

Soccer pacing strategy: chronological intracomparison of the same soccer athletes, disputing with the same opponent during the same year

LUCAS DE ALBUQUERQUE FREIRE¹, PABLO MERINO-MUÑOZ², ESTEBAN AEDO-MUÑOZ³, DANY ALEXIS SORBAZO SOTO⁴, CIRO JOSÉ BRITO⁵, BIANCA MIARKA⁶

^{1,2,6}Postgraduate Program in Physical Education, School of Physical Education and Sports, Department of Fights. Federal University of Rio de Janeiro, BRAZIL.

² Núcleo de investigación en ciencias de la motricidad humana, Universidad Adventista de Chile, CHILE

³ Physical Education Department. Universidad Metropolitana de Ciencias de la Educación, Santiago, CHILE.

⁴ Escuela de Kinesiología. Universidad Santo Tomas, Santiago, CHILE.

⁵ Postgraduate Program in Physical Education, School of Physical Education and Sports. Federal University of Juiz de Fora, BRAZIL

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Abstract

Purpose: Compare the pacing strategy used in each global positioning system (GPS) parameter by the context and regulation over the year's championship, disputing with the same opponent. **Methods:** Forty performances of the same eight professional soccer athletes, disputing with the same opponent during the Carioca (State) Tournament (first and second games winning, and third losing a game) and in the Brazilian National Tournament (4th winning game and 5th losing game). Performance analysis of Professional soccer players was monitored using a portable 5-Hz GPS unit (Catapult; Melbourne; AUS) during games. ANOVA repeated measures analysis with Bonferroni post-hoc tests were used to compare the external load parameters between the moments.

Results: The percentage of sprints with a velocity >18 km/h presented significance, but post hoc did not detect effects ($F=47.65$, $p=0.006$, $\eta^2p=0.94$). A significant effect between the games was detected in the distance of sprints >24 km/h variable ($F=20.35$, $p=0.006$, $\eta^2p=0.95$) and indicated that soccer players sprinted longer distances in the second game than in the first game (187 ± 100 vs 166 ± 71.3 m). Significant differences between the games in the relative load ($F=11.20$, $p=0.019$, $\eta^2p=0.92$), specifically, the first game had a lower relative load than the third game and higher than the fifth game (9.13 ± 1.25 vs 9.80 ± 1.48 vs 8.80 ± 1.10 scores respectively). Finally, differences in deceleration frequencies ($F=6.44$, $p=0.049$, $\eta^2p=0.87$), where the second game had lower frequencies than the fourth game (29.1 ± 9.26 vs 40.8 ± 12.1 frequency). **Conclusion:** The present research ends by introducing a novel hypothesis inspired by an ecological approach to integrating information in the context of pacing during soccer games. Results supported the self-regulation hypothesis and showed that the distance of sprints with more incredible velocity than 24km/h indicated that soccer players sprinted longer distances in the second winning game than in the first winning game. In addition, the first winning game had a higher relative load than both losing games, while the second winning game had a lower number of decelerations than the fourth winning game. No effects were observed in total distance, number of sprints, maximal velocity, total load, total jumps, or total time. These facts reinforce the concept that professional soccer athletes maintained a submaximal work rate in a similar pattern until determinant actions. This evidence could help soccer professionals more successfully design training programs and prevent injury.

Keywords: external load, football, global positioning system, match running, pacing, professional athlete.

Introduction

During soccer matches, players perform various physical actions such as running, sprints, jumps, accelerations, decelerations, and changes of direction (Freire et al., 2021). The connection of sequential actions during the match and critical indicators represents the main aspects of attacking systems by soccer athletes (Borges, Guilherme, Rechenchosky, da Costa, & Rinaldi, 2017; Freire et al., 2020). Some of these, such as sprinting and changes of direction, are usually the most performed by players before scoring a goal in the German Bundesliga (Bundesliga) (Faude et al., 2012), so the optimization and analysis of these actions are often important for coaches (Pérez-Contreras et al., 2021).

In professional competitions of soccer, athletes dispute between two and five games per month that last for ~90 minutes. In case of a tie, games could be extended, and preceding reports indicated that prolonged cognitive tasks might be a mediating factor in passing decision-making performance in male professional soccer athletes (Gantois et al., 2019; Freire et al., 2021). In soccer, pacing could be defined as the distribution of energy resources to optimize match running performance (MRP) (Waldron & Highton, 2014), although in open task sport and exercise science, this phenomenon is little investigated (Antonietto et al., 2019; Bradley & Noakes,

2013). Edwards & Noakes (2009), proposed a model where the athlete regulates his or her efforts based on macro, meso, and micro pacing strategies. Macro pacing strategies are determined before the match, which can be modulated between halves of the game (meso) or continuously (micro) (Edwards & Noakes, 2009). Despite the performance-oriented sports context, pacing has been associated with the possibility to give referential regulation of exercise intensity throughout an action bout based on circumstantial factors of the championships to maintain internal homeostasis (Bradley & Noakes, 2013) or to avoid early fatigue (Bangsbo, Iaia, & Krstrup, 2007; Bradley & Noakes, 2013; Coutinho et al., 2017). Due to difficulties in conducting physiological evaluations during a match, researchers interested in the physiological responses to soccer have been used to conduct time-motion analysis of the global positioning system (GPS) parameters to infer the metabolic and mechanical profile of soccer matches (Anderson et al., 2019; Casamichana, Bradley, & Castellano, 2018; Freire et al., 2022). This knowledge could improve training with specific exercises and GPS parameters. In open tasks modalities, like soccer, it is challenging to investigate, and this knowledge is unknown because the pacing and decision-making findings must include a sequential combination of aspects of the tournaments with a combination of interoceptive (i.e., physiological, psychological, or technical analysis) (Esteves et al., 2021; Esteves et al., 2020) and exteroceptive (i.e., environmental) factors (Bradley & Noakes, 2013; Edwards & Noakes, 2009). Many researchers have shown how related self-paced performances and pacing (Black et al., 2019; Bradley & Noakes, 2013; Malone, Solan, & Collins, 2017; Sampson Fullagar, & Gabbett, 2015). In soccer, macro, meso, and micro pacing strategies have been studied within soccer matches. Some of them have been, match location (home or away), ranking (best or worst), dehydration, periods of high intensity within the match, periods of match congestion, match status (winning, tying, or losing), match importance, among others (Bradley & Noakes, 2013; Buchheit et al., 2018; Edwards & Noakes, 2009; Ferraz et al., 2018; Link & De Lorenzo, 2016; Vieira et al., 2018). Soccer has not done any researchable to integrate chronological intra-comparisons and pacing strategies based on self-paced actions and as teams play multiple games against one opponent in the same year, both for the same championship (home and away) and other local tournaments (Freire et al., 2022), knowing which MRP indicators change could help coaches plan the competitive microcycle. Based on these findings, a well-established experimental paradigm to investigate pacing strategy, using the same athletes, and the same opponent in the same year, according to GPS parameters during sequential actions as precisely as possible, requires a chronological database table to show sequential actions of the same athletes. Therefore, the present research provides an overview of how pacing strategies are treated in the external soccer loads on match regulation and pacing by five different moments of the year, losing and winning. The current investigation compares the pacing strategy used in each GPS parameter by the context and regulation over the year's championship, disputing with the same opponent.

Methods

Participants

Forty performances of the same eight professional Brazilian soccer athletes (1st game-winning, 2nd game-winning, 3rd losing-game, 4th winning-game, and 5th losing-game), disputing with the same opponent during the Carioca (State) Tournament (1st game-winning, 2nd game-winning, and 3th losing-game – 10.02.2018 and 03.03.2018, and 28.03.2018 respectively) and in the Brazilian National Tournament (4th winning-game – 21.07.2018 and 5th losing-game – 10.11.2018) were used in the present investigation. These performances were from professional athletes who competed in international and national representative tournaments once/ week and regularly specific soccer training 4 to 7 times/ week during the research moment (Tvrđy, Lednický, Peráček, Obetko, & Babic, 2020). Inclusion criteria: Present research included complete data of players playing together in all games included, aged over 18 years, without mental or physical disorders, without surgeries, and for more than 3 years at the national and international level. Exclusion criteria were soccer athletes who could not complete less than 90% of the game or had limitations during the study, mainly for health reasons, duly certified by doctors. Athletes could not intake alcohol or drugs for at least 24 hours before the games and procedures and were to continue regular nutrition. Before proceeding with data collection, all athletes attended a briefing meeting and signed an informed consent certificate to ensure an acceptance of the testing factors and the risks and benefits related to the investigation. A letter of consent was signed by the soccer clubs of the athletes. This investigation was approved by the UFRJ Committee of Ethics in Research, following the resolution of the National Health Council, considering the WMA Declaration of Helsinki.

Procedures and measures

Athletes wore one GPS apparatus (Catapult Innovations; Scoresby; AUS) (Jennings, Cormack, Coutts, Boyd, & Aughey, 2010). Performance analysis of Brazilian soccer players was observed via a 5-Hz GPS equipment (Catapult; Melbourne; AUS) during tournaments (Freire et al., 2020a). The GPS device was located following preceding protocols (Petersen, Pyne, Portus, & Dawson, 2009). The GPS apparatus was started, and a satellite lock was realized for at least fifteen min before the player took the field as per the manufacturer's recommendations (Petersen et al., 2009). After each match, the recorded information was downloaded using Caput Sprint software (Catapult; Melbourne; AUS) for analysis. The mean quantity of satellites and the

horizontal dilution of position were recorded during data collection (Abbott et al., 2018; Freire et al., 2020a). External loads of GPS parameters following the preceding protocol are designated in Table 1.

Table 1. Description of external loads parameters.

Parameters	Description
Total distance (m)	Distance traveled during the tournament
Relative distance (m/ min)	Total distance per minute
Distance >14km/h (%)	% distance traveled running (>14km/h)
Distance>18km/h (%)	% distance traveled sprinting (>18km/h)
Sprints>18km/h (freq)	Frequency of times sprinting (>24km/h)
Distance>18km/h (m)	Distance traveled sprinting (>18km/h)
Sprints>24km/h (freq)	Frequency of times sprinting (>24km/h)
Distance>24km/h (m)	Distance traveled sprinting (>24km/h)
Max-velocity (km/h)	Maximum velocity during the game
Total-load (score)	Load work of the game
Relative load (score/ min)	Load work rate by minute
Accelerations (freq)	Frequency of accelerations (above 3 m/s ²)
Decelerations (freq)	Frequency of decelerations (above 3 m/s ²)
Jumps>30cm (freq)	Frequency of jumps (vertical axis >30 cm)
Explosive-efforts (freq)	Total of accelerations, deceleration, & jumps
Total-time (min)	Total time playing in the game

Statistical Analysis

A normal distribution of the data was assumed through the Shapiro-Wilk test ($p>0.05$). Descriptive data are demonstrated as mean (M) and standard deviation (SD). ANOVA repeated measures and Bonferroni post-hoc tests were used to compare the external load factors between the game's moments. Partial eta squared (η^2p) values were calculated to evaluate the ANOVA effect size, with $p\leq0.05$. All analyses were done using SPSS software (SPSS 20.0; Chicago; USA).

Results

Table 2 shows descriptive analysis of external loads and ANOVA with repeated measures results. The percentage of distance with a velocity >18 km/h presented significance, but post hoc did not detect effects ($F=47.65$, $p=0.006$, $\eta^2p=0.94$). A significant effect between the games was detected in the distance of sprints >24 km/h variable ($F=20.35$, $p=0.006$, $\eta^2p=0.95$) and indicated that soccer players sprinted longer distances in the second game than in the first game (187 ± 100 vs 166 ± 71.3 m). Significant differences between the games in the relative load ($F=11.20$, $p=0.019$, $\eta^2p=0.92$), specifically, the first game had a lower relative load than the third game and higher than fifth games (9.13 ± 1.25 vs 9.80 ± 1.48 vs 8.80 ± 1.10 scores respectively). Finally, differences in deceleration frequencies ($F=6.44$, $p=0.049$, $\eta^2p=0.87$), where the second game had lower frequencies than the fourth game (29.1 ± 9.26 vs 40.8 ± 12.1 frequency).

Table 2. Descriptive analysis of external loads of soccer games with the same athletes and opponent.

	1st game winning	2nd game winning	3rd game losing	4th game winning	5th game losing
Parameters	M $\pm$ SD	M $\pm$ SD	M $\pm$ SD	M $\pm$ SD	M $\pm$ SD
Total distance (m)	9217 $\pm$ 1340	8782 $\pm$ 1249	8781 $\pm$ 1307	9927 $\pm$ 902	9278 $\pm$ 917
Relative distance (m/min)	97.2 $\pm$ 6.96	101 $\pm$ 12.2	103 $\pm$ 5.40	103 $\pm$ 11.4	96.8 $\pm$ 9.52
Distance >14km/h (%)	19.1 $\pm$ 3.83	20.0 $\pm$ 6.08	20.4 $\pm$ 3.58	20.7 $\pm$ 6.27	17.0 $\pm$ 3.39
Sprints >18km/h (%)*	8.88 $\pm$ 2.36	8.71 $\pm$ 2.69	8.80 $\pm$ 1.64	9.38 $\pm$ 3.85	7.40 $\pm$ 1.82
FS >18km/h (freq)	58.7 $\pm$ 17.9	52.1 $\pm$ 15.8	55.0 $\pm$ 10.3	68.0 $\pm$ 26.4	52.6 $\pm$ 20.5
DS >18km/h (m)	834 $\pm$ 277	773 $\pm$ 301	782 $\pm$ 192	948 $\pm$ 409	677 $\pm$ 215
FS >24km/h (freq)	10.1 $\pm$ 4.39	11.0 $\pm$ 3.37	10.0 $\pm$ 3.54	11.7 $\pm$ 8.99	7.60 $\pm$ 5.50
DS >24km/h (m)	166 $\pm$71.3	187 $\pm$100^a	146 $\pm$70.8	177 $\pm$151	97.0 $\pm$76.4
Max-velocity (km/h)	29.8 $\pm$ 1.81	30.0 $\pm$ 1.83	30.4 $\pm$ 2.70	29.6 $\pm$ 2.26	28.0 $\pm$ 2.55
Total-load (score)	874 $\pm$ 168	789 $\pm$ 140	814 $\pm$ 129	969 $\pm$ 89.8	839 $\pm$ 117.5
Relative load (score/min)	9.13 $\pm$1.25	9.14 $\pm$1.95	9.80 $\pm$1.48^a	10.3 $\pm$1.41	8.80 $\pm$1.10^a
Accelerations (freq)	29.3 $\pm$ 7.09	25.2 $\pm$ 5.71	28.6 $\pm$ 8.32	32.3 $\pm$ 7.85	31.4 $\pm$ 7.33
Decelerations (freq)	33.7 $\pm$9.08	29.1 $\pm$9.26	32.2 $\pm$10.8	40.8 $\pm$12.1^b	35.2 $\pm$13.0
Jumps >30cm (freq)	13.2 $\pm$ 5.18	10.8 $\pm$ 5.64	12.0 $\pm$ 4.64	17.1 $\pm$ 3.18	11.6 $\pm$ 4.51
Explosive efforts (freq)	122 $\pm$ 46.9	94.7 $\pm$ 16.6	95.0 $\pm$ 8.43	134 $\pm$ 50.9	135 $\pm$ 15.0
Total-time (min)	94.0 $\pm$ 9.5	90.4 $\pm$ 10.7	85.0 $\pm$ 16.2	95.5 $\pm$ 4.24	96.0 $\pm$ 1.00

M = mean; SD standard deviation; a = significant difference from the 1st game $p<0.05$; b = significant difference from the 2nd game $p<0.05$; * = significant difference $p<0.05$ but not post-hoc difference. **FS frequency of sprints**; DS distance of sprints;

Discussion

Over the last decades, soccer studies from various approaches have contributed to establishing a wide range of aspects that might be involved in determining soccer athletes' pacing strategy during tournaments (Bradley & Noakes, 2013; Francini et al., 2019). This could reveal how to improve player performance, manipulating carefully key task constraints to adapt tactical actions during championships and training (Filetti, Ruscello, D'Ottavio, & Fanelli, 2017; Nagy, Holienka, & Babic, 2020). The present research was the first study to use paired data of the same athletes with the same opponent in the same year. This control increased the statistical power and the internal validity, reducing the effects of confounders factors. This method established a trustworthy cause-and-effect relationship between external loads control with self-paced strategies and the game outcome (Ispyrilidis et al., 2020), highlighting sprints and deceleration as the principal factors associated with winning games of intra-comparisons.

The present results showed mechanisms involved in the pacing strategy used in each self-paced external-load parameter by the context and regulation over the games with the same opponent of professional athletes. Results seem to associate pacing with interoceptive and exteroceptive circumstantial factors, integrated with outcomes. The main differences indicated that winning games had longer sprinting moments and higher load per minute. Also, the current ecological approach to pacing was considered, and no effects were observed when comparing the self-paced states between the frequencies of sprints (Freire et al., 2021), jumps (Merino-Muñoz et al., 2020), accelerations (Merino-Muñoz et al., 2021), and explosive efforts (Nagy et al., 2020) - this reveals that the pacing of duration and frequency between the same professional athletes are very similar. At the same time, the intensity of the intense actions consequent of determinant decisions had significant differences, particularly between winning and losing matches (Freire et al., 2022). Another study with professional soccer players found that Spanish athletes covered 118 m/ min during the first half, and 111 m/ min, in the second half, respectively (Barbero-Alvarez, Soto, Barbero-Alvarez, & Granda-Vera, 2008). Present collect data demonstrated that high intensity running seems to be influenced by scoreline, this modification during match performance could be associated with tactical, situational, mental, and or physical fatigue, as indicated by previous authors (Beato, Coratella, Schena, & Hulton, 2017; Bradley & Noakes, 2013; Buchheit, Lacombe, Cholley, & Simpson, 2018; Coutinho et al., 2017).

Total and relative distance by the minute of the game is in agreement with preceding reports that demonstrated between ~8,000 and 10,500 with a range of ~100-120 m/ min by the game (Reinhardt, Schwesig, Lauenroth, Schulze, & Kurz, 2019), low-intensity running performance was not determinant in intra-games comparisons, as demonstrated by preceding reports (Di Salvo et al., 2010; Modric, Versic, Sekulic, & Liposek, 2019; Freire et al., 2020a), while number and distance of sprints greater than 18km/h seem to be the key in winning matches of professional soccer athletes (Abbott et al., 2018; Andrzejewski, Chmura, Pluta, Strzelczyk, & Kasprzak, 2013). As in our results during tournaments, previous research has shown that sprint running performance during training and assessments tends to have high variability (Mara, Thompson, Pumpa, & Ball, 2015; Roecker, Mahler, Heyde, Roll, & Gollhofer, 2017). Present data demonstrate a range of external loads for the same athletes and GPS control methods. Both information could improve operational aspects for monitoring training demand and subsequent physical performance, ensuring that training periodization goals are met (Mara et al., 2015; Freire et al., 2020a).

About 10% of total distance were running with velocities higher than 18km/h - this aspect reinforces the use of anaerobic valuations, as the RAST evaluation (Cipryan & Gajda, 2011; Freire et al., 2020; Slimani et al., 2019) demonstrated correlations with 30-s all-out running assessments (Andrade et al., 2015). Preceding research in high-level soccer games indicated that players spend ~90% of the game-time in low-intensity velocity ranges (standing, walking, and jogging). Previous reports with amateurs' soccer players showed a positive relationship between total distance in the running activity and the performance (Rampinini, Impellizzeri, Castagna, Coutts, & Wisloff, 2009; Freire et al., 2021). This circumstance could be explained by non-elite soccer players' attempts to regain the ball more times. As the athletes improve specific skills, it becomes more effortless to maintain ball control. Longer running distances were negatively connected with goal attempts, shots, and assists (Rampinini et al., 2009), as confirmed by recent associations between physical performance match analysis from the Italian football league (Longo et al., 2019).

Moreover, present results demonstrated a higher deceleration in the fifth game. A better position-timing could explain this fact and increased accuracy for sequential shots, goal attempts, steals, and assists - as preceding reports suggested that the explosive efforts, the ability to increase and decrease velocity over the covered distance, and reaching peak velocity are fundamental mechanisms affecting the soccer players' success during a game (Castillo, Raya-Gonzalez, Manuel Clemente, & Yanci, 2019; Freire et al., 2022; Konefal et al., 2019; Longo et al., 2019). Therefore, the present approach can lead to much more comprehensive knowledge about self-paced performance than other conventional analyses, comparing the same soccer players with games with the same opponent during a year, with more than three weeks of the interval between them.

The present study is not without limitations. There are situational factors that affect running performance during a match, such as the match running performance of the opposing team (Rampinini et al., 2007), the type of

tournament played (Freire et al., 2022) as well as the tactical system employed by the teams (Vieira et al., 2018). These factors should be considered in future studies to diminish the effects of influencing factors.

Conclusions

The present research ends by introducing a novel hypothesis inspired by an ecological approach to integrating information in the context of pacing during soccer games. Results supported the self-regulation hypothesis and showed that the distance of sprints with more incredible velocity than 24km/h indicated that soccer players sprinted longer distances in the second winning game than in the first winning game. In addition, the first winning game had a higher relative load than both losing games, while the second winning game had a lower number of decelerations than the fourth winning game. No effects were observed in total distance, number of sprints, maximal velocity, total load, total jumps, or total time. These facts reinforce the concept that professional soccer athletes maintained a submaximal work rate in a similar pattern until determinant actions. This evidence could help soccer professionals more successfully design training programs and prevent injury.

Conflicts of interest - None of the authors have any conflicts of interest.

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