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Facultad de Humanidades y Ciencias de la Educación
Departamento de Educación Física

Temporal goal scoring characteristics in elite Brazilian football: a longitudinal study

Características temporales de la anotación de goles en el fútbol de élite brasileño: un estudio longitudinal

Características temporais da marcação de gols no futebol de elite brasileiro: um estudo longitudinal

Guilherme de Sousa Pinheiro
Chair of Performance Analysis and Sports Informatics, Faculty of Sport and Health Sciences, Technical University Munich, Munich, Alemania
UFMG Soccer Science Center, Sports Department, Federal University of Minas Gerais, Belo Horizonte, Brasil
guilherme.gsp11@hotmail.com
https://orcid.org/0000-0002-5572-1505

Daniel Campos
UFMG Soccer Science Center, Sports Department, Federal University of Minas Gerais, Belo Horizonte, Brasil
daniel_hcdasilva@hotmail.com

Varley Teoldo da Costa
UFMG Soccer Science Center, Sports Department, Federal University of Minas Gerais, Belo Horizonte, Brasil
vtcosta@hotmail.com
https://orcid.org/0000-0001-5786-633X

Abstract

This study aimed to investigate the temporal pattern of goal scoring in recent 8 editions of the elite Brazilian Championship. The sample consisted of 3,039 matches (7,170 goals) from the seasons 2012 to 2019 of the 1st division of the Brazilian Championship. The official match reports, which are publicly available on the website of the Brazilian Football Confederation - CBF (www.cbf.com.br), were analyzed. Data collection occurred through the observational methodology. Two experienced observers registered the data. Inter and intra-rater reliability was calculated to guarantee the quality of the observation system. During the 2012-2019 seasons an average of 393.50 goals occurred in the 1st half, and 502.75 in the 2nd half. The average number of goals per match was 2.36. Results indicated a higher incidence of goals scored in the 2nd half of the match ($p < 0.05$). An upward trend in the number of goals scored was observed as match-play time progressed. Football coaches and practitioners may plan and practice match strategies more effectively according to the time trend of goals in a match.

Keywords: Performance Analysis, Football Analytics, Additional Time, Goal Incidence, Match Analysis.

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Resumen

Este estudio tiene como objetivo investigar el patrón temporal de la marcación de goles en las últimas 8 ediciones del Campeonato Brasileño de élite. La muestra consistió en 3.039 partidos (7.170 goles) de las temporadas 2012 a 2019 de la 1ª división del Campeonato Brasileño. Se analizaron las actas oficiales de los partidos publicadas y disponibles en el sitio web de la Confederación Brasileña de Fútbol - CBF (www.cbf.com.br). La recolección de datos se realizó a través de la metodología observacional; dos observadores experimentados registraron los datos. Se calculó la fiabilidad inter e intra observador para garantizar la calidad del sistema de observación. Durante las temporadas 2012-2019 se produjo una media de 393,50 goles en la 1ª parte, y 502,75 en la 2ª parte. La media de goles por partido fue de 2,36. Los resultados indicaron una mayor incidencia de goles marcados en la 2ª parte del partido ($p < 0,05$). Se observó una tendencia ascendente en el número de goles marcados a medida que avanzaba el tiempo de juego del partido. Los entrenadores y profesionales del fútbol pueden planificar y practicar estrategias de partido de forma más eficaz en función de la tendencia temporal de los goles en un partido.

Palabras clave: Análisis del Rendimiento, Analítica del Fútbol, Tiempo Adicional, Incidencia de Goles, Análisis de Partidos.

Resumo

Este estudo teve como objetivo investigar o padrão temporal da marcação de gols nas 8 edições recentes do *Campeonato Brasileiro* de elite. A amostra consistiu em 3.039 partidas (7.170 gols) das temporadas de 2012 a 2019 da 1ª divisão do *Campeonato Brasileiro*. Foram analisados os relatórios oficiais das partidas, que estão disponíveis publicamente no site da *Confederação Brasileira de Futebol* — CBF (www.cbf.com.br). A coleta de dados ocorreu por meio da metodologia observacional. Dois observadores com experiência registraram os dados. A confiabilidade inter e intra dos avaliadores foi calculada para garantir a qualidade do sistema de observação. Durante as temporadas de 2012–2019, ocorreu uma média de 393,50 gols no 1º tempo e 502,75 no 2º tempo. O número médio de gols por partida foi de 2,36. Os resultados indicaram uma maior incidência de gols marcados no segundo tempo do jogo ($p < 0,05$). Foi observada uma tendência no aumento do número de gols marcados à medida que o tempo de jogo avançava. Os treinadores e profissionais de futebol podem planejar e praticar estratégias de jogo de forma mais eficaz conforme a tendência temporal dos gols em um jogo.

Palavras-chave: Análise de desempenho, Futebol analítico, Tempo adicional, Incidência de gols, Análise de jogos.

Introduction

The average number of goals scored in elite football matches is typically low (*i.e.*, 2.5-3), both for national and international competitions (Sánchez-Flores, Martín-González, García-Manso, De Saa, Arriaza-Ardiles & Da Silva-Griglotett, 2016). This low frequency of goals makes studies on goal scoring pattern of great practical importance, as it could provide useful information to plan offensive and defensive tactical actions, as well as adjust the substitutions strategy during the match to maximize chances of team success (Zhao & Zhang, 2019; Pratas, Volossovitch & Carita, 2018). Notably, researchers have shown a significant interest in uncovering factors related to goal-scoring patterns (Rodenas, Malavés, Desantes, Ramírez, Hervás & Malavés, 2019; Yi, Gómez, Liu & Sampaio, 2019; Wright, Atkins, Polman, Jones & Sargeson, 2011).

Different technical, tactical, and contextual factors (e.g., scoring opportunities, ball possession, match status, penalty kicks, psychological aspects) are related to goal scoring in elite football (Li & Zhao, 2021; Pinheiro, Nascimento, Dicks, Costa & Lames, 2021; Rodenas, Malavés, Desantes, A. T., Ramírez, Hervás & Malavés, 2019; Aguado-Méndez, González-Jurado, Callejas-Jerónimo & Otero-Saborido, 2020; Fagundes, Costa, Reis, Pinheiro & Costa, 2021; Fagundes, Noce, Albuquerque, Andrade & Costa 2019). However, previous research has found that goal-scoring patterns are time-dependent (Kubayi y Toriola, 2019). Studies investigating different competitions (e.g., World Cups; FIFA and UEFA tournaments; major European and South American leagues) found that the period with the highest incidence of goals is the final 15 minutes of the match (Li & Zhao, 2021; Zhao & Zhang, 2019; Kubayi y Toriola, 2019; Njororai, 2014; Alberti, Iaia, Arcelli, Cavaggioni & Rampinini, 2013; Souza, Farah & Dias, 2012; Armatas, Vasilis & Yiannakos, 2010; Armatas, Giannakos, Skoufas & Papadopoulou, 2009; Armatas, Yiannakos & Sileloglou, 2007). Mitrotasios and Armatas (2012) demonstrated that 57.9% of the goals were created in the second half of the match in the 2012 European Football Championship and most of the goal-scoring during the 75-90 min period. Alberti, Iaia, Arcelli, Cavaggioni & Rampinini (2013) analyzed 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, with the same trend in all competitions.

The reasons for this temporal trend in goals scored in elite football are diverse and interrelated (Zhao & Zhang, 2019). Factors such as increased fatigue (Smith, Fransen, Deprez, Lenoir & Coutts 2017; Smith, M. R., Zeuwts, Lenoir, Hens, De Jong & Coutts, 2016; Rivilla-García et al., 2019; Fransson, Krustrup and Mohr, 2017), decreased physical performance (Vigne, Gaudino, Rogowski, Alloatti & Hautier, 2010; Carling & Dupont, 2011), technical errors (Lames, 2018) and tactical changes (Bradley, Lago-Peñas and Rey, 2014; Rey, Lago-Ballesteros and Padrón-Cabo, 2015; Lorenzo-Martínez, Padrón-Cabo, Rey and Memmert, 2020) are commonly mentioned in the literature to possibly explain this trend.

The identification of goal-scoring patterns is one of the most pertinent issues in football match analysis (Rodenas, Malavés, Desantes, Ramírez, Hervás & Malavés, 2019; Pratas, Volossovitch & Carita, 2018). Previous studies analyzed the scoring time pattern during the national and club league matches (Aguado-Méndez, González-Jurado, Callejas-Jerónimo & Otero-Saborido, 2020; Alberti, Iaia, Arcelli, Cavaggioni & Rampinini, 2013; Andrade, Boaventura, Mendes & Santo, 2015; Kubayi, & Toriola, 2019). For analysis purposes, full matches are commonly divided into 15-minute intervals (Wang and Qin, 2020). To the best of our knowledge, only one study has longitudinally investigated temporal patterns in goal scoring in the Brazilian championship. However, this study analyzed data from the 2006 to 2010 seasons (Andrade, Boaventura, Mendes & Santo, 2015). Elite football competition has evolved substantially, with large increases in physical and technical demands that are often interrelated (Bradley, Lago-Peñas & Rey, 2019), changing, therefore, the dynamics of the game. As such, it is necessary to investigate longitudinally whether the temporal incidence of goal scoring has changed. It is essential that football coaches and technical staff pay more attention to goal scoring patterns as such information can be helpful in devising strategies that could maximize team success (Kubayi and Toriola, 2019). Therefore, the aim of this study is to

longitudinally investigate the temporal pattern of goal scoring in 8 recent editions of the elite Brazilian Championship.

Methods and Materials

Sample

The sample consisted of 3.039 matches (7.170 goals) from the seasons 2012, 2013, 2014, 2015, 2016, 2017, 2018, and 2019 of the 1st division of the Brazilian Championship. This study did not involve data collection with human beings, so submission to the ethics committee was not necessary. However, all procedures performed in the study were in strict compliance with the Declaration of Helsinki, as well as with the ethical standards of the Technical University of Munich and the Federal University of Minas Gerais.

Procedures

The official match reports, which are publicly available on the website of the Brazilian Football Confederation - CBF (*www.cbf.com.br*), were analyzed. Data collection occurred through the observational methodology (Lames, M., & McGarry, T., 2007; Lames, M., 2006; Lames, M., and Hansen, G., 2001). Two experienced observers registered the data. Inter and intra-rater reliability was calculated to guarantee the quality of the observation system (Pinheiro et al., 2021). The following scoring pattern was analyzed: a) scoring frequency per 45 minutes plus additional time; b) scoring frequency per 15 minutes: 0-15, 16-30, 31-45 plus additional time, 46-60, 61- 75 and 76-90 plus additional time.

As inclusion criteria, data were collected from all championships that were registered (i.e., match reports) on CBF's official website. The exclusion criterion adopted was the elimination of data from seasons in which the VAR started to be used. Errekagorri, Castellano, Echeazarra, & Lago-Peñas (2020) suggested that the VAR hardly changes the game in elite football. The season that occurred during the pandemic of COVID-19 (2020) was not included as there were changes in match intervals and match rules - i.e., increase in the number of substitutions (Mohr et al., 2020).

Statistical Analysis

A descriptive analysis of the data was performed, presenting the results in mean and standard deviation. Shapiro Wilk test was performed to verify data normality. Paired sample t-test was adopted to check the difference of goals scored in the 1st and 2nd half. Multinomial tests were performed to analyze the variance of all evaluated periods (15min interval).

For the inter-observer agreement, apart from the analysis carried out by the main researcher, a second researcher was trained in the analysis of the match reports. After the training period, the two observers independently registered 40 randomly selected matches from the season 2012 and 2019. Regarding the intra-observer agreement, the principal investigator performed the same analysis 4 weeks after the first analysis thus minimizing task familiarity (Pinheiro, et al., 2021), without conducting any type of analysis during this time (Aranda, González-Ródenas, López-Bondia, Aranda-Malavés, Tudela-Desantes, & Anguera, 2019). The interpretation of this coefficient was adopted as follows: $\kappa > 0.8$ very good; $0.6 < \kappa < 0.8$ good; $0.4 < \kappa < 0.6$ moderate; $0.2 < \kappa < 0.4$ fair; $\kappa < 0.2$ poor (O'Donoghue, 2009; Altman, 1991). Kappa values of the observational measurements were 0.99 for intra-reliability and 0.98 for inter-reliability, indicating a high level of reliability of the measures (O'Donoghue, 2009). The level of statistical significance adopted was $p < 0.05$. All data were analyzed using JASP software (Team, 2020; JASP Version 0.14; Computer software).

Results

Descriptive results

During the 2012-2019 seasons an average of 393.50 goals occurred in the 1st half, and 502.75 in the 2nd half. The average number of goals per match was 2.36. Table 1 shows the average number of goals at each 15-minute interval during the match.

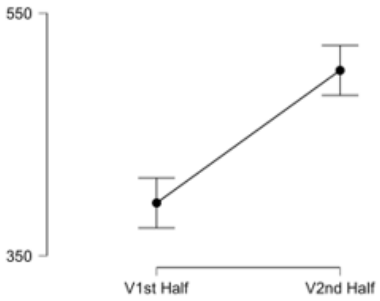
Table 1
Goals per 15min interval

	0-15	16-30	31-45	45+	46-60	61-75	76-90	90+
Mean(sd)	113.63 ± 13.09	126.13 ±19.59	136.25 ± 17.55	17.50 ± 7.56	150.75 ± 10.53	152.63 ±13.93	159.63 ±7.31	39.75 ± 10.57

Goal scoring frequency per 45 minutes

In the 2012-2019 seasons, a higher number of goals were scored in the 2nd half ($p < 0.05$). On average, the difference of goals scored in the 1st and 2nd half was 109.25 (sd: 12.30 goals). A paired samples t-test showed this difference to be significant ($t(7) = 8.880$, $p < 0.05$). Cohen's d states that this is a large effect ($d = 3.140$). The graph 1 shows the comparison of the average number of goals (2012-2019 seasons) in the 1st half plus additional time and 2nd half plus additional time

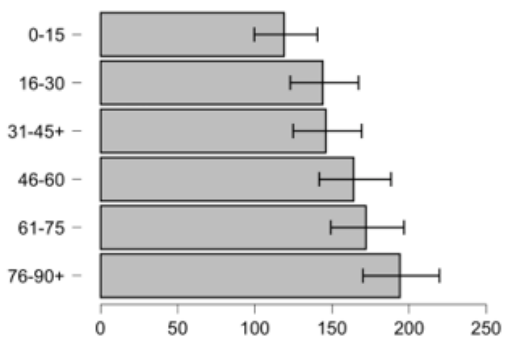
Graph 1
Scoring per 45-minutes interval: 1st half vs 2nd half



Scoring frequency per 15 minutes

The scoring frequency per 15 minutes (0-15, 16-30, 31-45 plus additional time, 46-60, 61- 75 and 76-90 plus additional time) is presented in Graph 2 (2012-2019 seasons). The multinomial test results showed that the observed distribution is significantly different ($x^2 = 21.569$, $p < 0.05$) to an equal distribution. An upward trend in the number of goals scored was observed as match-play time progressed ($p < 0.05$).

Graph 2
Scoring frequency per 15-minutes



Discussion

This study aimed to longitudinally investigate the temporal pattern of goal scoring of the elite Brazilian Championship. The main findings of the present were that there is a higher incidence of goals scored in the 2nd half of the match; an upward trend in the number of goals scored was observed as match-play time progressed, with the final 15 minutes of the match being the moment with the highest incidence of goals. The present higher incidence of goals scored in the 2nd half of the match corroborates with previous findings in past editions of the Brazilian league (Andrade, Boaventura, Mendes & Santo, 2015; Campos, Drezner, Cortez, 2016; Souza, Farah, Dias, 2012).

Despite the technical and tactical evolution of the match (Bradley, Lago-Peñas & Rey, 2019), the present finding demonstrates that the goal dynamics between the 1st and 2nd half of the match in professional football remains the same for the elite Brazilian Championship. The same trend in the number of goals scored has been observed in European leagues and World cups (Njororai, 2014; Alberti, Iaia, Arcelli, Cavaggioni, Rampinini, 2013; Armatas, Giannakos, Skoufas, & Papadopoulou, 2009; Mitrotasios and Armatas, 2014; Armatas, Yiannakos & Sileloglou, 2007; Kubayi, 2020). It has been suggested that the temporal patterns of goal incidence are not related to a particular season or league (Alberti, Iaia, Arcelli, Cavaggioni, Rampinini, 2013). This may suggest that temporal patterns (i.e., comparison between 1st and 2nd half) of goal incidence are not related to the format of the competition (e.g., league or group stage with knockout matches).

The increase in the number of goals in the 2nd half of a match is complex phenomena (Zhao and Zhang, 2019). It could be explained by the influence of physical and mental fatigue (Kubayi, 2020; Reilly, 1997), increased risk taking by the team that is behind, and a change in tactics due to approaching the end of the match (Reilly, 1997). Players tend to cover shorter total distances and shorter distances at high speed in the 2nd half when compared to the 1st half (Rivilla-García et al., 2019; Smith, Zeuwts, Lenoir, Hens, De Jong & Coutts, 2016; Carling and Dupont, 2011). This could cause reduced defensive coverage on the pitch, facilitating the construction of offensive plays. Prolonged mental effort, as is demanded in a professional football match, could also impair the players technical performance (e.g., errors in passing and ball control) (Smith, Fransen, Deprez, Lenoir & Coutts 2017; Smith, Zeuwts, Lenoir, Hens, De Jong & Coutts, 2016).

During half-time, coaches may provide feedback about the opponent and their own team's performance, as well as substitute players to modify their tactics (Rey, Lago-Ballesteros & Padrón-Cabo, 2015). Substitutions made in the 2nd half of tend to influence the physical dynamics of the match (Bradley, Lago-Peñas and Rey, 2014; Rey, Lago-Ballesteros and Padrón-Cabo, 2015; Lorenzo-Martínez, Padrón-Cabo, Rey and Memmert, 2020). Bradley, Lago-Peñas & Rey (2014) points out that the highest incidence of substitutions happens at half-time and between 60-85 minutes of the match play and can be mostly characterized as more offensive, which corroborates with the higher incidence of goals in the 2nd half. Players who enter during the match tend, during the period they are on the pitch, to cover greater distances, perform more sprints, and perform more high-intensity sprints than other players who were already on the pitch from the start of the match (Bradley, Lago-Peñas & Rey, 2014; Lorenzo-Martínez, Padrón-Cabo, Rey & Memmert, 2020). The substitute players tend also to perform better on technical variables (e.g., correct passes, shots, interceptions) and be more successful in individual match duels (Lorenzo-Martínez, Padrón-Cabo, Rey & Memmert, 2020; Gantois et al., 2019; Rivilla-García et al., 2019; Smith, Fransen, Deprez, Lenoir & Coutts 2017; Smith, Zeuwts, Lenoir, Hens, De Jong & Coutts, 2016; Carling and Dupont, 2011; Vigne, Gaudino, Rogowski, Alloatti, and Hautier, 2010).

The present result of an upward trend in the number of goals scored as match-play time progressed corroborate Campos, Drezner & Cortez (2016) and Souza, Farah & Dias (2012), who also analyzed the Brazilian championship. Previous research, analyzing several European leagues in different seasons, have also found an upward trend in the number of goals scored as match-play time progressed (Li and Zhao, 2021; Zhao and Zhang, 2019; Njororai, 2014, Alberti, Iaia, Arcelli, Cavaggioni, Rampinini, 2013; Armatas, Giannakos, Skoufas & Papadopoulou, 2009). However, the present results contrasts with Andrade, Boaventura, Mendes & Santo (2015). When comparing these results, it is noticeable that in the most recent editions of the Brazilian championship the final 15 minutes of the match became the period with the highest number of goals. It seems that the final fifteen minutes of the 2nd half frequently represents a critical period in the match (Pratas, Volossovitch & Carita, 2018) in different leagues and seasons. These findings could be also explained by increased fatigue (Pratas, Volossovitch & Carita; Rivilla-García et al., 2019; Fransson, Krustrup and Mohr, 2017). Excessive fatigue, typical in the final minutes of the match, may influence players' decision-making ability (Gantois et al., 2019), reduce physical fitness, and impair technical movements (Lames, 2018). Another explanation could be the adoption of riskier attacking strategies to change the score for the team's success (Njororai, 2014). Cardoso, García-Calvo, Patrick, Afonso & Teoldo (2021) found a high inverse association between cognitive effort and tactical behavior efficiency; players with less cognitive effort during a task displayed higher values of tactical behavior efficiency on the field.

The limitation of this study was to not evaluate other performance indicators, such as psychological constructs, physical performance, technical and tactical behavior. These measures could complement the analysis of the goal incidence and understand better the differences. Despite this, the present study brings reflections and practical findings about the temporal pattern of goals in professional football. Football coaches and performance analysts could plan and practice match strategies more effectively (e.g., pressure marking at a certain moment of the game). Future research could model goal scoring patterns in professional football using psychological, physical, and tactical variables. Physical performance should also be assessed, to investigate its relationship with temporal goal dynamics.

Another important consideration for future research is the impact of post-pandemic COVID-19 changes in the game, such as the number of player substitutions, on temporal goal scoring. The introduction of five substitutions might potentially influence goal-scoring patterns, as this alteration changes the dynamics of the game. Moreover, future studies should consider analyzing goal conversion rates in various competitions to identify potential differences in goal-scoring patterns and investigate the underlying factors contributing to these variations.

It is also relevant to note that the time interval analyzed may influence the goal distribution results. In the present study, the scoring frequency was analyzed in 15 minutes intervals. However, when the time interval is reduced to 5-minute, the distribution might change. Therefore, when comparing results caution should be taken.

Conclusion

The longitudinal analysis in the Brazilian elite football, a higher number of goals has been scored in the 2nd half. In the analysis of 15-minute intervals, it was observed more goals scored in the last 15 minutes of the match. An upward trend in the number of goals scored was observed as match-play time progressed.

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