

Exploring the impact of possession-based performance indicators on goal scoring in elite football leagues

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Abstract:

Background: Performance analysis has garnered significant attention in recent years, both in research and its practical implementations on the field. A substantial portion of performance analysis revolves around performance indicators. **Purpose:** This study's objective is to examine the impact of 13 performance indicators on teams' goal-scoring prowess. **Methodology:** Data were obtained from the FBref website, and included the mean values of teams' goals and 13 other performance indicators. This study's sample comprised 123 teams participating in 11 leagues during the 2021–2022 season. Using k-means clustering, the sample was divided into two groups based on each team's goal-scoring patterns (many goals/few goals). Subsequently, independent sample t-tests and Mann Whitney U-tests were conducted to determine whether there were any significant differences between the two groups in terms of the 13 performance indicators. To confirm the relationship between the performance indicators and goal-scoring, a Spearman correlation analysis was performed. **Results:** The findings revealed that teams employing long passes against well-organised defences tended to be less effective in scoring goals. Conversely, teams with higher possession rates and a propensity for penetrating passes beyond the first 40 meters from their own goal exhibited a greater ability to score goals. **Conclusions:** This study sheds light on the influence of various performance indicators on teams' goal-scoring abilities. It underscores the importance of possession-oriented game play and well-executed progressive passes in achieving success in football. The conclusions drawn from this research hold substantial practical importance in the realms of player recruitment and training. Last, the study highlights the importance of recruiting footballers with exceptional ball control skills and the ability to execute penetrating passes from the midfield and attacking third.

Key Words: performance indicators; goals; possession; pass length; progressive passes; touches

Introduction

Performance analysis in sports has gained remarkable attention in recent years, both in academic research and its practical application on the field (Plakias, Moustakidis, Kokkotis, Papalexi, et al., 2023; Plakias, Moustakidis, Mitrotasios, et al., 2023). Football, besides having the largest number of participants, is also the most extensively studied sport, with nearly 14,000 references in the PubMed database. Research on football was limited until the late 1970s, with an upward trend emerging after 1980 (Kirkendall, 2020). In recent years, coaches have placed significant emphasis on performance analysis, which has become the primary focus of research in football (Bailey, 2011). The study of performance indicators (PIs) is of particular interest in performance analysis (Hughes & Bartlett, 2002; James, 2006), as they provide valuable information, although they may not explain tactical aspects as well as playing styles (Plakias, Kokkotis, Moustakidis, et al., 2023; Plakias, Moustakidis, Kokkotis, Tsatalas, et al., 2023). For instance, many researchers have attempted to identify PIs that contribute to the success (or lack thereof) of a team in the competitions they participate in (Anwar et al., 2022; Bekris et al., 2013; Coppola et al., 2019). Others have focused on PIs that lead to victory or defeat in specific matches (Sgrò et al., 2015; Zainuddin et al., 2022). Additionally, artificial intelligence techniques have been employed to recognize PIs that determine the exact goal difference between a team and its opponent in a match (Moustakidis et al., 2023). In line with this focus, the present study aims to delve into the influence of thirteen distinct performance indicators on teams' effectiveness in scoring goals.

The goal, although not occurring frequently in football (only 1% of team possessions at the professional level result in scoring, with an average of 2.5 to 3 goals per game) (Rodenias et al., 2020), is the most crucial factor in determining a team's success (Clemente et al., 2012; Kubayi & Toriola, 2020). Researchers have attempted to correlate goals with PIs that involve various game situations. Many have focused on the impact of contextual variables, specifically studying the effect on goals by analyzing the two halves of matches (Alberti et al., 2013; Armatas et al., 2007; Stafylidis et al., 2022), 15-minute periods (Alberti et al., 2013; Armatas et al., 2007; Bamplekis et al., 2021; Kubayi, 2020), competition (Papadopoulos et al., 2021), location (Armatas et al., 2009; Pollard & Armatas, 2017), team quality (Lago-Peñas & Lago-Ballesteros, 2011), and match status (Lago

& Martín, 2007). Other researchers have examined the role of defensive behavior by opponents in achieving goals (Tenga et al., 2010; Vogelbein et al., 2014; Wright et al., 2011).

Naturally, the majority of studies on goal achievement focus on the ball possession phase. Specifically, the following have been studied: the type of attack (set play/open play) (Stafylidis et al., 2022; Wang & Qin, 2020), the type of phase in open play (organized/counter-attack) (Kubayi, 2020; Papadopoulos et al., 2021; Yiannakos & Armatas, 2006), the type of set piece (corner/foul/penalty) (Bamplekis et al., 2021; Kubayi, 2020; Yiannakos & Armatas, 2006), specific characteristics of a set piece (Casal et al., 2014; Plakias, Kokkotis, Tsaopoulos, et al., 2023), the area where the possession phase started (Tenga et al., 2010; Tenga & Sigmundstad, 2011), the zone of the assist (Papadopoulos et al., 2021) and the final action (Bamplekis et al., 2021; Papadopoulos et al., 2021; Yiannakos & Armatas, 2006), the number (Izzo et al., 2020; Kubayi, 2020; Wang & Qin, 2020), length (Tenga et al., 2010), and penetrative nature (Gonzalez-Rodenas et al., 2017; Plakias et al., 2022; Rein et al., 2017) of passes, as well as the duration of the entire phase leading to a goal (Tenga & Sigmundstad, 2011), the type (Michailidis et al., 2013; Yiannakos & Armatas, 2006) and length (Kubayi, 2020) of the final pass, the way of goal scoring (shot, header, own goal) (Michailidis et al., 2013; Papadopoulos et al., 2021), overall ball possession percentage (Plakias et al., 2022; Pratas et al., 2016; Wright et al., 2011), total number of shots (Bamplekis et al., 2021), and finally, the number of shots on target (Pratas et al., 2016).

Consequently, based on the aforementioned analyzed data, the value attributed by researchers to studying factors that contribute to goal achievement in football teams becomes apparent. Despite the extensive range of studies, due to the chaotic nature of the sport (Augste & Prestel, 2021; Ferrarini, 2016) and the vast amount of data available through modern technology (Goes et al., 2021; Rein & Memmert, 2016), there are still certain parameters that have not been investigated. Specifically, no research to date has examined as factors contributing to goal achievement: the percentage of individual player touches within each third of the field, the length of passes expressed as a percentage for short, medium, and long passes, the progressiveness of passes expressed as a percentage relative to the total distance covered, the number of dribbles per game by teams, the number of crosses per game, and finally, the penetrative passes made per game, excluding those made in the defensive 40% of the field. We formulated new variables that align with the previously mentioned concepts, employing suitable mathematical equations. We posited that certain variables exert more significant influence than others on teams' goal attainment. This approach enables us to derive dependable insights concerning the technical-tactical determinants that drive goal achievement in contemporary football. Therefore, the primary objective of this study was twofold: to firstly devise novel variables and subsequently investigate the extent to which these factors influence goal attainment among elite-level teams. We accomplished this by employing appropriate statistical methodologies to analyze the data.

Material & methods

Sample: The data was collected from a total of 223 teams participating in 11 different leagues. Each team was considered as a separate observation, and the means of each team on the variables under study were recorded. Table 1 provides an overview of the leagues included in the study, along with the corresponding number of teams in each competition.

Table 1. Leagues studied and number of teams in each league.

COMPETITION	TEAMS
England 1st	20
Spain 1st	20
Italy 1st	20
Germany 1st	18
France 1st	20
USA 1st	27
England 2nd	24
Brazil 1st	20
Holland 1st	18
Portugal 1st	18
Mexico 1st	18
SUMMARY	223

Procedure / Data collection: We collected data from the FBREF website (<https://fbref.com/en/>), specifically from three statistical categories: "possession," "passing," and "goal and shots creation." This resulted in obtaining 33 different Excel sheets, as each of the 11 leagues provided three sheets. The data available on this website is considered reliable (Hopkins, 2022) and has been widely utilized in numerous studies (Cross & Uhrig, 2023; Phatak et al., 2022; Zaytseva & Shaposhnikov, 2020). We merged the 33 Excel sheets into one dataset. Among the three statistical categories, we initially selected the variables presented in Table 2 to be used in our research.

Table 2. Variables from FBREF website retained in consolidated initial excel.

ABBREVIATION	INTERPRETATION
Att.P	Attempted passes
TotDist	Total distance, in yards, that completed passes have traveled in any direction
PrgDist	Progressive Distance i.e. Total distance, in yards, that completed passes have traveled towards the opponent's goal (Passes away from opponent's goal are counted as zero progressive yards).
S.Att	SHORT Attempted passes (<15yards)
M.Att	MEDIUM Attempted passes (>15yards & <30yards)
L.Att	LONG Attempted passes (>30yards)
P.ATT.3RD	Completed passes that enter the 1/3 of the pitch closest to the goal (Not including set pieces)
PPA	Completed passes into the 18-yard box (Not including set pieces)
Prog	Progressive Passes i.e. Completed passes that move the ball towards the opponent's goal at least 10 yards from its furthest point in the last six passes, or any completed pass into the penalty area (Excludes passes from the defending 40% of the pitch)
Prog_per_G	Progressive Passes i.e. Completed passes that move the ball towards the opponent's goal at least 10 yards from its furthest point in the last six passes, or any completed pass into the penalty area (Excludes passes from the defending 40% of the pitch) per game
P.ATT.3RD_per_G	Completed passes that enter the 1/3 of the pitch closest to the goal (Not including set pieces) per game
PPA_per_G	Completed passes into the 18-yard box (Not including set pieces) per game
CrsPA_per_G	Completed crosses into the 18-yard box (Not including set pieces) per game
Poss	Calculated as the percentage of passes attempted
Touches	Number of times a player touched the ball (Note: Receiving a pass, then dribbling, then sending a pass counts as one touch)
T.Def.3rd	Touches def 3rd
T.Mid.3rd	Touches mid 3rd
T.Att.3rd	Touches att 3rd
D.Att	Dribbles attempted
D.Att_per_G	Dribbles attempted per game
Gls	Goals per game

Of the variables presented in Table 2, seven were kept constant for the final analysis (Gls, P.Att.3RD_per_G, PPA_per_G, CrsPA_per_G, Prog_per_G, Poss, D.Att_per_G). Additionally, new variables were created and calculated from the variables in Table 2, using the mathematical equations shown in table 3.

Table 3. Calculation of new variables

ABBREVIATION	MATHEMATICAL EQUATION
PROGRESSIVENESS	$\text{PrgDist} * 100 / \text{TotDist}$
S.Att.PERC	$\text{S.Att} * 100 / \text{Att.P}$
M.Att.PERC	$\text{M.Att} * 100 / \text{Att.P}$
L.Att.PERC	$\text{L.Att} * 100 / \text{Att.P}$
T.Def.3rd.PERC	$\text{Touches def 3rd} * 100 / \text{Touches}$
T.Mid.3rd.PERC	$\text{Touches mid 3rd} * 100 / \text{Touches}$
T.Att.3rd.PERC	$\text{Touches att 3rd} * 100 / \text{Touches}$

Therefore, 14 variables were finally used in the research (7 obtained ready-made from the FBREF website and 7 obtained indirectly based on mathematical equations). Abbreviations of the 14 variables ultimately used in the study are shown in Table 4.

Table 4. Abbreviations of variables used in the study.

Gls	PROGRESSIVENESS	S.Att.PERC
M.Att.PERC	L.Att.PERC	P.Att.3RD_per_G
PPA_per_G	CrsPA_per_G	Prog_per_G
Poss	D.Att_per_G	T.Def.3rd.PERC
T.Mid.3rd.PERC	T.Att.3rd.PERC	

Statistical analyses: Firstly, k-means clustering was performed to classify the teams into two groups (many goals / low number of goals) based on the average goals per match scored in their respective leagues. K-means clustering is a method for finding groups of variables or observations in multivariate data (Kodinariya & Makwana, 2013; Martínez et al., 2023). Thus, the categorical variable "GROUP_Gls" was created. A check for normal distribution was then conducted for the thirteen variables in Table 4 (excluding the variable "Gls"). The normality test was performed using the Kolmogorov–Smirnov test (Cardozo et al., 2021; Das & Imon, 2016). Mann-Whitney U tests or independent samples t-tests were conducted to examine differences between teams that score many goals and those that score a low number of goals. The second method was chosen for dependent variables where both groups exhibited a normal distribution, while the first method was chosen for cases with one or no groups following a normal distribution (de Souza-Pajuelo et al., 2021; Gryaznykh et al., 2022; Gulewitsch et al., 2011). In the case of independent sample t-tests, the homogeneity of variances was established with Levene's test (Glass, 1966; Kurniawan et al., 2022). Also the practical significance of the results was examined with Cohen's d (Cohen, 2013) and classified as insignificant (<0.2), small (>0.2–0.6), moderate (>0.6–

1.2), large ($>1.2-2.0$) and very large ($>2.0-4.0$) (Batterham & Hopkins, 2006). Finally, to confirm the relationship between "Gls" and the remaining thirteen quantitative variables, a correlation analysis was performed. The distribution of the "Gls" variable was found to be non-normal, thus Spearman correlation was applied (Bejger, 2021; Schober et al., 2018). Correlation coefficient values were interpreted as: 0.90 - 1.00 (very high correlation), 0.70 - 0.89 (high correlation), 0.50 - 0.69 (moderate correlation), 0.30 - 0.49 (low correlation), 0.00 - 0.29 (little or no correlation) (Asuero et al., 2006).

Ethics: The research was conducted in accordance with the guidelines and approved by the Internal Ethics Committee of the Department of Physical Education and Sports Science at the University of Thessaly (Protocol No. 2080 / Date 08/02/2023). Permission was not required to download the data from the FBREF website as it is a publicly available database with free access to its data (Hopkins, 2022).

Results

Cluster Analysis: By applying k-means cluster analysis, it was determined that 67 teams were classified into the first group (many goals), while 156 teams were classified into the second group (low number of goals).

Descriptive Statistics: Table 5 presents the number of cases (N), means, and standard deviations for the entire set of teams, as well as separately for each group. The means for each variable in both groups are visualized in Figure 1.

Table 5. Number of cases (N) and means with standard deviations (MEAN) for each variable.

VARIABLE	TOTAL CASES		MANY GOALS		LOW NUMBER OF GOALS	
	N	MEAN	N	MEAN	N	MEAN
Gls	223	1,30±0,41	67	1,80±0,34	156	1,08±0,19
PROGRESSIVENESS	223	37,72±3,14	67	35,48±2,58	156	38,68±2,86
S.Att.PERC	223	41,14±3,64	67	43,25±3,98	156	40,23±3,09
M.Att.PERC	223	40,85±2,23	67	41,39±2,18	156	40,61±2,21
L.Att.PERC	223	18,01±3,27	67	15,36±2,78	156	19,16±2,76
P.ATT.3RD_per_G	223	29,19±6,45	67	34,81±7,38	156	26,77±4,12
PPA_per_G	223	7,29±2,13	67	9,40±2,26	156	6,39±1,25
CrsPA_per_G	223	2,05±0,52	67	2,14±0,61	156	2,01±0,48
Prog_per_G	223	27,14±5,59	67	32,42±5,74	156	24,87±3,67
Poss	223	50,00±5,45	67	54,60±5,46	156	48,02±4,09
D.Att_per_G	223	16,14±2,58	67	17,18±2,93	156	15,69±2,28
T.Def.3rd.PERC	223	32,40±3,80	67	29,73±3,69	156	33,55±3,24
T.Mid.3rd.PERC	223	44,80±2,50	67	46,09±2,39	156	44,24±2,34
T.Att.3rd.PERC	223	22,80±2,69	67	24,18±2,83	156	22,20±2,40

Normality tests: a) For the variables P.ATT.3RD_per_G, PPA_per_G, CrsPA_per_G, D.Att_per_G, and T.Att.3rd.PERC, at least one of the two groups did not follow a normal distribution ($p < 0.05$). However, for the variables PROGRESSIVENESS, S.Att.PERC, M.Att.PERC, L.Att.PERC, Prog_per_G, Poss, T.Def.3rd.PERC, and T.Mid.3rd.PERC, both groups exhibited normal distribution ($p > 0.05$). Consequently, the Mann-Whitney U-test was employed to detect differences between the two groups for the former variables, while the independent samples t-test was utilized for the latter variables. b) The variable GlS significantly deviated from normal distribution ($p < 0.001$). Therefore, to explore its correlation with the remaining variables, the Spearman Correlation method was employed.

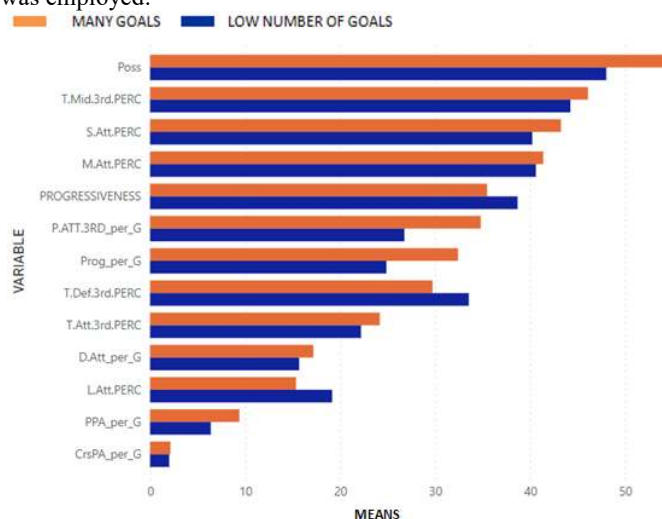


Figure 1. The means for each variable in both groups.

Table 6. Kolmogorov–Smirnov tests of normality

VARIABLE	GROUP_Gls	Kolmogorov-Smirnov ^a		
		Statistic	df	Sig.
Gls		0,127	223	0,000
PROGRESSIVENESS	MANY	0,067	67	,200*
	FEW	0,035	156	,200*
S.Att.PERC	MANY	0,071	67	,200*
	FEW	0,053	156	,200*
M.Att.PERC	MANY	0,068	67	,200*
	FEW	0,056	156	,200*
L.Att.PERC	MANY	0,087	67	,200*
	FEW	0,050	156	,200*
P.ATT.3RD_per_G	MANY	0,109	67	0,046
	FEW	0,054	156	,200*
PPA_per_G	MANY	0,130	67	0,006
	FEW	0,062	156	,200*
CrsPA_per_G	MANY	0,117	67	0,024
	FEW	0,044	156	,200*
Prog_per_G	MANY	0,099	67	0,169
	FEW	0,058	156	,200*
Poss	MANY	0,053	67	,200*
	FEW	0,043	156	,200*
D.Att_per_G	MANY	0,120	67	0,019
	FEW	0,046	156	,200*
T.Def.3rd.PERC	MANY	0,053	67	,200*
	FEW	0,044	156	,200*
T.Mid.3rd.PERC	MANY	0,053	67	,200*
	FEW	0,069	156	0,069
T.Att.3rd.PERC	MANY	0,121	67	0,016
	FEW	0,068	156	0,077

Mann-Whitney U-tests: Mann-Whitney U-tests were conducted to determine whether differences exist in the variables P.ATT.3RD_per_G, PPA_per_G, CrsPA_per_G, D.Att_per_G, and T.Att.3rd.PERC between the two groups (MANY GOALS / LOW NUMBER OF GOALS). Table 7 demonstrates that no statistically significant differences were found in the variable CrsPA_per_G ($p = 0.303$), whereas significant differences were noticed in the other four variables ($p < 0.01$).

Table 7. Man Whitney U-tests

	P.ATT.3RD_per_G	PPA_per_G	CrsPA_per_G	D.Att_per_G	T.Att.3rd.PERC
Mann-Whitney U	1656,000	923,500	4771,000	3718,500	3020,000
Sig.2-tailed	0,000	0,000	0,303	0,001	0,000

Independent sample t-tests: Table 8 reveals that all variables subjected to independent sample t-tests exhibited a statistically significant difference between the two groups ($p < 0.05$). The practical significance for the M.Att.PERC variable was small ($d = 0.356$). The differences for the variables T.Mid.3rd.PERC ($d = 0.786$), T.Def.3rd.PERC ($d = -1.131$), S.Att.PERC ($d = 0.892$), and PROGRESSIVENESS ($d = -1.152$) weremoderate. Notably, the differences observed for the variables Poss ($d = 1.447$), Prog_per_G ($d = 1.72$), and L.Att.PERC ($d = -1.370$) hold great practical importance.

Table 8. Independent sample t-tests

VARIABLES	t	df	p (2-Sided)	Cohen's d
PROGRESSIVENESS	-7,886	221	0,000	-1,152
S.Att.PERC	6,108	221	0,000	0,892
M.Att.PERC	2,437	221	0,016	0,356
L.Att.PERC	-9,382	221	0,000	-1,370
Prog_per_G	11,776	221	0,000	1,720
Poss	9,905	221	0,000	1,447
T.Def.3rd.PERC	-7,744	221	0,000	-1,131
T.Mid.3rd.PERC	5,384	221	0,000	0,786

Correlations: Table 9 indicates the following correlations with respect to the variable Gls: M.Att.PERC and CrsPA_per_G showed no correlation, D.Att_per_G exhibited a very weak positive correlation, PROGRESSIVENESS and T.Def.3rd.PERC demonstrated a weak negative correlation, S.Att.PERC, T.Mid.3rd.PERC, and T.Att.3rd.PERC displayed a weak positive correlation, L.Att.PERC exhibited a moderate negative correlation, P.ATT.3RD_per_G, Poss, and Prog_per_G revealed a moderate positive correlation, and finally, PPA_per_G showed a strong positive correlation with Gls. The correlation coefficients of the 13 variables with the Gls variable are depicted in the diagram presented in Figure 2.

Table 9. Correlation of Gls with the remaining variables.

	Gls	
	Correlation Coefficient	Sig. (2-tailed)
PROGRESSIVENESS	-,477**	0,000
S.Att.PERC	,347**	0,000
M.Att.PERC	,178**	0,008
L.Att.PERC	-,525**	0,000
P.ATT.3RD_per_G	,624**	0,000
PPA_per_G	,725**	0,000
CrsPA_per_G	,134*	0,045
Prog_per_G	,687**	0,000
Poss	,630**	0,000
D.Att_per_G	,267**	0,000
T.Def.3rd.PERC	-,475**	0,000
T.Mid.3rd.PERC	,334**	0,000
T.Att.3rd.PERC	,364**	0,000

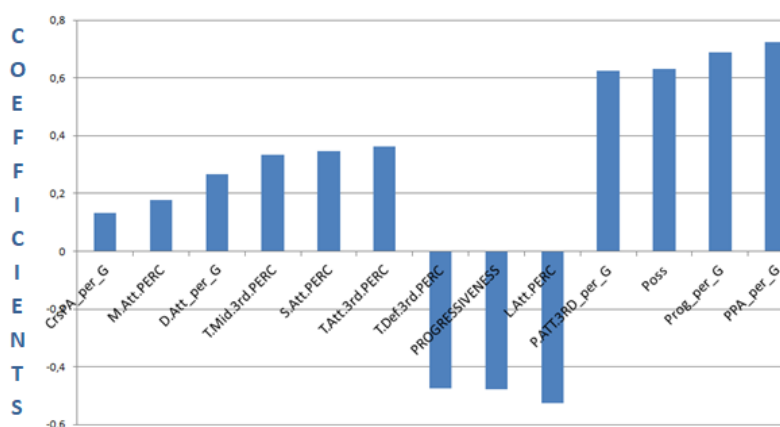


Figure 2. The correlation coefficients of Gls with the other variables.

Discussion

The purpose of this research was to explore PIs related to ball possession and their impact on goal scoring in elite football leagues. Initially, 21 PIs were collected from the FBREF website, and then 7 new variables were calculated from the original indicators using mathematical formulas. The 7 newly created variables and 7 pre-collected variables from the FBREF website were ultimately used (one of which was the dependent variable Gls). The most significant findings from the analysis of the 13 performance indicators were as follows: a) Entries into the attacking third and the opponent's penalty area, ball possession, and progressive passes made in the attacking 60% of the field contribute positively to goal scoring by teams. b) Long passes from the defensive third and the progressiveness of the passes (including passes from the defensive 40%) have a negative impact on goal achievement. c) Crosses and dribbles are not influential. d) Regarding individual ball possessions (touches) in the three-thirds of the field, it appears that as the percentage increases in the attacking third, the chances of scoring a goal also increase.

In the present research, it has been demonstrated that entries into both the attacking third and the opposition area have a positive impact on goal scoring. These findings align with previous studies, which have shown that entering the penalty area increases the likelihood of scoring (Michailidis et al., 2013; Moustakidis et al., 2023), teams that face more entries into their own penalty area are significantly more prone to conceding goals (Ruiz-Ruiz et al., 2013), successful teams generate more shots from inside the area compared to unsuccessful ones (Azhar et al., 2020), initiating possession from the attacking third is more effective in goal

scoring compared to the defensive and middle third (Tenga et al., 2010), and the number of entries into the attacking third decreases from top to bottom positions in the ranking (Yang et al., 2018).

Our research did not find a significant effect, either positive or negative, on goal scoring for crosses and dribbles. Contradictory findings exist in the international literature regarding these factors. Specifically, for crosses, Harrop and Nevill (2014) found no statistically significant differences between winning, losing, or drawing teams, while Sinicariello (2017) identified a negative correlation between crosses and points in the final ranking. Conversely, other studies have demonstrated a positive correlation between crosses and goals (Michailidis et al., 2013; Stafylidis et al., 2022) or the team's ranking on the scoreboard (Bekris et al., 2013). On the other hand, regarding dribbles, Liu et al. (2015) found a negative effect on the likelihood of winning, whereas Harrop and Nevill (2014) did not observe a statistically significant difference in dribbles between winning and non-winning teams, and Sinicariello (2017) concluded that dribbles do not contribute to predicting team points in the final ranking. The conflicting results among these studies indicate the need for a more in-depth examination of crosses and dribbles, taking into account contextual variables.

Regarding the length of passes, our research has shown that short passes contribute positively to goal scoring, while long passes have the opposite effect. This finding is consistent with the studies conducted by Tenga et al. (2010) and Kubayi (2020), who examined the impact of tactics on goal scoring and found that shorter passes were more effective than longer ones. Similar results were also observed in the research conducted by Liu et al. (2015), who investigated the correlation between performance indicators and match outcomes. Liu's study demonstrated a positive effect of short passes on the likelihood of winning and argued that maintaining continuous ground passes helps create scoring opportunities. However, contrasting findings seem to emerge from the research conducted by Yiannakos and Armatas (2006), which indicated that long passes were the most common action leading to goals. It's important to note that in their study, long passes were compared to a combination play that could involve numerous short or medium passes as well.

Ball possession is perhaps the most widely discussed performance indicator in the international literature. Our research confirms that a high possession rate has a positive impact on teams' goal-scoring ability. This finding is consistent with the results of a study (Plakias et al., 2022), which demonstrated a strong correlation between these two variables. Similar conclusions have been drawn from other research showing that winning teams tend to have higher possession rates compared to losing teams (Bekris et al., 2013; Castellano et al., 2012; Janković et al., 2011; Lago-Peñas et al., 2011; Liu et al., 2015; Yang et al., 2018). However, Göral (2015) found that although winning teams had slightly higher possession rates than losing teams (51% vs. 49%), the difference was not statistically significant. It is possible that teams in the lead adopted a more conservative and less risky style of play, focusing on maintaining their advantage and inviting the opponent to attack. This aligns with the findings of studies examining possession rates in relation to the scoreline (Bradley et al., 2014; Jones et al., 2004; Lago, 2009; Lago & Martín, 2007), which indicate that teams that are trailing in a match tend to increase their possession. Furthermore, there are studies (Gonzalez-Rodenas et al., 2015; Tenga et al., 2010; Wright et al., 2011) that explore the relationship between the number of passes during possession and the probability of scoring goals. They suggest that longer possession sequences, involving four or more passes, are associated with higher goal-scoring rates. However, it's important to note that while longer possession sequences within individual ball possessions yield higher goal-scoring percentages, it doesn't necessarily mean that teams with the highest overall possession percentages achieve the highest goal-scoring rates throughout the entire match. Nonetheless, it indicates that maintaining possession can contribute to creating goal-scoring opportunities, which supports our conclusion that a high possession rate is strongly correlated with goal-scoring success.

Contrary to the well-researched possession rate, there are currently no studies in the international literature that specifically examine the contribution of progressivity and touches rate in each third of the pitch to goal scoring, at least as defined in our study. In our research, we utilized two variables to measure the progressivity of passes. The first variable, PROGRESSIVENESS, was calculated as the ratio of $\text{PrgDist} \times 100$ to TotDist , where PrgDist represents the total distance (in yards) covered by completed passes towards the opponent's goal (passes away from the opponent's goal were considered zero progressive yards), and TotDist represents the total distance (in yards) covered by completed passes in any direction.

The second variable, Prog_per_G , was calculated as the ratio of Prog to N , where Prog represents the number of completed passes that moved the ball at least 10 yards towards the opponent's goal in the last six passes or any completed pass into the penalty area (excluding passes from the defending 40% of the pitch), and N represents the number of matches. Our research demonstrated that the first variable, which includes progressive passes from the defensive 40% of the pitch, has a negative impact on goal achievement, while the second variable, which includes progressive passes only from the attacking 60% of the pitch, has a positive impact. In a study by Watanabe and Rewliak (2022), where the term "progressive passes" was used without a clear definition, it was observed that the correlation between progressive passes and assists is stronger for defensive players than for midfielders and forwards. We did not find any other research in the international literature that specifically examined the effectiveness of progressive passes. However, there are studies (Mao et al., 2016; Plakias et al., 2022; Tenga et al., 2010) that have investigated passes that bypass opposing players

(such as through balls and penetrative passes), which are considered progressive passes, but they do not encompass all forward passes since a forward pass may not surpass any opposing defenders. Nevertheless, these studies do demonstrate a correlation between such passes and success. Turning to individual player possessions, we utilized the "Touches" variable, defined as the number of times a player touched the ball (receiving a pass, dribbling, and then passing count as one touch). We then calculated the percentage of touches in each third of the field for each team's players and explored whether these percentages were associated with the team's goal-scoring efficiency.

The statistical analysis revealed that teams that had a higher number of individual possessions in the attacking third displayed greater goal-scoring efficiency. Although individual possessions have been widely examined in the international literature (Dellal et al., 2010; Li et al., 2023; Russell et al., 2013), their effectiveness in relation to goal scoring has not been investigated in these particular studies. Nonetheless, two studies indirectly support our findings. The first study (Small, 2015) examined the possession time in the attacking third for teams that were winning or losing a match. The results indicated that winning teams spent more time in their attacking third compared to losing teams. Consequently, the time of possession in the attacking third increases, as the number of individual touches in this area also increases. In the second study (Rein et al., 2017), it was demonstrated that passes from the midfield into the attacking zone and passes within the attacking third led to a greater control of space in the attacking third, in comparison to passes from the defensive third into the midfield and passes within the midfield. The control of space is significantly correlated with successful gameplay in terms of the number of goals scored. Therefore, it can be inferred that having more individual possessions in the attacking third will enhance the control of space (and consequently increase goal-scoring opportunities), as both passes from the midfield into the attacking zone and passes within the attacking third contribute to a higher number of individual possessions in the attacking third.

Regarding to the limitations of the present study, some aspects should be highlighted:

a) The study was conducted using a static rather than a dynamic approach. From a static perspective, performances are recorded using notational analysis methods that focus on the final statistics of a match or the average values of a competition, with minimal or no observation within the context of the game at any specific moment. In contrast, the dynamic approach records actions in relation to the game situation at each moment in a chronological and sequential order. Thus, the variables were captured independently of the score's progression during the match. Inevitably, there is an information loss as the collected data do not imply changes in player performance over time and the evolution of the score. Despite these specific limitations, the static approach is widely used in performance analysis, and studies published have identified various PIs associated with goal scoring (Pratas et al., 2018).

b) The data only pertains to the possession phase of the game, without taking into account the defensive behavior of the opponent and without distinguishing between organized attacks and counterattacks. However, it can provide valuable insights into all situations where a team has possession of the ball.

c) The data was collected during a single football season. Despite this, because it covers a very recent season (2021-2022) and includes 11 different leagues, it can offer good generalization of the findings.

d) The statistical data was obtained from the FBREF website, for which, although there are scientific references regarding its reliability (Hopkins, 2022), there is no documentation of this specific claim to our knowledge. However, it is known that the FBREF website uses advanced statistics from the Opta company (Fbref, 2023; Hewitt & Karakuş, 2023), whose data reliability has been scientifically documented (Erreagorri et al., 2020; Liu et al., 2013).

Conclusions

Despite its limitations, the present study provides valuable insights into ball possession phase. The results indicate that teams that avoid long passes from the defensive third and instead focus on maintaining ball possession, with the intent of making progressive passes beyond the 40% mark of the pitch length from their goal, entering the attacking third, and sustaining possession there while entering the opponent's penalty area, are the ones that achieve the highest goal-scoring outcomes. These conclusions can offer useful information to team coaches (for tactical selection and training in ball possession) as well as scouts and technical directors (for selecting players who can maintain ball possession and execute progressive passes towards the opponent's area within limited time and space, as observed in the defensive third of the opposing team). For future researchers, it is recommended to develop new variables or combinations thereof (reflecting team playing styles) or even employ artificial intelligence methods to validate or reject existing data and extract novel information. Lastly, it is important to consider contextual variables when studying certain PIs.

In conclusion, our investigation enhances the comprehension of performance indicators' influence on teams' goal-scoring abilities. By illuminating the intricate connections between various metrics and on-field outcomes, this study contributes to the strategic arsenal of football professionals. Our research supports the idea that a comprehensive understanding of performance indicators empowers teams to devise more effective strategies, elevating their chances of scoring goals and achieving success on the pitch.

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