Past, present and future of goal scoring analysis in professional soccer
Pasado, presente y futuro del análisis de goles en el fútbol profesional

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Abstract. The aim of this theoretical review is to summarize the key performance indicators and contextual variables that have been related to goal scoring in soccer, as well as to discuss the new perspectives and future challenges for the development of research studies on this topic. Firstly, situational variables such as match location, time of the game, opponent level, as well as match status have been shown to have an influence on goal scoring. Secondly, tactical factors such as the team possession type of start, starting zone, initial opponent positioning, type of attack, pass number per possession, type of assist, finishing zone and type of finishing have been described as performance indicators related to goal scoring in professional soccer. During the past, the vast majority of studies analysed tactical or technical indicators isolated from the complex and multifactorial process of creating goal scoring situations. Currently, the emergence of new research methods such as position data, network analysis, temporal patterns or mixed methods has broadened the possibilities for researchers to capture the complexity of soccer actions and interactions. Thus, some future challenges in the analysis of goal scoring in soccer should explore: a) the multidimensional evaluation of shooting effectiveness, b) the goal effectiveness of different styles of play, c) the goal-scorer's skills, d) the further exploration of the effect of players interactions on goal scoring, e) f) the effects of training methods on goal scoring and f) the influence of contextual variables on goal scoring actions.
Key words: match analysis, attacking performance, notational analysis, goal attempt, football.

Resumen. El objetivo de esta revisión teórica es sintetizar los principales indicadores de rendimiento y variables contextuales que han sido relacionados con marcar goles en fútbol, así como discutir nuevas perspectivas y futuros retos en el desarrollo de estudios científicos sobre este tema. En primer lugar, variables contextuales como localización del partido, tiempo de juego, nivel del oponente y marcador han mostrado una influencia en el proceso de marcar goles. En segundo lugar, indicadores tácticos como el tipo de inicio de la posesión ofensiva, la zona de inicio, el posicionamiento inicial del equipo rival, el tipo de ataque, el número de pases por posesión, el tipo de asistencia, la zona de finalización y el tipo de finalización han sido descritos en la literatura relacionada con el análisis del gol en fútbol. Sin embargo, la gran mayoría de estudios han analizado indicadores tácticos y técnicos aislados del proceso complejo y multifactorial que supone generar situaciones de gol. En los últimos años, han surgido nuevas metodologías de investigación como el «position data», «análisis de redes», «análisis de patrones temporales» y «métodos mixtos» que han aumentado las posibilidades de capturar e investigar la complejidad de las acciones e interacciones del juego en fútbol. Por lo tanto, algunos de los retos de futuros estudios sobre análisis de los goles en fútbol deberían explorar: a) la evaluación multidimensional de la efectividad del tiro en fútbol, b) la efectividad para marcar gol de diferentes estilos de juego, c) las habilidades especificas de los goleadores, d) la mayor exploración del efecto de las interacciones entre jugadores en la generación de situaciones de gol, e) los efectos del entrenamiento en la capacidad de marcar goles y f) la influencia de las variables contextuales en las acciones relacionadas con los goles.
Palabras clave: Análisis táctico, ocasión de gol, rendimiento ofensivo, análisis notacional.

Introduction

Scoring a goal is the most successful action in soccer although only the 1% of team possessions in professional level lead to score (Pollard & Reep, 1997; Tenga, Ronglan & Bahr, 2010a). Currently, the average of goals per game has been found to be between 2.5 and 3 both for national and international competitions (Sánchez-Flores, Martin Gonzalez, García-Manso, Saa, Arriaza-Ardiles & Da Silva-Griglotetto, 2016; Njororai, 2013a; www.uefa.com, 2019; www.fifa.com, 2019) but it has been observed how this average has been gradually decreasing from the first World Cup tournaments (1930: 3.89; 1934: 4.12; 1938: 4.67) until the most recent ones (2006: 2.3; 2010: 2.27; 2014: 2.7; 2018: 2.6) (Castellano, Perea & Hernández Mendo, 2008; Njororai, 2013; www.fifa.com). This low frequency of goals per game makes soccer different from other invasion team sports such as basketball that averages between 160-200 points per game; www.stats.nba.com; www.euroleague.net) or futsal, where the number of goals per game is between 4.5 and 8

(www.uefa.com; www.fifa.com; Alvarez-Medina, Ramirez San Jose & Murillo Llorente, 2019).

In terms of attacking performance in soccer, the solely analysis of goals may not truly represent the underlying tactical strategies of a team, i.e., those that are concerned with the actual development of goal scoring opportunities (James, Mellalieu & Hollely, 2002). For this reason, other attacking outcomes such as scoring opportunities or score-box possessions have been analyzed in the scientific literature due to their higher frequency during the match (Tenga Holme, Ronglan, & Bahr, 2010b; Lago-Ballesteros, Lago & Rey 2012; Gonzalez-Rodenas, Lopez-Bondia, Calabuig & Aranda, 2015a). These attacking indicators represent successful team possessions where the attacking team achieved to penetrate over the defensive team towards close areas from the opposing goal and had the chance of shooting at goal. This higher frequency of successful attacking outcomes allows researchers to analyse more offensive sequences per team during the match and consequently, to capture more tactical patterns related to the teams' style of play that are associated with attacking success.

Nevertheless, creating more scoring opportunities or score-box entries does not guarantee a greater amount of

goals. In fact, it has been observed that the ratio shot/goal is a key aspect that differentiates the successful teams from the non-successful teams (Castellano, Casamichana & Lago, 2012; Delgado-Bordonau, Domenech-Monforte, Guzman & Mendez-Villanueva, 2013; Dufour, Phillips & Ernwein, 2017). For this reason, the specific analysis of actions that lead to a goal in soccer may reveal the most effective ways to create scoring sequences as well as the special individual skills that goal scorers possess.

However, according to recent literature reviews about match analysis in soccer (Mckenzie & Cushion, 2013; Sarmento, Marcelino, Anguera, Campaniço, Matos & Leitão, 2014; Sarmento, Clemente, Araujo, Davids, McRobert & Figuereido, 2018) there have been very few studies about goal scoring in recent years. This fact is surprising, especially considering that one of the most challenging objectives of professional soccer clubs is to recruit or develop players who have the capacity to score or create high amounts of goals. To our knowledge, only few studies have explored the special skills of great goal scorers such as Lionel Messi and Cristiano Ronaldo (Castañer, Barreira, Camerino, Anguera, Canton & Hileno, 2016; Castañer, Barreira, Camerino, Anguera, Fernandes & Hileno, 2017) while the general understanding of the multidimensional qualities of top goals scorers are still based on subjective opinions based on coaches, scouts and sporting directors' perceptions.

In this regard, the complexity of the game of soccer, considered as dynamic and interactive, makes difficult its observation and analysis (Sarmento et al., 2014) since goals are scored not only due to the interdependence of tactical, technical or strategical factors, but also physical, psychological and contextual ones. For that reason, the design of future research studies that try to capture the key elements related to goal scoring in soccer may require a deep understanding of the factors that are involved in the process.

Therefore, the aim of this theoretical review is to describe the key performance indicators and contextual variables that have been related to goal scoring in soccer, as well as to propose and discuss future challenges that may contribute to the development of this research topic in the field of performance analysis.

Current scientific knowledge

Contextual variables
Match location
The fact of playing at home has been associated with scoring more goals and obtaining a greater percentage of wins for the home team (Lago-Peñas & Lago-Ballesteros, 2010; Almeida & Volossovitch, 2017, Pic & Castellano, 2017). According to the literature, local teams win the 60 and 70% of the matches (Jamieson, 2010; Pollard & Gomez, 2014). Moreover, in top European competitions, it has been observed that local teams scored first the 57.8% of the matches and went on obtain the 84.85% of the points won in these games (Lago-Peñas, Gómez-Ruano, Megias-Navarro & Pollard, 2016). Some explanations of this trend have included the factors related to the numbers of spectators in the stadium, the familiarity of the match conditions, the referee, the travel effects, as well as psychological and tactical

effects (Pollard, 2008). In this sense, the altitude of the stadium, the number of spectators and the change of time zone were relevant to have home advantage in the preliminary qualification process for the World Cup Finals (Pollard & Armatas, 2017). Moreover, the greater winning expectative, the establishment of more ambitious objectives and a more offensive strategy have been observed in coaches when playing at home (Staufenbiel, Lobinger & Strauss, 2015) and may encourage players to be more oriented to be offensive. Regarding tactical factors, the scientific literature show that home teams have more shots, dribbles and passes in the final third (Carmichael & Thomas, 2005; Tucker, Mellalieu, James & Taylor, 2005), greater amount of ball possession than the opponent (Lago & Martin, 2007), greater effectiveness in goal scoring (Tenga et al., 2010) and have attacking patterns more complex and structured (Diana, Zurloni, Elia, Cavalera, Jonsson & Anguera, 2017). Therefore, a greater offensive strategy seems to be implemented at home and this fact may be directly related to goal scoring and the probability to win.

Quality of the teams
The quality of the teams is a relevant factor that influences the tactical context of the game (Sarmento et al., 2018). Lago-Ballesteros and Lago-Peñas (2010) observed how higher ranked teams obtained more shots, more goals per game and the need of having fewer number of shots to score a goal. In this sense, while low ranked teams needed an average of 11.25 shots to score a goal, the highest ranked teams needed 8. Other studies (Szwarc, 2004; Castellano, Casamichana & Lago, 2010; Delgado-Bordonau, Domenech-Monforte, Guzman & Mendez-Villanueva, 2013; Dufour, Phillips & Ernwein, 2017) found that one of the most relevant differences between winning and losing teams was the ratio shot/goal. This fact may be related to a better technical and tactical skills of players from high ranked teams, that may have the ability not only to produce more quantity of offensive actions but also to be more accurate when shooting at goal.

Match status
Match status is also an important variable to consider when analysing goal scoring in soccer. In fact, research studies found that the team that scored first won the game the 70% of the matches (Armatas, Yiannakos, Papadopoulou & Skoufas, 2009; Armatas & Yiannakos, 2010). Furthermore, multiple studies have observed how scoring a goal causes a change in the tactical context of the rest of the game, both for short and long term. For short-term effects, it has been reported that the scoring team decreases its ball possession in attacking zones and the opponent has a greater percentage of ball possession in the next five minutes after scoring a goal (Ridgewell, 2017), besides a decrease in the accuracy of passes (Redwood-Brown, 2008). However, Heuer and Rubner (2012) found that the team that conceded a goal was less successful in scoring a goal during the next minutes after conceding. For long-term effects, several studies (Lago & Martin, 2007; Lago et al., 2012) observed that teams that are ahead in the score, decreased their ball possession and had poorer offensive performance in comparison to when they were drawing or losing. Also, the study of Ruiz-Ruiz, Fradua,

Fernandez-Garcia and Zubillaga (2013) observed that teams losing by one, two or more than two goals received significantly fewer entries into the penalty area than teams winning by one or two goals. This change in the offensive production of winning teams may be related to the priority of defending the score instead of increasing the advantage. Therefore, goal scoring seems to be related to the match status. Thus, scoring a goal can change the tactical game scenario not only by modifying the teams' strategies and priorities but also by possibly affecting to the emotional and psychological state of the players.

Time of the match

Interestingly, more goals are scored during the second half of the match and especially during the last 15 minutes. Leite (2013) analysed 2208 goals from the 19 World Cup tournaments and found that the 54.4% of the goals were scored during the second half and 19.61% took place during the last 15 minutes of the game. Also, Alberti, Iaia, Arceli, Cavaggioni and Rampinini (2013) analysed 11.000 goals from top European competitions and observed that 55.1% of goals were scored in the second half while the number of goals was increasing throughout the game (13.7%, 15,1%, 16.2%, 17.7%, 17.2% y 20.2% for 0-15, 15-30, 30-45, 45-60, 60-75 and 75-90 intervals, respectively) with the same trend in all competitions. In a recent study, Pratas, Volossovitch and Carita (2018) observed that not only a higher frequency of the second goals were scored in the second half of a match (58%) but also during the last 5 min periods of each half. These interesting facts are due to the interaction between several factors. In this manner, several studies have reported a decrease in the physical performance during the second half of the matches (Vigne, Gaudino, Rogowski, Alloatti & Hautier, 2010; Carling & Dupont, 2011) what can predispose players to make more defensive mistakes during the last minutes of the game or at the end of the first half, due to the physical and mental fatigue. Furthermore, the tactical context in the last minutes of the game may become more desperate for the team that chases a score, requiring more offensive tempo and production, what at the same time, may provoke more defensive risks and vulnerability (Abt, Dickson & Mummery, 2002). This context in the last minutes would create a more urgent play in offensive terms and a more open play in terms of space, what adding the physical and mental fatigue, may increase the possibility of scoring goals.

Technical and tactical factors

The start of the team possession
Starting field zone

The study of Wright, Atkins, Polman, Jones and Lee (2011) observed how 62% of goals scored in English Premier League were started in the opposing half. Likewise, Caro and Caro-Muñoz (2016) found how more than 60% of the goals achieved by two top teams in Spanish La Liga during the 2012/2013 season started in the opposing half. In addition to starting in offensive zones, other studies (Armatas, Yiannakos, Ampatis, & Sileloglou, 2005; Wright et al., 2011) highlighted the great importance of starting the team possessions in central areas of the field. This data is not surprising because soccer is an invasive sport and the fact to start the team possession closer to the goal can facilitate the faster penetration towards shooting zones. Also, starting the ball possession in central areas of the field could help the attacking team have more immediate options to progress towards the goal, rather than starting in wide areas, where it would be easier for the opponent to close down central gaps and protect the goal.

However, despite these findings are relevant, the fact of studying only the field space does not truly represent the real tactical and interactive tactical context. For this reason, other tactical and behavioral dimensions should be considered at the beginning of offensive sequences. In this sense, the fact of starting the goal sequences from higher or lower positions can be influenced by the style of play or technical and tactical level of the teams. For instance, Tenga and Sigmundstad (2011) observed how the highest ranked teams in the Norwegian League scored more goals in team possessions that started in defensive zones in comparison with the lowest ranked teams. Besides, the fact of regaining the ball in offensive zones of the field does not directly mean that the offensive team is located in penetrating spaces within the defensive structure of the defensive team (Gonzalez-Rodenas et al., 2015a). Consequently, the field space should be only another dimension that researchers or coaches should consider among other tactical and behavioral variables during ball transitions periods.

The initial defensive behavior

In the moments of transition between the attack and defense, the positioning and behavior of the defensive team is crucial to understand the interactive tactical context. However, very few studies have considered this aspect when analysing attacking performance in soccer (Mckenzie & Cushion, 2013). In fact, the optimal defensive indicators in transitions from attack to defense such as exerting pressure after losing the ball and regaining quickly the ball possession have been associated with high ranked teams in German Bundesliga (Vogelbein, Nopp & Hokelmann, 2014) as well as with teams that achieve to win a greater number of games (Winter & Pfeiffer, 2016). In this line, Olsen and Larsen (1997) reported a greater creation of goal scoring opportunities and goals by counterattacking when the opposing team was unbalanced defensively. Similarly, Tenga et al. (2010c) observed how the counterattacks were more effective than organized attacks in scoring goals only when the defensive team was defensively unbalanced. Another study of Gonzalez-Rodenas (2013) reported that team possessions that led to a goal in the World Cup 2010 started more frequently against a defensive team with fewer players between the ball and the opposing goal, in comparison with team possessions that created goal scoring opportunities.

Additionally, recent studies based on the analysis of attacking performance have analysed other variables related to the initial moment of the team possession such as the space of defensive occupation, the opponent pressure after losing the ball or the initial penetration performed by the offensive team (Tenga, Holme, Ronglan, & Bahr 2010; Lago-Ballesteros, Lago & Rey, 2012: Gonzalez-Rodenas, Lopez-Bondia, Calabuig, Turpin & Aranda, 2015). These studies

highlight the importance of penetrating as soon as possible when the opponent is not exerting pressure after losing the ball or when the ball is in opposing invasive zones in order to achieve higher odds of creating goal scoring opportunities. However, more research is needed to understand the influence of the initial tactical situation on the possibility not only to create goal scoring opportunities but also to score goals.

The development of the team possession
Passing sequences and type of attack

There has been a debate in soccer research about whether it is more effective to attack with longer or shorter possessions in order to achieve attacking success (Collet, 2013; Kempe, Vogelbein, Memmet & Nopp, 2014, Pollard, 2019). This debate began when Reep and Benjamin (1968) observed that 80% of the goals were created in sequences of 3 or fewer passes after analysing 3213 matches from 1953 to 1968. In this sense, Hughes and Franks (2005) confirmed that more than 80% of goals during the 1990 and 1994 World Cups were scored after sequences of four or fewer passes. However, this study normalized the data by considering the goal effectiveness of the total number of possessions per match and concluded that longer possessions (five or more passes) were more effective to achieve goals than shorter possessions (four or less passes), even though more goals were scored in short possessions in absolute terms.

However, the fact of only counting the number of passes excludes other essential characteristics of the type of attack developed by the teams, and a more detailed analysis of tactical factors involved in the development of possessions would be needed to understand why and how the teams score goals (Pollard, 2019). For this purpose, the multidimensional and qualitative evaluation of the types of attack permits to categorize the observations and can improve the ability to describe the team possessions in soccer (Tenga, Kanstad, Rongland & Bahr, 2009).

Several studies have analysed qualitatively the type of attack and have observed that most of goals were produced by means of positional attack. This type of attack produced 44.1% of goals during the Eurocup 2004 (Yiannakos & Armatas, 2006) compared with the 35.6% of counterattacks and 20.3% of set pieces. Similar results were found in the World Cup 2006 (Armatas & Yiannakos, 2010) where the positional attack produced the 47.1% of goals, followed by set pieces (32.6%) and counterattacks (20.3%). Njororai (2013b) described that 75.86% of goals were created in open play situations especially by «combinative play» (26.3%) or «wide play» (26.36%) but without differentiating between counterattacks or positional attacks. In another study, Mitrotasios and Armatas (2014) observed that 72.4% of goals were produced in open play sequences during the Eurocup 2012. In these situations, 60.0% were positional attacks, 20.0% were counterattacks and 20% were direct attacks. In addition to this, Barreira, Garganta, Castellano, Prudente and Anguera (2014) analysed the sequences that achieved a goal in World Cups and Eurocups and reported that the creation of goal scoring situations is evolving from a more individual perspective based on dribbling and personal moves towards a more collective participation with more importance of passes and crosses.

In regards to the high number of goals scored by positional attacks, recent studies reported a considerably higher proportion of positional attacks during the games, what would lead to greater possibilities to score goals in absolute terms. However, in relative terms, the counterattacks have been shown to have higher effectiveness in creating goal scoring opportunities and goals (Tenga et al., 2010b; Lago-Ballesteros, Lago & Rey, 2012; Gonzalez-Rodenas et al., 2015b).

To conclude this section, it should be noted the great complexity of analysing the association between passing sequences and number of goals in soccer. On one hand, it seems that short passing sequences achieve high number of goals in soccer, what may be related to the effectiveness of counterattacks and set pieces. On the other hand, organized attacks seem to produce between 40-50% of the goals, what shows the importance of building offensive sequences against organized defensive systems. Finally, the production of goals is going to be specific to the teams' style of play and the technical profile of the players, what is going to determine the tactical construction of team sequences and their attacking success.

Set pieces

Set pieces have been shown to produce approximately 30% of goals in recent international tournaments (Armatas & Yiannakos, 2010, Mitrotasious & Armatas, 2014; Gonzalez-Rodenas, Lopez-Bondia, Aranda-Malaves, Tudela & Sanz-Ramirez & Aranda). This percentage is very relevant considering that this type of possession is not very frequent during the matches in comparison with positional attacks or counterattacks. Gonzalez-Rodenas et al. (2015b) found that teams in Major League Soccer had an average of 10 set pieces actions per game. Similarly, Silva (2011) observed an average of 5 corner kicks, 4 indirect free kicks, 0.85 free kicks and 0.2 penalty kicks per team and match in Spanish La Liga. These types of actions are characterized by the proximity to the opposing goal, the capacity of deciding the moment to start the action, as well as the possibility to put the ball in the opposing penalty box very quickly with the immediate intention to score a goal.

Silva (2011) observed that penalty kicks were the type of set piece that achieved more proportion of goals (30.5%), followed by indirect free kicks (26.3%), corner kicks (24.6%), direct free kicks (13.5%) and throw ins (4.6%). Yiannakos and Armatas (2006) found a greater proportion of goals produced by corner kicks (40.0%), followed by the indirect or direct free kicks (30.0), penalty kicks (25.0%) and the throw in (5%) during the Eurocup 2004. Another example is the study of Njororai (2013) in the World Cup 2010, where the corner kicks and indirect free kicks obtained the highest number of goals (28.6 and 28.6, respectively) followed by the penalty kick (25.7%) and direct free kick (14.3%).

Consequently, the indirect free kicks and corner kicks are a great source of goals in set pieces. For both types of actions, a header after a cross was the most frequent action to score and the critical zone of the penalty box (space between the penalty spot and the line of the goal box) was the space with the highest number of goals (Silva, 2011). In relation to the corner kicks, this study highlighted that one third of the

goals were scored after a defensive rebound, as well as more than the 50% of the contacts with the ball occurred in the near post area. Recent studies (Sainz de Baranda & López-Riquelme, 2012; Casal, Maneiro, Ardá, Losada & Rial, 2014; Casal, Maneiro, Ardá, Losada & Rial, 2015; Maneiro, Losada, Casal & Ardá, 2017) have reported how the percentage of creation of goal scoring opportunities ranged between 20-30% while only between 1.5 and 3.0% were converted in goal. These studies agreed in observing that both corner kicks and indirect free kicks were majorly executed in a direct way (immediate cross towards the penalty box) but were more effective when the teams performed an indirect action by means of a short pass, where 3 or 4 players participated in the possession and the decisive pass was made on the ground. According to the authors, short passing start and executing these set pieces by an indirect action would cause uncertainty for the defenders, who should not only pay attention to their direct opponent, but also to the movement of the ball.

In regards to the direct free kick, Silva (2011) found a goal effectiveness of 6.2%. This study observed how the 64% of goals were achieved by kicking the ball with the inside part of the foot and by going over the wall (56%), while the 24% and 20% went by the wall or through the wall, respectively. Moreover, the direct free kicks executed from central areas of the field and kicked with the opposite leg to the side of the field where it is executed, are the most effective to score (Carling, Williams & Reilly, 2005).

Lastly, the penalty kick is the type of set piece with a higher degree of effectiveness because between 70-85% of the actions lead to a goal (Jordet, Hartman, Visscher & Lemmink, 2007; Palau, Lopez-Montero & Lopez-Botella, 2010). These studies also noted how there is a tendency to shot towards low areas of the goal although high shots achieved 10% more effectiveness. Bar-Eli and Azar (2009) observed that those penalties directed to the high corners of the goals had 100% of effectiveness. In this sense, the accuracy of the players that kick the ball is crucial, maybe for this reason players normally use the inside part of his feet to execute the penalty kicks (Silva, 2011). The high effectiveness of penalty kicks may be due to the fact that goalkeepers have less time available than they require to dive and intercept the ball (Van der Kamp, Dicks, Navia & Noel, 2018). In this sense, Hunter, Angilleta and Wilson (2018) found that increasing the shot speed from 20 m per second to 30 m per second reduced the probability that the goalkeeper blocked the shot from 82% to 38%. For this reason, the interaction between the kicker and the goalkeeper is key to understand the performance in penalty kicks (Dicks, Button & Davids, 2010). Palacios-Huerta (2003) found that both kickers and goalkeepers behave perfectly randomly in penalty kicks. This author suggested that players use their instinct or intuition in each particular situation rather than having a similar pattern of behaviour. Another interesting result of this study was that goalkeepers chose to jump to the same side as the kicker shot in about half of the penalties, achieving over 60% of goals when this happens, while the effectiveness was practically 100% when the kicker and the goalkeepers chose different sides.

The end of the team possession

The previous action («goal pass» or «assist»)

Within the study of the finishing actions, the «previous pass» or «assist» is starting to be a very important indicator to define the attacking success of soccer players and teams. In this way, the players that are able to create a scoring opportunity for another teammate can be as important as the players who score the goal. Horn, Williams and Grant (2000) found how assists from the «zone 14» (central zone located in the opposing half just in front of the penalty box) created the highest proportion of goals in World Cup 1998. Another study of Horn, Williams and Ensum (2002) observed how passes from «zone 14» to the penalty box produced more goals than crosses in the English Premier League 2001/2002. Similarly, Silva, Sánchez Bañuelos, Garganta and Anguera (2005) showed that the majority of offensive sequences that led to goal did not come from wide areas but from central areas. Also, Smith and Lions (2017) studied the goals scored during four editions of the World Cup (2002-2014) and found how passing in behind the defense from central areas was the most used action, while a lower proportion of goals were scored from crossing situations or from positions located in front of the defensive line.

In relation with the previous actions, it has been found that long passes and combinative play (short passes) were the most frequent tactical actions during the Eurocup 2004 and World Cup 2006, while individual actions (dribbling or running with the ball) produced less than 20% of the goals. (Yiannakos & Armatas, 2006; Armatas & Yiannakos, 2010).

In this sense, Durlik and Bieniek (2014), observed that 69.3% of goals were scored after an assist from a teammate, while only the 12.8% came from an individual play performed by the goal scorer during the English Premier League. The location of the assist was predominantly central areas, while 32.2% came from wide areas. In the analysis of Mitrotasious and Armatas (2014), the cross produced the 43.7% of the goals in the Eurocup 2012, followed by short passes (35.2%), while the individual actions produced the 9.9% of the goals. As regards as the physical component, Faude, Koch and Meyer (2014) observed how the player who assisted to the goal scorer, performed a sprint (67.0% of the goals), and frequently (64.0%) this sprint was performed with the ball and against a close defender (48%).

According to these studies, the actions that lead to the goal were predominantly originated in central and advanced areas of the opposing half, while the crosses have been shown to represent around 30-40% of the assists. This fact highlights the importance of progressing towards central spaces in order to make passes in behind the defense. Furthermore, the collective combinations seem to be the main tactical way to score goals, since the individual actions produce less than 20% of the goals. This may indicate a high difficulty to disorder the defensive systems by means of actions purely individual. Moreover, previous research has found how the goals scored after individual actions have been decreasing in favor of collective actions such as passes and crosses during international competitions (Barreira et al., 2014). This study associated this fact with the higher player density around the player with the ball in recent tournaments (2002-

2010), what makes more difficult to create offensive superiority near the ball.

The proximity and the shot angle with respect to the goal

The proximity and the angle with respect to the goal have been two of the most important factors related to goal scoring in soccer. The majority of the studies have found that 80-90% of the goals are scored from inside the penalty box and 20% of them were scored inside the goal area (Yiannakos & Armatas, 2006; Armatas & Yiannakos, 2010; Michalidis, Michaildis & Primpa, 2013). Previous research suggested that there is an «effective area» inside the penalty box were more than 40% of the total goals are scored (Hughes, 1996; Carling, Williams & Really, 2005; Mitrotasius & Armatas, 2014). This area is located between the penalty spot and the line of the goal area.

Kirkendall, Dowd and DiCicco (2002) analysed the effectiveness of scoring goal depending on the distance in respect to the goal during the 1998 World Cup. These authors observed a 1/7 ratio for shots taken from the goal area, 1/9 ratio for shots taken from the penalty box and 1/33 for shots taken from outside the penalty box. Pollard, Ensum and Taylor (2004) analysed a total of 1096 shots and revealed that for each extra yard farther from the goal, the chances of scoring are reduced by 15%, for each degree that is lost with respect to the shooting angle with the goal is a reduction of 2% of possibilities. Also, they found that the probability for goal scoring double if the attacking player is more than 1 meter away from the nearest defender.

The final defensive positioning

Another important factor for goal scoring seems to be the defensive context where the shot takes place. Wright et al, (2011) found that 86% of goals had 2 or less defensive players between the ball and the goal. Gonzalez-Rodenas (2013) observed that offensive sequences that led to a goal had fewer players between the ball and the goal, as well as the goal scorer had greater spatial superiority than those sequences that led to scoring opportunities. Another study from Gonzalez-Rodenas et al. (2015a) analysed the ratio scoring opportunity/goal according to the space of defensive occupation where the last action took place. Consequently, the scoring opportunities that took place behind the defensive line showed 31.3% and 24.3% of effectiveness for counterattacks and positional attacks, respectively. This effectiveness decreased to 11.1% and 11.7% when the scoring opportunity took place in front of the defensive line.

The final actions of the goal scorer

Existing research studies have observed how strikers score approximately the 50% of goals, followed by wingers (20-30%), midfielders (10-20%) and defenders (10%) (Acar, Yapicioglu, Arikan, Yalcin, Ates & Ergun, 2009; Durlik & Bieniek, 2012; Njorarai, 2013, Mitrotasious & Armatas, 2014). However, the final actions (tactical, technical or physical) that the final players perform in goal situations have not been fully explored in the literature. In this vein, few existing studies have found how shooting with the feet seems to achieve between 70-80% of goals, whereas the rest the goals are achieved from headers (Durlik and Bieniek, 2014; Mitrotasious & Armatas, 2014). According to the specific part of the foot, the instep seems to be the most used surface, followed by the inside part of the foot (Michailidis et al., 2013, Michailidis, 2013). For instance, the study of Mitrotasios and Armatas (2014) in the Eurocup 2012, described how instep shots accounted for 38.67% of goals, while inside part of the foot and headers achieved the 32.0% and 29.3% respectively. Regarding the coordinative and temporal situations, Durlik and Bieniek (2014) noted how 69.3% of goals were scored directly after an assist of teammate which means no contact with the ball before the kick, while 17.9% were preceded by interception and 12.8% were scored after dribbling the ball. As far as the physical actions, Faude et al. (2012) observed in German Bundesliga how high-speed situations are key in goal scoring actions. In this way, this study showed that sprinting in straight direction was the most predominant action (61.0%), followed by jumping (22.0%), change of direction (8.0%) and player rotation or turn (8.0%). Interestingly, the majority of the sprints were performed without the ball (75.0%). Therefore, according to the existing literature, the last action in goal scoring situations require high-speed movements both to cover space (sprinting) and to shoot at goal (a great proportion of one-touch finishing).

Practical applications

Firstly, this paper has noted how the contextual factors have a very important role in goal scoring in professional soccer. Variables such as venue, match status, quality of the teams and the time of the match seem to cause different physical, psychological and emotional situations that may alter the tactical performance of teams in terms of goal scoring. In this manner, soccer coaches, analysts, fitness coaches and players should know the effect of the contextual factors and maximize or minimize their effects according to the tactical and strategical objectives of the team. For example, soccer coaches should adapt their strategies during the second half and specially during the last 15 minutes of the game because more goals are scored in that time period. Also, soccer coaches should take advantage of playing at home, because it has been observed how home teams score more goals than away teams in general terms. Additionally, coaches should prepare their teams to get adapted quickly to changes in the match status and anticipate the possible tactical and psychological consequences of scoring or conceding a goal.

Secondly, existing research has identified several tactical indicators that have been associated with goal scoring. For the possession start, performance indicators such as «starting the possession by winning the ball in open play», in «attacking zones», in «central channels of the pitch» and against an «imbalanced defence» have been highlighted in the literature. For the possession development, short passing sequences seem to obtain a great percentage of goals in form of counterattacks and set pieces although the «positional attack» was the most predominant type of progression. Also, set pieces have been shown to achieve a third of the total goals in different competitions. As far as the assist location and actions, more goals have been scored after passing from

«central areas of the pitch» while crossing actions seems to account for 20-30% of goals. Finally, more goals have been scored by shooting 'inside the penalty box', in 'behind the defensive line', without 'defensive pressure', having an 'open angle between the goal and the ball', using predominantly the «feet», with only «one contact with the ball after the pass of a teammate» and after «sprinting without the ball».

In terms of practical applications, these performance indicators are useful to understand «what» technical or tactical actions are predominant when goals are scored in soccer, as well as «when» or «where» these actions take place. With this information, soccer coaches could design training exercises that reproduce these scenarios in order to increase goal-scoring in their teams. For example, coaches should prepare their teams to gain the ball in attacking and central areas of the pitch and take advantage of counterattacks. Also, coaches should give importance to both offensive and defensive set pieces because they produce great quantity of goals. Regarding the final action, coaches should create exercises that include quick actions such as sprinting and finishing in one touch.

New perspectives and future challenges of goal scoring analysis

As we reviewed in the first part of the paper, the research methodology used in the vast majority of past studies was based predominantly on registering isolated actions without considering the interdependence of multiple factors in the creation of goal scoring situations. This fact was addressed by several critical studies (Glazier, 2010; Mckenzie & Cushion, 2013) that claimed the necessity of creating and using new research approaches in order to understand not only «what», «when' and 'where' actions occur, but also «how» and «why» the interaction between offensive, defensive and contextual factors influence the performance of teams and players. This information would allow coaches to design specific training environments where the modulation of different task constraints would reproduce a real context for the development of collective interactions and/or specific skills related to goal scoring in soccer.

Due to this necessity, there has been an increase in research methods in the field of performance analysis in soccer during the last few years (Sarmento et al., 2018). This scientific evolution aims to capture the interactive and complex nature of soccer and to provide new insights to researchers and soccer practitioners for the development of innovative studies. These recent methods include position data (Memmert, Lemmink & Sampaio, 2017, Memmet & Rein, 2018) network analysis (Passos, Davids, Araújo, Paz, Minguéns, & Mendes, 2011), sequential and temporal patterns (Camerino, Chaverri, Anguera & Gudberg, 2012), multidimensional qualitative data (Sarmento et al., 2018) and mixed methods (Anguera, Camerino, Castañer, Sanchez-Algarra & Onwuegbuzie, 2017). In this vein, understanding the potential of these methodologies for the analysis of goal scoring in soccer, we describe and discuss the newest findings on this field and propose future challenges for the development of research studies:

Multidimensional evaluation of shooting effectiveness

First of all, the low scoring frequency of soccer makes it difficult to build relationships between the general tactical offensive patterns of the teams and the way goals are scored. For this reason, the only analysis of sequences that lead to goal may not represent the real attacking play of soccer teams. Thus, it would be interesting for future studies to include the analysis of team possessions or player actions with different outcomes and study the differences between goal scoring possessions and also the rest. For instance, the fact of comparing team possessions that lead to scoring opportunities with team possessions that lead to goal may offer a significant view of the decisive dimensions that are related to goal effectiveness. One example of this approach was the study of Tenga et al. (2010), where they used a design that included cases and controls in order to compare offensive sequences that led to a goal with other types of possessions. In another example of this approach, Schultz et al. (2017) analysed the shots performed by a professional team and evaluated the influence of the positioning of the defenders and the goalkeeper on the goal effectiveness. This study reported that the distance of the closest defender and the sight of goal affected the quality of the shots.

Also, the recent development of statistical analysis using automatic tracking data is revealing multiple possibilities of analysing goal scoring in soccer. For instance, Fairchild, Pelechrinis and Kokkodis (2018) demonstrated how Major League Soccer teams with higher offensive efficiency tend to utilize a smaller area on the field with regards to their shots. Fernando, Wei, Fookes, Sridharan and Lucey (2015) identified different scoring methods depending on the team based on spatial and temporal patterns. Lucey, Bialkowski, Monfort, Carr, and Matthews (2015) observed that defender proximity, the interaction of surrounding players, speed of play, coupled with the shot location play an impact on determining the likelihood of a team scoring a goal.

These scientific approaches are helping calculate the «expected goals» that teams may score or concede by means of creating different statistical models that include the analysis of the effects of variables such as the location of the ball, the shot angle, the assist type and type of technical action. This metric allows soccer analysts and coaches to calculate the quantity of goals that a player or team should have scored on average, considering the quality of shots that they took. Also, this metric help predict the quantity of goals that a player or team will score in the future, what can be a powerful tool for scouts when recruiting soccer players (Rathke, 2017). Therefore, future studies should create complex models that capture the combined effects of offensive, defensive and spatiotemporal variables on the shooting effectiveness, facilitating the comparison between different teams, players or competitions.

Goal effectiveness of styles of play

The analysis of playing styles is arising in recent years (Fernandez-Navarro, Fradua, Zubillaga, Ford, Allistair, & McRobert, 2016; Yang, Leicht, Lago-Peñas, & Gomez, 2018; Gomez, Mitrotasios, Armatas, & Lago-Peñas, 2018). However, there is a lack of research on the real effectiveness of the team's style of play to score goals or create goal scoring

opportunities. In this sense, the use of data from multiple teams could mask the factors that determine or contribute to the success or low performance of each team (Taylor, Mellalieu, James & Shearer, 2008). The study of specific teams could help understand the effectiveness of certain tactical models to create scoring opportunities and score goals. Also, it could be interesting to evaluate the association between training methods and the achievement or concession of goals. For instance, Caro and Caro-Muñoz (2016) did not find a direct association between the tactical model implemented by professional soccer teams and their effectiveness to score goals. This type of studies could help soccer coaches know about the validity of training methods and tactical strategies.

Discovering the goal scorer skills

Very few studies have analysed the different coordinative, cognitive, perceptual, psychological or physical skills that special goal scorers possess in comparison with other players. Following this approach, recent studies (Castañer et al., 2016; Castañer et al., 2017) have evaluated the technical and tactical actions of Messi and Cristiano Ronaldo in goal scoring situations by means of the analysis of temporal patterns and polar coordinates. Thus, some factors highlighted in both players in goal actions were the anticipation to create situations of positional superiority (no pressure of the opponent) in their actions, the use of the outside part of the foot to drive the ball and face one-on-one situations, as well as the versatility to use different actions such as pass feints, change of direction feints, changes of directions, or the use of both legs. Specifically, Messi showed greater unpredictability in his actions prior to the goal, while Ronaldo showed to be a very precise shooter with more defined motor patterns. In addition to the movements with the ball, Spearman (2018) has recently introduced and studied the interesting concept of «off-ball scoring opportunity». This concept involves the evaluation of the off-ball positioning of players preceding shots, that could lead to goals, even if they finally did not receive the ball.

On the other hand, goal scorers and players with high quantity of assists seem to have higher levels of executive functions such as creativity, response inhibition, cognitive flexibility and working memory, in comparison to other players (Vestberg, Gustafson, Maurex, Ingvar & Petrovic, 2012; Vestberg, Reinebo, Maurex, Ingvar & Petrovic, 2017). Likewise, an interesting study of Kempe and Memmet (2018) based on systematic observation, reported that high creativity in the last two actions before the actual shot on goal proved to be the best predictor for game success. Therefore, recent research has shown how players who score goals or create goal situations may possess special cognitive, perceptual, technical or tactical skills. Future research should study the different 'goal skills' such as positioning, anticipation, tactical movements on and off the ball, technical accuracy, dribbling ability, etc. The knowledge of these skills would allow coaches to design specific training sessions and individualize training methods.

The effect of players interactions and synergies

Soccer is a collective, interactive and complex sport where the collaboration, communication and understanding between teammates is crucial to achieve attacking performance. For this reason, in addition to the analysis of individual skills, future studies also should evaluate the interactions and synergies between players to generate goal scoring situations. This would help understand why some players perform more effectively in certain teams, under certain strategies or surrounded by teammates with specific skills. The development of research studies should have a practical focus in order to help coaches and analysts to evaluate the tactical performance of their teams or players, as well as to understand what profile of players they should recruit to maximize the team interactions in the creation of goal scoring situations. Although a great number of studies have analysed general team interactions (Gama et al., 2014; Clemente, Martins, Kalamaras, Del Wong & Mendes, 2015), there are very few studies that have researched on the influence of players interactions on goal scoring situations. For instance, Clemente, Martins and Mendes (2016) evaluated the team interactions by using 'network analysis' and observed the tactical relationships between players that created goal scoring situations. This study concluded that wing midfielders and attacking midfielders were the most used players and lateral defenders were the players that initiated most attacking plays. Other study performed by Mclean, Salmon, Gorman, Stevens and Solomon (2018) observed how goal scoring passing networks were highly varied when studying several teams.

Additionally, the analysis of the interaction with the opponent is key to understand the tactical behavior in soccer (Tenga et al., 2010; Gonzalez-Rodenas et al., 2015a). However, very few studies have evaluated the relationships between offensive and defensive behaviors in goal scoring situations. For example, Gonzalez-Rodenas et al. (2019) observed that goals scored by using one contact to the ball or goals created by crossing were more frequent against organized defences than against circumstantial defences, what indicates that the type of defence influences the finishing process in goal-scoring situations.

In this way, future studies should create research methodologies that are able to integrate the analysis of offensive and defensive interactions. This fact would explain in which tactical scenarios the ball was gained, why goals were scored after a counterattack or positional attack or how the defensive structure or behavior of the opposing team influenced the final offensive actions. Therefore, future studies should test new hypothesis about the relationships between team interactions and their interdependence with the opponent structure and behavior.

Effects of training methods on goal scoring

Despite the key importance of goals for the success of teams and players, little is known about what are the best practices to improve the goal scoring capacity both collectively and individually. According to our knowledge, no studies have analyzed the effects of specific training methods on the creation of goal scoring situations both from a collective and individual perspective. In this sense, soccer coaches normally design finishing exercises based on numerous repetitions of shots from multiple positions, focusing on the accuracy and technique of the actions. Also,

soccer coaches usually design large and small sided games to create interactions and synergies between the attacking players in order to improve the attacking success of the team. However, the effectiveness of these practices has not been discussed in the scientific literature.

In this way, the future analysis of especial coordinative, tactical or physical skills related to goal scoring in soccer will help coaches design specific exercises that maximize the learning process of soccer players. Besides, further analysis of the effects of training methods on goal effectiveness would help coaches improve the training methodology in order to develop more creative and offensive players.

Influence of contextual factors on goal scoring

It has been demonstrated in the past how the contextual variables are related to goal-scoring. However, there is no evidence of how contextual variables influence the technical or tactical actions or interactions related to goal scoring in soccer. For instance, the fact of playing at home or away creates a different tactical context that can modulate the way that goals or goal scoring opportunities are achieved. Similarly, the fact of playing against a high-ranked opponent may alter the way that the team is going to attack and this is going to affect the technical and tactical characteristics of the goals and goal scoring opportunities. One example of this approach was addressed by the study of Mitrotasious, Gonzalez-Rodenas, Armatas and Aranda (2019). This study observed particular tactical characteristics in the creation of goal scoring opportunities according to each domestic competition. For this reason, further research should analyse the combined and interactive effects of tactical and contextual variables. In this vein, factors as the type of competition, match location, altitude, quality of the opponent, minute of play, match status, numerical inferiority or superiority, type of game (knockout rounds, first or second leg, group stage) and adverse or extreme environmental conditions should be considered when designing research studies on goal scoring in professional soccer.

Conclusions

During the past, the literature based on notational analysis highlighted numerous tactical and contextual factors related to goal scoring in soccer. This information represents a valuable knowledge for soccer coaches and analysts and establishes an appropriate starting point towards a better understanding about the process that leads to goal scoring in soccer. However, these studies presented limitations to analyze the multifactorial nature of goal scoring. Currently, the emergence of new research methodologies permits the development of more integrative approaches that are able to capture the interactive and complex environment of soccer actions. Thus, some future challenges in the analysis of goal scoring in soccer should explore: a) the multidimensional evaluation of shooting effectiveness, b) the goal effectiveness of styles of play, c) the goal-scorer's skills, d) the further exploration of the effect of the interactions between teammates and defenders on goal scoring, e) f) the effects of training methods on goal scoring and f) the influence of contextual variables on goal-scoring actions.

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