore, during the Post5 period, there were significant differences compared to Pre5, with lower values observed in DC (MD = -2.40 m·min-1 95% CI [-4.27, -0.54], p = 0.023, d = -0,07 95% CI (-0,13, -0,02) , Trivial), Dec2-3 (MD = -0.08 count·min-1 95% CI [-0.15, -0.01], p = 0.049, d = -0,06 95% CI (-0,12, -0,01) , Trivial),), Dec>3 (MD = -0.18 count·min-1 95% CI [-0.27, -0.09], p < 0.001, d = -0,11 95% CI (-0,17, -0,06) , Trivial) in the Post5.

Table 2. Relative external load of the team in the moments before and after scoring a goal.

Variable	Pre10	Pre5	Post5	Post10
DC (m·min^{-1})	109.74 ± 1.50	109.86 ± 1.48	107.46 ± 1.48^	104.92 ± 1.53*
DC > 21 km·h^{-1} (m·min^{-1})	6.86 ± 0.31	7.64 ± 0.31	6.98 ± 0.32	6.18 ± 0.32
DC > 24 km·h^{-1} (m·min^{-1})	3.92 ± 0.17	5.16 ± 0.20	4.68 ± 0.21	3.57 ± 0.19
Player Load (AU·min^{-1})	1.38 ± 0.03	1.36 ± 0.03	1.33 ± 0.03	1.32 ± 0.03*
$Acc_{2\text{-}3}$ (counts·min^{-1})	1.45 ± 0.04	1.40 ± 0.04	1.31 ± 0.04	1.31 ± 0.04*
$Acc_{>3}$ (counts·min^{-1})	0.58 ± 0.02	0.56 ± 0.02	0.52 ± 0.02	0.59 ± 0.02
$Dec_{2\text{-}3}$ (counts·min^{-1})	1.24 ± 0.03	1.20 ± 0.03	1.13 ± 0.03^	1.19 ± 0.04
$Dec_{>3}$ (counts·min^{-1})	2.07 ± 0.05	2.02 ± 0.05	1.84 ± 0.05^	1.89 ± 0.06*

DC: total distance covered; DC > 21 km·h^{-1}; Distance covered above 21 km·h^{-1}, DC > 24 km·h^{-1}: Distance covered above 24 km·h^{-1}; $Acc_{2\text{-}3}$: Accelerations between 2 to 3 m·s^{-2}; $Acc_{>3}$: Accelerations above 3 m·s^{-2}, $Dec_{2\text{-}3}$: Decelerations between 2 to 3 m·s^{-2}; $Dec_{>3}$: Decelerations above 3 m·s^{-2}; Pre 10: the 10 minutes before a scored goal; Pre 5: the 5 minutes before a scored goal; Post 5: the 5 minutes after a scored goal; Post 10: the 10 minutes after a scored goal. *: $p \leq 0.05$ statistically significantly different from Pre 10; ^: $p \leq 0.05$ statistically significantly different from Pre 5.

Figure 2. Comparative analysis between times before and after scored goals.



Each box plot represents the data distribution at a specific time point. For each box plot, the line inside the box represents the median, the box edges represent the first and third quartiles, and the whiskers extend from the box to the most extreme values within 1.5 times the interquartile range. Points outside the whiskers represent outliers. The symbol inside each box represents the mean and the 95% confidence interval (CI). A) Total distance covered, B) Distance covered above 21 km·h^{-1}, C) Distance covered above 24 km·h^{-1}, D) Player load, E) Accelerations between 2 to 3 m·s^{-2}, F) Accelerations above 3 m·s^{-2}, G) Decelerations between 2 to 3 m·s^{-2} and H) Decelerations above 3 m·s^{-2}. Pre 10: the previous 10 minutes before scoring a goal; Pre 5: the previous 5 minutes before scoring a goal; Post 5: the 5 minutes after scoring a goal; Post 10: the 10 minutes after scoring a goal. *: p ≤ 0.05 statistically significantly different from Pre 10; ^: p ≤ 0.05 statistically significantly different from Pre 5. See the text for further explanation.

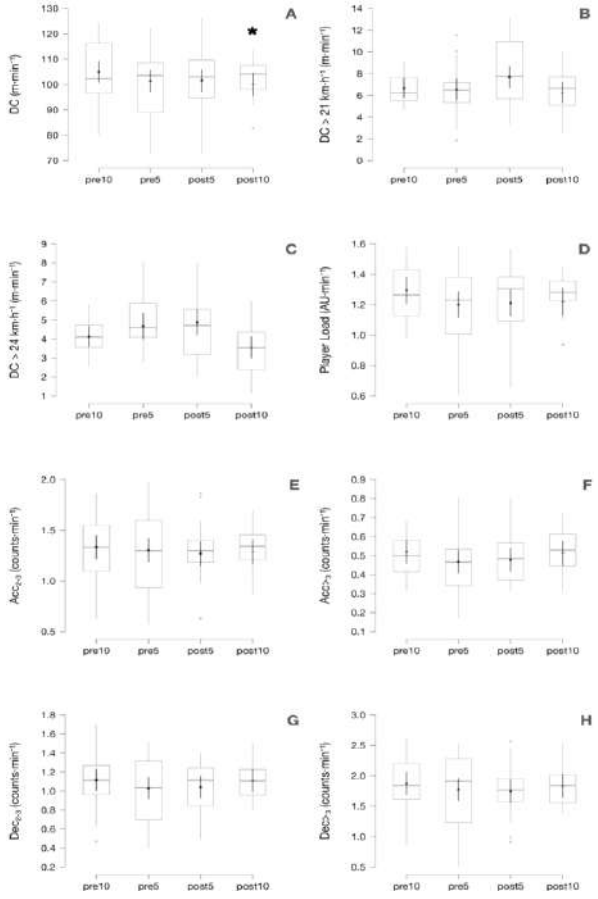
The comparison of the external load in the moments preceding and following the concession of a goal is presented in Table 3 and Figure 3. Among all variables studied, differences were observed only in DC between Post10 and Pre10, with significantly higher values recorded before the goal (MD = -4.87 m 95% CI [-8.49, -1.25], p = 0.017, d = -0,12 95% CI (-0,21, -0,03), Trivial).

Table 3. Relative external load of the team in the moments before and after conceding a goal.

Variable	Pre10	Pre5	Post5	Post10
DC (m·min^{-1})	104.97 ± 2.18	101.40 ± 2.17	101.60 ± 2.23	100.10 ± 2.25*
DC > 21 km·h^{-1} (m·min^{-1})	6.65 ± 0.47	6.53 ± 0.50	7.68 ± 0.51	6.25 ± 0.49
DC > 24 km·h^{-1} (m·min^{-1})	4.13 ± 0.28	4.68 ± 0.34	4.87 ± 0.34	3.55 ± 0.29
Player Load (AU·min^{-1})	1.30 ± 0.04	1.20 ± 0.04	1.21 ± 0.04	1.22 ± 0.05
Acc_{2-3} (counts·min^{-1})	1.33 ± 0.06	1.31 ± 0.06	1.27 ± 0.06	1.29 ± 0.06
$Acc_{>3}$ (counts·min^{-1})	0.52 ± 0.03	0.47 ± 0.03	0.48 ± 0.03	0.51 ± 0.03
Dec_{2-3} (counts·min^{-1})	1.12 ± 0.06	1.03 ± 0.06	1.04 ± 0.06	1.11 ± 0.06
$Dec_{>3}$ (counts·min^{-1})	1.87 ± 0.09	1.78 ± 0.09	1.75 ± 0.09	1.83 ± 0.10

DC: total distance covered; DC > 21 km·h^{-1}; Distance covered above 21 km·h^{-1}, DC > 24 km·h^{-1}: Distance covered above 24 km·h^{-1}; Acc_{2-3}: Accelerations between 2 to 3 m·s^{-2}; $Acc_{>3}$: Accelerations above 3 m·s^{-2}, Dec_{2-3}: Decelerations between 2 to 3 m·s^{-2}; $Dec_{>3}$: Decelerations above 3 m·s^{-2}; Pre10: the 10 minutes before a scored goal; Pre5: the 5 minutes before a scored goal; Post5: the 5 minutes after a scored goal; Post10: the 10 minutes after a scored goal. *: $p \leq 0.05$ statistically significantly different from Pre 10; ^: $p \leq 0.05$ statistically significantly different from Pre 5.

Figure 3. Comparative analysis between different times before and after conceded goals.



Each box plot represents the data distribution at a specific time point. For each box plot, the line inside the box represents the median, the box edges represent the first and third quartiles, and the whiskers extend from the box to the most extreme values within 1.5 times the interquartile range. Points outside the whiskers represent outliers. The symbol inside each box represents the mean and the 95% confidence interval (CI). A) Total distance covered, B) Distance covered above 21 km·h^{-1}, C) Distance covered above 24 km·h^{-1}, D) Player load, E) Accelerations between 2 to 3 m·s^{-2}, F) Accelerations above 3 m·s^{-2}, G) Decelerations between 2 to 3 m·s^{-2} and H) Decelerations above 3 m·s^{-2}. Pre 10: the 10 minutes before a conceded goal; Pre 5: the 5 minutes before a conceded goal; Post 5: the 5 minutes after a conceded goal; Post 10: the 10 minutes after a conceded goal. *: $p \leq 0.05$ statistically significantly different from Pre 10; ^: $p \leq 0.05$ statistically significantly different from Pre 5.

Discussion

The aim of the study was (i) to analyze differences in teams' external load in the moments before and after scoring a goal, regardless of whether it was in their favor or against, and (ii) to analyze the differences in external load in the moments before and after the goal, distinguishing between whether it was scored or conceded. The main findings show that when a goal is scored, regardless of whether it is in favor or against, there is a reduction in the team´s external load for DC, PL, Acc2-3, Dec>3 in the Post10 period, and Acc2-3 and Dec>3 in Post5, compared to the external load recorded during these same time periods immediately prior to the goal. Similarly, when analyzing the team's behavior during scored goals, similar results were obtained as when no distinction was made between goals scored in favor and

against. In contrast, and contrary to our initial hypothesis, there was a decrease in DC at Post10 following the concession of a goal.

Although previous studies have shown a shift in running patterns prior to a goal (Faude et al., 2012; O'Donoghue & Robinson, 2016; Schulze et al., 2022), information regarding the external load of soccer teams before and after goals remains exceedingly limited. In this study, twice as many of the goals analyzed were scored goals. Considering that when teams score a goal, they tend to create a more comfortable situation, leading to a slower game pace with less intense running and lower distances covered by players (Bloomfield et al., 2005), this could justify a reduction in players' external load in the 5 and 10 minutes following the scoring of a goal. Previous authors (O'Donoghue & Robinson, 2016) have shown that teams showed a lower relative DC and fewer changes of direction and sharp path changes after scoring, which may be reflected in our results with lower numbers of decelerations and accelerations and lower PL scores. Although straight sprinting is most frequent in players who score goals and provide assists (Faude et al., 2012), the results of this study did not show differences in the distance covered >21 and >24 km·h-1 in the moments before and after a goal was scored during the match (it did not change in any of the cases studied). Although the variability of high speed in football matches is high (Gregson et al., 2010), the circumstance that it does not change in the moments before and after a goal may be due to the requirement of a specific context for its development (wide spaces, specific tactical requirements, such as the high pressure or transition strategic, etc.), and it is less dependent on the emotional state or the tactical change that may result from the occurrence of a goal in the match (Asian-Clemente et al., 2022). On the other hand, variables such as accelerations and decelerations are more frequent in football than high speed (Oliva-Lozano et al., 2020), as they require less of this specific context, which could explain why their response is more sensitive to these aspects. The fact that periods of 5 and 10 min were considered, rather than just the action before and after the goal, could have led to differences between the results of this study and those reported in the literature. Another aspect that may justify the discrepancy observed in this study is that the values of all players on the team were used, not just those involved in the goal-scoring action. Considering that tactical behavior influences the running demands of soccer players (Asian-Clemente, Suarez-Arrones, Requena, & Santalla, 2022) teams' behavior could be affected in such a way that players closer to the goal-scoring action may have been exposed to higher-intensity actions, but the team data would be balanced by those players further from the ball, whose efforts would be of lower intensity. These results are in line with previous observations by other authors who did not observe changes in high-intensity activity after scoring a goal (Castellano et al., 2011).

The reduced external load observed after a goal is scored may also be attributed to a pacing strategy adopted by players upon scoring. In football, players have been shown to modulate their efforts under different circumstances during matches. For instance, players who complete the entire match have reported a positive pacing profile characterized by a gradual decline in total and high-intensity running compared to non-starting players (Edwards & Polman, 2013; Waldron & Highton, 2014). Similarly, to how a player modulates their efforts based on their expected playing time, the outcome of the match could also influence players' externar load, as it is known that during soccer tasks, the decision to reduce, increase or maintain a given power output will depend on the perceived benefits of each moment (Ferraz et al., 2018). Once a team scores a goal, it could be inferred that they have achieved their aim, and that they may adopt a more conservative strategy, reducing their efforts. In fact, it has been postulated that scoring, in most cases, is a comfortable status for a team and it is possible that players assume a ball contention strategy, keeping the game slower, which results in lower speeds and running distances (Bloomfield et al., 2005). This could also be related to the findings of previous authors, suggesting that less successful teams exhibit increased physical activity, while their players report decreased specific skill involvement and proficiency compared to their winning counterparts (Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009; Sullivan et al., 2014). However, these results should be interpreted with caution, as there are other studies that do not find differences in external load between the more successful and less successful teams in a league (Asian-Clemente et al., 2019). It is also true that, alongside pacing strategies, effective playing time could have influenced the results of this study. The literature has shown that effective playing time affects physical parameters during football games (Tojo et al., 2023). Therefore, the presence or absence of interruptions in the moments before and after goals could have conditioned the results. Unfortunately, this aspect was not controlled in the study. While this is indeed an important factor, the authors believed that establishing a fixed time window of 5 to 10 minutes was an initial step to help readers understand the significance of the moments before and after a goal. However,

further research is needed to deepen our understanding of this aspect, considering effective playing time.

On the other hand, although it is known that, after conceding a goal, players may feel pressure from their fans, coaching staff, and themselves to react positively (Thelwell et al., 2008), teams tend to cover more distance and more high intensity distance (Castellano et al., 2011) and they may experience an additional competitive drive to demonstrate their resilience and endurance after a setback in the match (Jones et al., 2005). Contrary to our thoughts, with the exception of DC at Post10 (Table 3), all the variables studied remained similar after conceding a goal. When a team concedes a goal, the opposing team typically gives up space and ball possession, which could result in a more positional attack from the conceding team, leading to a reduction in their DC. From a practical standpoint, a decrease of ~5 m·min^{-1} in DC is important to consider, as coaches sometimes design drills where the starting conditions are not equal, potentially leading to different DC demands on the players. It is also important to note that previous authors (Suarez-Arrones et al., 2015) have reported positional inequality in the DC supported during matches with similar score differentials. Therefore, even though this difference might seem small, it is crucial to take it into account when quantifying the players' load. Similarly, other possible explanation for why players' external load were not altered after conceding a goal could be the large number of goals scored and matches won during the season (65%). Conceding a goal is generally considered an adverse circumstance in football. However, when a team has scored double the number of goals it has conceded and has won three times more than it has lost during the season, most of the times the team concedes a goal, it does so in situations where it is already in a favorable position on the scoreboard. This may influence the players' external load to a lesser extent, as confidence and the advantage in the score can mitigate the emotional impact of conceding a goal and maintain stability in the team's performance. Considering that this has not been studied in this work, future studies should investigate the external load of football teams knowing the exact score of the match at the time of the goal (winning, drawing, or losing).

This study is not without limitations. Firstly, although these results are novel, it is important to note that effective playing time was not used (the time when the ball was not in play was not excluded). Aspects such as goal celebrations or stoppage time during set-piece actions were not removed from the results. These factors could have influenced the outcomes and should be considered when interpreting the results. For this reason, future studies analyzing the external load of players in the moments before and after a goal, while considering effective playing time, should be conducted. Similarly, discussing the external load of players before scoring or conceding a goal, without considering the entire team, could further explain our results, as it has been observed that defenders cover greater distances at high speeds before conceding a goal, while strikers do so before their team scores a goal (Schulze et al., 2022). Lastly, if a goal is scored from a set-piece free kick, a significant amount of time elapses from when the foul is committed, the referee signals the spot where players form the wall, and the actual kick takes place. This could impact the external load of the team in the minutes before the goal compared to what occurs after it.

Conclusions

When a goal was scored, regardless of whether it was in favor or against, there was a reduction in team's external load in the periods of 5 and 10 min after the goal in comparison with before. Interestingly, these results were highly influenced by the external load of the team when they scored a goal, as the change in external load activity was very similar. However, following the concession of a goal all the variables studied remained similar at both 5 and 10 min after the goal, with the exception of DC at Post10. However, these results should be treated with caution and should not be generalized, as they were obtained in a specific context of a youth professional soccer team during a successful season, and effective playing time was not considered in the analyzed periods.

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