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Linear advancing actions followed by deceleration and turn are the most common movements preceding goals in male professional soccer

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ABSTRACT

Data were collected through time-motion analysis from soccer players participating in the English Premier League using a modified version of the Bloomfield Movement Classification with differences analysed through chi-square.

The most common individual movement preceding a goal was a linear advancing motion (32.4 ± 1%), followed by deceleration (20.2 ± 0.9%) and turn (19.8 ± 0.9%). Actions also involved were change in angle run (cut and arc run), ball blocking, lateral advancing motion (crossover and shuffle) and jumps. Although players followed similar trends, there were dissimilarities based on the role, with attackers (assistant and scorer) performing more linear actions, subtle turns and cuts and defenders (defender of assistant and defender of scorer) more ball blockings, lateral movements and arc runs. In 82.9 ± 1.5% of player involvements, there was at least one high intensity (HI) movement with assistant showing the lowest percentage and defender of scorer the highest.

This study shows the multidirectional nature and context specificity of soccer during goal scoring situations, with linear actions such as sprints being the most common movements, followed by decelerations and turns. Moreover, it highlights the recurrent application of these at HI, and so, training strategies should prioritize the development of player's explosiveness.

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KEYWORDS
Movements; sprint; goal scoring actions; position specific; English Premier League

Introduction

Soccer is a team sport where players not only require technical and tactical abilities (Forsman et al. 2016) but must also develop a high level of athleticism to be successful (Turner and Stewart 2014). Soccer match activities have been widely analysed with researchers generally utilizing linear direction activities such as walking, jogging, running, high intensity (HI) running, and sprinting (Sarmento et al. 2014). Decelerations have also shown to be highly frequent with a meta-analysis showing these at HI to be more numerous than accelerations at HI (Harper et al. 2019). Moreover, soccer match analysis has shown numerous changes in activities, averaging 1431 ± 206 (Rienzi et al. 2000) with players performing more than 90 path changes from 45° to greater than 135° (Robinson et al. 2011) and more than 700 turns (Bloomfield et al. 2007), most of them between 0° and 90°. Furthermore, several conditions have shown to influence the quantity of change in directions. In this sense, a study by Granero-Gil et al. (2020) showed that the change in direction demands is higher during international matches compared to national or friendly matches while a large goal difference both in winning and losing teams produces a decline in the change in directions. When analysing locomotor activities, it is also important to consider the fact that 90-min average distances are lower compared to peak game demands, especially for HI activities (Riboli et al. 2021a), which are usually calculated with ranges going from 1 min peak to 10 min peak (Oliva-Lozano et al. 2021). In this sense winning, the match has shown to result in higher peak demands for high-speed running distance and speed distance in comparison to drawing or losing (Oliva-Lozano et al., 2020). In addition, team formation as well as playing position has shown to influence peak demands, with a recent study showing central and wide midfielders covering greater 1-min peak total distance and high-speed running while wide midfielders and forwards showed greater sprint and acceleration/deceleration 1-min peaks (Riboli et al. 2021b). This movement data, commonly obtained with GPS, has limited significance regarding subtle manoeuvres taking place in goal scoring situations. In this sense, accelerations, decelerations, or change of direction (COD) activities have shown poor accuracy when comparing different tracking measurement systems (Fischer-Sonderegger et al. 2021) and high variability when comparing different GPS brands (Jennings et al. 2010; Buchheit et al. 2014) or sampling frequency of systems (Duffield et al. 2010). Several studies have highlighted the complexity of effective creation and conversion of goal scoring opportunities with research investigating many key performance indicators (Wright et al. 2011; Pratas et al. 2018). In addition to technical variables and player movements, consideration has been given to contextual factors and tactical concepts (Lago-Ballesteros et al. 2012; Sarmento et al. 2018). It is also important to consider the relationship between these components with evidence suggesting that an increase in an attacking players physical output is essential for disturbing defensive organisation and providing space for goal scoring opportunities (Schulze et al. 2021). To the authors knowledge, only one study has analysed the movements occurring before

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a goal in relation to physical actions. Faude et al. (2012) analysed 360 goals of the German National League 2007/2008 using multiple replays and categorising into one of the following: straight sprint, rotation, jump, change-in-direction sprint, a combination or absence of these movements. Results showed that 83% of the goals were preceded by at least one powerful action of the scoring or the assisting player with straight sprint showing to be the most common action. This pioneering study highlights the importance of powerful actions before a goal in scoring and assisting players. Nevertheless, it is of interest to determine movement characteristics of other leagues besides German National League, such as English Premier League (EPL). There is need for a more detailed analysis which includes a wider range of movements, intensities and directions. Furthermore, the inclusion of players with defending roles would bring insight into common patterns performed by these as well as the main differences with their attacking counterparts. This would lead to a greater understanding of movements occurring in key moments of the game and help practitioners on the selection of drills based on how players are habitually involved in these actions.

The aim of this study was to gain a clear understanding of the movements that occur before a goal in male elite soccer. In order to achieve this aim, the study had the following objectives: 1. Acknowledge the most frequent movements preceding a goal and the percentage of involvements they are present in. 2. Identify similarities and differences between players based on their role. 3. Examine the movement intensity, direction, and interaction with the ball.

Methods

Procedures

EPL goals for the 2018/2019 season were analysed (video analysis) through broadcast footage using the same provider. Researchers had access to all goals, which could be seen in slow motion and through multiple angles. Motion analysis was evaluated for the attacking player that scored the goal (scorer), the attacking player who assisted the goal (assistant), closest defender to the scorer (defender of scorer), and closest defender to the assistant (defender of assistant). Motion analysis started just before the assistant (if applicable) received the ball from a teammate or when possession was regained and finished when the ball was passed to the scorer. Motion analysis for the scorer and the defender of the scorer (if applicable) started when the ball was passed to the scorer or regained the ball from the opposition and finished when the scoring player shot to goal. Analysis was limited to the last six movements of each player, with these being noted as '-5', '-4', '-3', '-2', '-1', and 'final movement'. The individual action or sequence of movements of each individual player performed before each goal was named as 'involvement'. Defender of assistant and defender of scorer together were named as 'defenders'. Assistant and scorer were named as 'attackers'.

Analysis of the movements preceding goals was performed using a modified version of the Bloomfield Movement Classification (BMC) (Bloomfield et al. 2004). Coding was performed by the lead author using a computerised notation system within a customised excel spreadsheet (Office 365 ProPlus) following the guidelines proposed for computerised performance analysis systems (O'Donoghue 2014).

Definition and Interpretation of Movements

Table 1 shows the movement classification table modified from BMC, which was used for data collection. Movements with similar characteristics were group together (Table 1). These were linear advancing motion (walk, jog, run, and sprint), lateral advancing motion (crossover and shuffle), change in angle run (cut and arc run), ball striking (pass and shot), and ball blocking (dive and slide). Movements with their own individual group

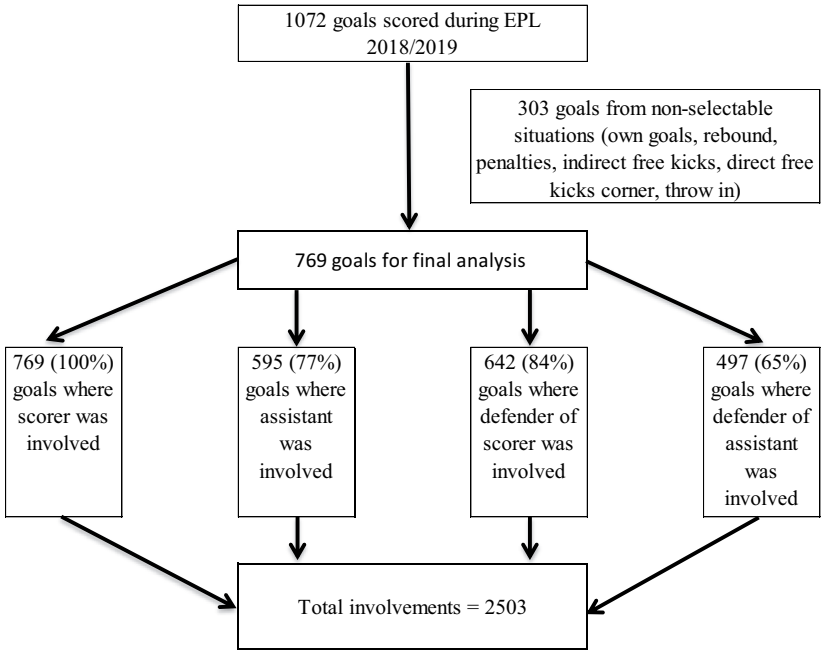

Figure 1. Flow chart of goals selected for analysis as well as total involvements.

were turn, deceleration, impact, stand still, jump, land, and fall get up (definitions of individual and group of movements can be found in Table 2). As seen in Table 1, direction modifier was applied to linear advancing motion, deceleration, turn and skip movements with diverse characteristics between these. More so, deceleration, turn, change in angle, and lateral advancing motion had intensity modifier: low intensity (LI), medium Intensity (MI), and high intensity (HI), while linear advancing motion intensities were defined as walk (LI), jog (LI), run (MI), and sprint (HI) with definitions presented in Table 3.

Statistics

Data were analysed using SPSS for Windows software version 22.0 (SPSS, Inc., Chicago, IL). Kolmogorov–Sirnov test was performed to assess for normal distribution, while significance level was set a $p < 0.05$. Data were not normally distributed. Pooled and individually coupled differences in frequencies between movements (individual and group of movements), players (individual and group of players), and movement modifiers (intensities, directions, and ball) were analysed through chi-square (x^2).

In order to obtain reliability of the movement classification system used, the same match day games (10 games) were analysed twice by the same researcher with 4 weeks between evaluations. This was analysed through intraclass correlation coefficients (ICC) (two-way mixed model, single rater, consistency) obtaining values of 0.87 which is considered good level of agreement (Koo and Li 2016).

Results

Total frequency and percentages of movements

A total of 9348 movements were recorded (3.1 per involvement), 7984 without the inclusion of pass and shot. Chi-square analysis showed significant differences between movements $x^2_{(7)} = 5694$, $p = 0.000$. As seen in Table 4, overall, the most common movement preceding a goal was a linear advancing motion, which was followed by deceleration and turn with no significant difference between these ($p = 0.526$). Other frequent movements can be found in Table 4.

Chi-square analysis showed significant differences for percentage of involvements where each movement was performed at least once ($x^2_{(6)} = 2051$, $p = 0.000$) as well as percentage of involvements where movement was performed at least once at HI ($x^2_{(6)} = 4216$, $p = 0.000$).

Intensity Modifier

Chi-square analysis showed significant differences for frequency of involvements where players performed at least one HI action ($x^2_{(3)} = 235$, $p < 0.0001$), with defender of scorer showing the highest percentages (Table 5). Significant differences were found between the three intensities in all movements when players were pooled together ($p < 0.0001$) (Figure 3). When looking at the differences between groups of players, defenders compared to attackers showed significantly greater amount of actions at HI in linear advancing motion ($p < 0.0001$), decelerations ($p < 0.0001$), and turns ($p < 0.0001$).

Direction Modifier

When analysing direction modifier for each movement, chi-square analysis showed significant differences in linear advancing motion ($x^2_{(2)} = 4380$, $p < 0.0001$), deceleration ($x^2_{(3)} = 690$, $p < 0.0001$) and turn ($x^2_{(4)} = 2139$, $p < 0.0001$). Most linear advancing motion activities had a forward direction (82.8% ±1.4%) followed by forward diagonal direction (15.3% ± 1.4%), with backward direction (1.9 ± 0.5%) being the least frequent. Most decelerations had a forward direction (43% ± 2.4%), followed by sideways (28.6% ± 2.2%) and forward

Table 1. Movement classification table for goal scoring situations analysis, modified from Bloomfield, et al. (2004)

GROUP OF MOVEMENTS	MOVEMENTS	MODIFIER 1: DIRECTION	MODIFIER 2: INTENSITY	MODIFIER 3: BALL
Linear Advancing Motion	Walk Jog Run Sprint	Forwards, Forwards Diagonally, Backwards	Walk (Low), Jog (Low), Run (Medium), Sprint (High),	Yes, No
Lateral Advancing Motion	Shuffle Crossover		Low, Medium, High	Yes, No
Change in Angle Run	Cut Arc Run		Low, Medium, High	Yes, No
Ball Striking	Pass Shoot			
Ball Blocking	Dive Slide			
Turn		0°-60°, 60°-120°, 120° −180°, 180°-270°, 270°-360°,	Low, Medium, High	Yes, No
Deceleration		Forwards, Forwards Diagonally, Backwards, Sideways	Low, Medium, High	Yes, No
Skip		Forwards, Backwards, Sideways		Yes, No
Impact				Yes, No
Stand Still				Yes, No
Jump				
Land				
Fall				
Get Up				

Table 2. Interpretation and definitions of movement group and movements.

Movement Group	Definition
Linear advancing motion	Actions were a player accelerates or maintains speed in a sagittal plane.
Lateral advancing motion	Actions were a player accelerates or maintains speed in a frontal plane.
Change in angle run	Actions were a player advancing on a linear direction maneuvers without or with very little loss in speed.
Ball blocking	Drive purposefully the lower limb or head in a certain manner to stop a ball or an attacker with
Ball striking	Contact made with the ball with the objective of passing or scoring a goal.
Movement	**Definition**
Walk:	Moving slowing by stepping.*
Jog:	Moving at a slow monotonous pace (slower than running, quicker than walking).*
Run:	Manifest purpose and effort, usually when gaining distance.*
Sprint:	Maximal effort, rapid motion.*
Shuffle:	Sideways advancing movement in which head, shoulders and hips face forward while legs and feet do not cross.
Crossover:	Sideways advancing movement in which head, shoulders and hips face forward while legs and feet cross.
Deceleration:	To slow down or brake suddenly.**
Turn:	To rotate while standing, decelerating or accelerating/ sprinting.
Cut:	Path change of less than 45° with this involving little or non-previous deceleration to accomplish the task.
Arc Run:	Player (often leaning to one side) moving in a semicircular direction.*
Skip:	Moving with small bound-like movements.*
Impact:	Any intense contact made with another player.*
Stand Still:	More or less stationary or staying in one spot.*
Jump:	Spring free from the ground or other base by the muscular action of feet and legs.*
Land:	Entered after jump when contact with ground is made.*
Dive:	To purposefully and controllably propel the body rapidly through the air either feet or head first.*
Slide:	To purposefully and controllably drive the body along the floor with feet leading the movement.
Fall:	Descending to the ground.*
Get up:	Ascending from the ground.*
Pass:	Any attempt to give the ball to a team-mate. Entered as contact made with the ball along with how*.
Shoot:	Any attempt on goal. Entered as contact made with the ball along with how.*

*Definition from Bloomfield et al. (2004)
** Modified definition from Bloomfield et al. (2004)

diagonal deceleration (25% ± 2.1%). The most common turning degree ranges were 0°-60° with 48.1% ± 2.5%, while 60° −120° (38.3% ± 2.4%) was the second most common and 120°-180° (10.8% ± 1.5%) the third. This trend showed to be different between positions as attackers showed significantly higher percentage of turns of 0° to 60° ($p < 0.0001$) while defenders presented significantly higher percentages of turns from 60° to120° ($p < 0.0024$). Additional data on difference between players and group of players for turn and deceleration direction modifier can be found in online Supplementary Table 1 and 2, respectively.

Ball Modifier

Assistant performed higher percentage of actions with the ball than without the ball in most of the movements while the opposite occurred in scorer except for cut were the latter also showed higher percentages with the ball ($p < 0.0001$). Additional data can be found in online Supplementary Table 3.

Table 3. Interpretation and definitions of different modifiers.

Modifiers	Definition
Direction	
Forward (Linear advancing motion)	Head, shoulders, hips all face forward moving in a forward direction.
Forward (deceleration)	Player braking with both or one limb and stopping body inertia pushing linearly forward.
Forward Diagonal (linear advancing motion)	Player's body turned about 45° left/right, head turned left/right, player looks over left/right shoulder, legs facing forward or slightly rotated advancing in a forward direction.**
Forward Diagonal (deceleration)	Player braking with both or one limb and body position turned approximately 45° left/right stopping body inertia pushing diagonally forward.
Backward (Linear advancing)	Head, shoulders, hips all face forward moving in a backward direction.
Backward (deceleration)	Head, shoulders, hips all face forward stopping body inertia pushing in a backward direction.
0°-60°:	Turn ≤1/6 circle.
60°-120°:	Turn > 1/6 circle and ≤ 1/3 circle.
120–180°:	Turn > 1/3 circle and ≤ 1/2 circle.
180°-270°:	Turn > 1/2 circle and ≤ 3/4 circle.*
270°-360°	Turn > 3/4 circle and ≤ full circle.*
Intensity	
Low:	Little effort.*
Medium:	Some to great effort.*
High:	Maximal effort.*
Ball	
Yes:	When the player is in possession of the ball
No:	When the player is not in possession of the ball

*Definition from Bloomfield et al. (2004)
** Modified definition from Bloomfield et al. (2004)

Discussion

The aim of this study was to gain a clear understanding of the movements that occur before a goal in elite soccer. The findings from the study highlight that the most common movement before a goal was a linear advancing motion followed by deceleration and turn. Moreover, while players followed similar trends, attackers performed more linear movements, subtle turns, and cuts, while defenders perform sharper turns, more lateral movements, ball blocking actions, and arc runs. Furthermore, in 82.9% ± 1.5% of player's involvements, there is a HI action, with assistant and defender of scorer showing the lowest and highest percentages, respectively.

The high frequency of linear advancing motion overall and during involvements shows similarities with Faude et al. (2012) who found sprints to be the most common action during goals scored, as this represents the fastest mode of travel to capitalize on or prevent goal scoring opportunities. In addition, when comparing between walk, jog, run, and sprint, the latter showed the highest percentages, highlighting the importance of accelerating fast and/or sprinting in goal scoring actions and that sprint ability has shown to discriminate between levels of performance (Haugen et al. 2013). Defending players showed greater percentages at HI compared to attackers, which could be related to the disadvantageous (tactically unbalanced) position compared to attackers. Defending players showed lower percentages of linear activities when compared to attackers which could be due to the difference in orientation, as habitually attackers would be facing the goal while defenders would have their backs to goal trying to protect it. Similar to

Table 4. Frequencies and percentages of movements in EPL overall, for individual players and groups of players.

Movements		Assistant (%)	Scorer (%)	Defender of Assistant (%)	Defender of Scorer (%)	Attackers (%)	Defenders (%)	Movement Total
Linear Advancing Motion		594 (35% ±2.3%)$^{¥x}$	862 (36.9% ±2%)$^{¥x}$	484 (29.8% ±2.2%)	648 (27.8% ±1.8%)	**1456 (36.1% ±1.5%)$^{\#}$**	1132 (28.6% 1.4%)	**2588 (32.4% ±1%)***
Deceleration		381 (22.5% ±2%)$^{\&x}$	431 (18.5% ±1.6%)$^{¥}$	399 (24.6% ±2.1%)^{x}	400 (17.2% ±1.5%)	812 (20.2% ±1.2%)	799 (20.2% ±1.3%)	**1611 (20.2% ±0.9%)****
Turn		388 (22.9% ±2%)$^{\beta}$	466 (20% ±1.6%)$^{¥}$	267 (16.4% ±1.8%)^{x}	458 (19.6% ±1.6%)	**854 (21% ±1.3%)$^{\#}$**	725 (18.3% ±1.2%)	**1579 (19.8% ±0.9%)****
Change in Angle Run	Arc Run	67 (4% ±0.9%)$^{\Omega}$	88 (3.8% ±0.8%)$^{x\Omega}$	72 (4.4% ±1%)$^{\Omega}$	118 (5.1% ±0.9%)$^{\Omega}$	155 (3.8% ±0.6%)$^{\# \Omega}$	**190 (4.8% ±0.7%)$^{\Omega}$**	345 (4.3% ±0.4%)
	Cut	104 (6.1% ±1.1%)$^{¥x}$	163 (7% ±1%)$^{¥x}$	31 (1.9% 0.6%)	48 (2.1% ±0.6)	**267 (6.6% ±0.8%)$^{\#}$**	79 (2% ±0.4%)	346 (4.3% ±0.4%)
	Totals	171 (10.1% ±1.4%)$^{¥x}$	251 (10.8% ±1.3%)$^{¥x}$	103 (6.3% ±1.2%)	166 (7.1% ±1%)	422 (10.5% ±1%)$^{\#}$	269 (6.8% ±0.8%)	691 (8.7% ±0.6%)*
Lateral Advancing Motion	Crossover	26 (1.5% ±0.6%)$^{\beta}$	65 (2.8% ±0.7%)$^{¥x}$	64 (3.9% ±0.9%)	94 (4% ±0.8)	91 (2.3% ±0.5%)$^{\#}$	158 (4% ±0.6%)	249 (3.1% ±0.4%)
	Shuffle	36 (2.7% ±0.8%)$^{¥x}$	49 (2.1% ±0.6%)$^{¥x}$	68 (4.2% ±1%)	91 (3.9% ±0.8)	85 (2.1% ±0.4)$^{\#}$	159 (4% ±0.6%)	244 (3.1% ±0.4%)
	Totals	62 (3.7% ±0.9%)$^{¥x}$	114 (4.9% ±0.9%)$^{¥x}$	132 (8.1% ±1.3%)	185 (7.9% ± 1.1%)	**176 (4.4% ±0.6%)$^{\#}$**	317 (8% ±0.9%)	493 (6.2% ±0.5%)*
Ball Blocking	Dive	9 (0.5% ±0.3%)$^{¥x}$	10 (0.4% ±0.3%)$^{¥x€}$	125 (7.7% ±1.3%)$^{€}$	186 (8% ±1.1%)	19 (0.5% ±0.2%)$^{\#}$	311 (7.9% ±0.8%)$^{€}$	330 (4.1% ±0.4%)$^{€}$
	Slide	3 (0.2% ±0.2%)$^{\beta}$	21 (0.9% ±0.4%)$^{\beta}$	38 (2.3% ±0.7%)$^{\beta}$	183 (7.9% ±1.1%)	24 (0.6% ±0.2%)$^{\#}$	221 (5.6% ±0.7%)	245 (3.1% ±0.4%)
	Totals	12 (0.7% ±0.2%)$^{¥x}$	31 (1.3% ±0.5%)$^{¥x}$	163 (10% ±1.5%)^{x}	369 (15.8% ±1.5%)	43 (1.1% ±0.3)$^{\#}$	532 (13.4% ±1%)	575 (7.2% ±0.6%)*
Jump		25 (1.5% ±0.6%)	93 (4% ±0.8%)$^{\beta}$	17 (1% ±0.5%)^{x}	46 (2% ±0.6%)	118 (2.9% ±0.5%)$^{\#}$	63 (1.6% ±0.4%)	181 (2.3% ±0.3%)
Other (skip, impact, stand still, land, fall, get up)		61 (3.6% ±0.9%)	86 (3.7% ±0.8%)	60 (3.7% ±0.9%)	59 (2.5% ±0.6%)$^{\beta}$	147 (3.6 ± 0.6%)	119 (3% ±0.5%)	266 (3.3% ±0.4%)
Player totals		1694 (100%)	2334 (100%)	1625 (100%)	2331 (100%)	4028 (100%)	3956 (100%)	7984 (100%)

Data expressed as frequency (percentage ±95% confidence intervals).
Horizontal axis, difference between players: $^{\beta}$ significant difference from the rest of the players, $^{\&}$ significant difference from scorer, $^{¥}$ significant difference from defender of assistant, ^{x} significant difference from defender of scorer, $^{\#}$ significant difference from defenders.
Vertical axis, difference only between movement totals (includes change in angle run totals, lateral advancing motion totals and ball blocking totals):* significant difference from the rest of the movements, ** significant difference from linear advancing motion, change in angle run, lateral advancing motion, ball blocking, jump.
Vertical axis, differences between movements in the same group (arc run and cut or dive and slide): $^{\Omega}$significant difference from cut, $^{€}$ significant difference from slide.

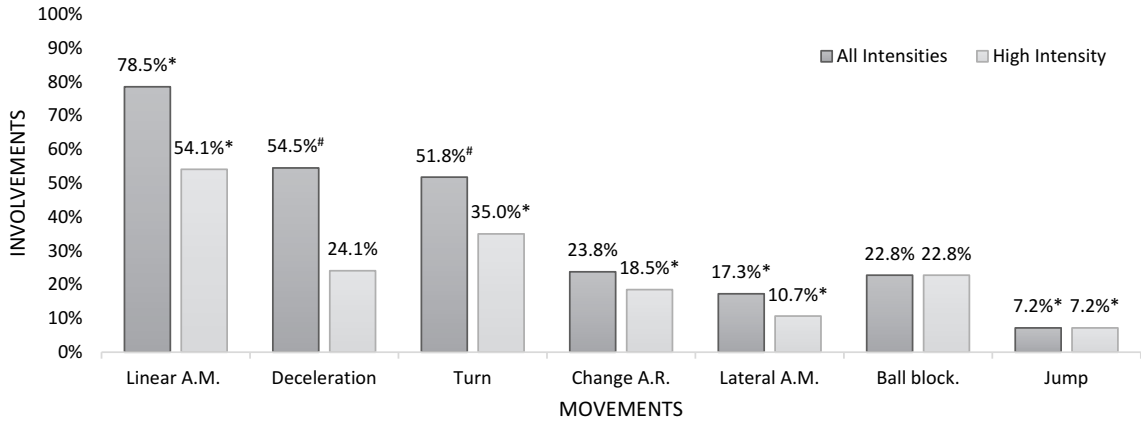

Figure 2. Percentage of involvements were movements were performed at least once. Jump and ball blocking actions are considered always as HI movements for analysis. *Significant difference from the rest of the movements of same group (all intensities or high intensity). #Significant different from linear advancing motion, change in angle run lateral advancing motion, ball blocking and jump. Linear A.M.: linear advancing motion; Change A.R.: change in angle run; Lateral A.M.: lateral advancing motion; Ball Block: ball blocking.

the findings from Faude et al. (2012) assisting players performed these linear actions commonly with the ball while scoring players performed these habitually without the ball. Therefore, training strategies to improve linear sprint should be a priority and could benefit from repetitions performed with the ball in players involved commonly in assisting activities, while sprint activities ending with a shot could be more suitable for players involved in scoring actions.

Deceleration was shown to be the second most common action along with turn and was present in 54.5 ± 2% of the involvements and 24.1 ± 1.7% when only counting involvements with HI decelerations. This decrease would be related to the fact that deceleration showed the lowest percentages of HI actions alongside shuffles. Attackers showed significant lower percentages of decelerations at HI compared to defenders. This would attend to the nature of attacking and defend-

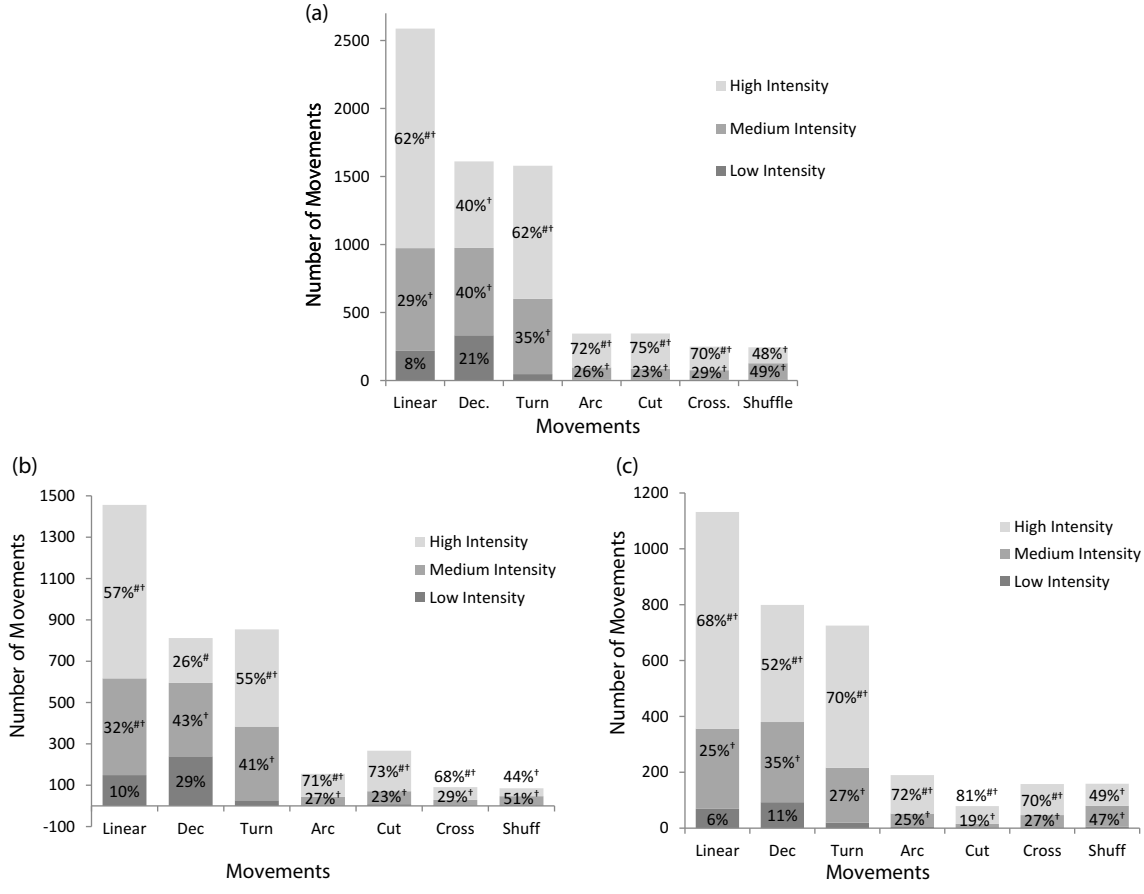

Figure 3. Movement intensity percentages for all players pooled (panel a), attackers (panel b) and defenders (panel c). #Significant difference from Medium Intensity. †Significant difference from Low Intensity. Linear: linear advancing motion; Dec.: deceleration; Arc: arc run; Cross.: crossover.

Table 5. Frequency and percentage of involvements were players performed at least 1 HI action.

Player	Frequency (percentage)
Assistant	379 (63.7% ±1.9%)*
Scorer	653 (84.9% ±1.4%)^
Defender of assistant	428 (86,1% ±1.4%)^
Defender of scorer	615 (95.8% ±0.8%)
Total Sum	2075 (82.9% ±1.5%)

Data expressed as frequency (percentage ±95% confidence intervals). Jump, ball blocking actions and impact are considered as HI movements for analysis. *Significant difference from the rest of the players, ^significant difference from assistant and defender of scorer.

ing movements, as attackers, who theoretically would perform this type of actions to create space by changing velocity (Young et al. 2015), usually perform turns of less than 60°, which would not require large deceleration (Hader et al. 2015; Dos'Santos et al. 2018). Conversely, defenders would need to rapidly close down attackers and/or brake forcefully when reacting to attackers in order to change into a new direction, with these players usually performing turns ≥60° requiring more strenuous decelerations compared to shallow turns (Dos'Santos et al. 2018). Given the demand of HI decelerations on the lower limb (Schreurs et al. 2017) and its possible implications for performance enhancement and injury prevention, it is recommended to include deceleration drills and eccentric overload exercises as part of a performance and injury mitigation training strategy, especially in defenders.

Turn showed to be the second most common action before a goal alongside deceleration and was present in 51.8 ± 2% of the involvements, decreasing to 35.1 ± 1.9% when only counting turns at HI. In agreement with Faude et al. (2012), rotations showed to be the second and third most frequent action involved in goal scoring situations for assistant and scorer, although they found lower percentages. This could be due to the actions defined as rotation, where only turns of the whole body over 90° were selected whereas in this study the highest percentage of turns were between 0° and 60°, followed by turns of 60° to 120°. Interestingly, attacking players performed higher percentage of turns but with lower percentages at HI compared to defenders, which could be related to the need to perform primarily subtle turns (between 0° and 60°). In contrast, defenders performed significantly higher amount of turns from 60° to 120° and from 120° to 180° compared to attackers, which again relates to the direction attackers and defenders commonly face in goal scoring situations. Moreover, the fact that defenders had the highest percentages of turns at HI would show the urgency of turning in these situations very close to goal. Therefore, training strategies should include drills were frequent turns are performed with the ball (e.g., small sided games [Evangelos et al. 2012]) but also explosive turns performed without the ball focusing on improving technique could be beneficial for performance enhancement, with sharper turning drills possibly more beneficial for defending players.

Attackers performed significantly higher percentage of cuts compared to arc runs while the opposite occurred in defenders. This could be due to the nature of these movements, as a cut would be performed by the attacker (usually with the ball) in order to gain advantage in a certain situation by changing initial direction and so possibly somewhat reducing traveling velocity in trade of this change in path. Meanwhile, defenders would preferably perform an arc run or curvilinear manoeuvre which has been theorized to be executed preferably to maintain velocity (Nimphius et al. 2018) thus regaining position in a faster manner compared to cutting.

Lateral advancing motion was performed more commonly in defenders compared to attackers which shows similarities to other studies analysing a whole match (Bloomfield et al. 2007). Overall, crossover showed greater percentages at HI compared to shuffle, which could mean that the latter is performed mainly for tracking and readjusting when defending without committing while crossover would also be performed to advance laterally when a superior speed is required and possibly as a preferred transition activity prior to an explosive type of movement.

The fact that 'jump' was the 7th most common action contrasts with the study by Faude et al. (2012), who found 'Jump' to be the second and third most common action for scorer for assistant, respectively, which could be due to this study analysing a wider variety of movements.

As an average, in 82.9 ± 1.5% of the involvements there was at least one HI movement, which is higher than the percentages found by Faude et al. (2012) were assisting and scoring player performed 55% and 62% of the goals with at least one explosive action. Regarding defending players, defender of assistant performed similar involvements with at least one HI compared to scorer, while defender of scorer performed HI actions in most of the involvements (95.8 ± 0.8%) showing significantly higher percentage compared to the rest. These differences would highlight the particularities of each group of players, with scorer, defender of assistant, and especially defender of scorer being frequently exposed to explosive actions. On the other hand, assistant players would also need to perform actions at HI in order to get into good positions to assist but would rely more heavily on passing accuracy in order to create perturbations leading to goals (James et al. 2012). These perturbations would possibly explain the differences in HI actions, as defenders would be in a disadvantageous position and would rely on HI movements to try to regain a stable defending state. This prevalence of HI actions is in contrast with the characteristics of a whole football match where low intensity activities are predominant (Akenhead et al. 2013) but could be in some way related to peak match demands. Although to the authors' knowledge there is no study analysing the relation between goal scoring situations and peak match demands, related contextual variables such as winning the match, team formation and playing position have shown to be associated with greater peak demands in the game (Oliva-Lozano et al., 2020; Riboli et al. 2021b).

This highlights the specific HI demands required during goal scoring situations, were players rely markedly on explosive activities realised in a short space of time. In this sense, faster or more explosive players in a multidirectional environment would be more likely to create these unstable situations while faster defending players would potentially be more successful than slower players when trying to deal with these. Therefore, physical training strategies should prioritize the multidirectional explosiveness of players.

A limitation of this study is that ICC of the modified BMC was based on ten matches (2.6% of all the matches) and so, certain movements with low frequencies could be underrepresented in this analysis. Another limitation was the system utilised for the analysis of movements, which was relatively 'manual'. Moreover, analysis was limited to the last six movements of each player prior to the goal which means that on a number of involvements some movements were removed for analysis.

Another limitation of the present study is the fact that analysis was performed only on goal scoring situations, which would represent only 1% of the attacks (Pollard and Reep 1997). Moreover, the fact that the analysis is based in successful attacks could bring into conclusion that the defensive actions analysed are unsuccessful defending activities. Finally, the broad definition for 'linear advancing motion' does not allow differentiation between actions with differing mechanical characteristics such as short accelerations and high-speed activities (Higashihara et al. 2018).

Conclusion

This study shows that linear advancing motion is the most common action prior to a goal and is performed in the highest percentage of involvements overall and at HI, showing to be the most decisive movement. Turn and deceleration are also highly involved in goal actions although the latter shows lower percentages at HI which could be related to less sharp turns in attackers.

Players display similar trends with varied characteristics depending on their role, with attackers performing more linear actions, cuts and subtle turns while defenders perform sharper turns, more lateral movements, blocking actions and arc runs. Moreover, HI movements show to be predominant, with 82.9% of the involvements being performed with at least one HI action and variations among players, with the assisting player showing the lowest percentages and defender of scorer the highest. These differences highlight the characteristics and demands of attacking and defending players, and so specific training strategies could be implemented depending on the way each player is habitually involved. In this sense, as part of a holistic approach for the enhancement of sprint performance, training should incorporate ball manipulation, especially in players involved in assisting actions, while forward players would benefit from speed actions ending with a shot on goal. Although there is a lack of research studies on the implementation of training strategies for turning speed development, we recommend the incorporation of specific turning overloaded training and technique modification training (Dos' Santos et al. 2019; Dos'Santos et al. 2021), especially for defenders as well as specific drills were turns are performed with the ball for attackers. As deceleration ability is largely influenced by eccentric strength (Jones et al. 2017) training protocols based on eccentric overload (de Hoyo et al. 2016) as well as multidirectional deceleration drills should be considered (Lockie et al. 2014). While defenders would benefit from reactive HI decelerations and sharp turning drills (i.e., change of direction drills with fast approach velocities and high turning degree angles), attackers would benefit from narrower angle turns and cuts with short but fast braking.

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Declarations of interest

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