Title of the Article: Effects of competitive standard, team formation and playing position on match running performance of Brazilian professional soccer players

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Keywords: association football; time-motion analysis; match demands; match preparation.

Abstract

This study examined the effects of competitive standard, team formation and playing position on match running performance in a Brazilian professional soccer team. Performance was investigated in 36 players in 48 matches at three competitive standards: 1st São Paulo State Championship; 3rd and 4th Brazilian leagues. Global Positioning System technology was used to determine total distance covered (TD), maximal running speed (MRS), mean speed (S_{MEAN}) and frequency of high-intensity activities (HIA). Data were compared across competitive standards, team formations and playing positions. Magnitude-based inferences showed greater values for TD, S_{MEAN} and HIA (*likely* to *almost certain*) in the lower national (3rd, 4th Brazilian) versus the top state division (1st São Paulo). Higher values for all variables were reported for the 1–4–3–3 versus the 1–4–4–2 formation (*likely* to *almost certain*). External defenders/midfielders and forwards reported greater values (*likely* to *almost certain*) versus central defenders/midfielders, especially in HIA. Linear regression analyses showed that playing position demonstrated a higher relative contribution to the variance in MRS (24%) and HIA (29%) compared to team formation (16% and 25%, respectively). In a Brazilian professional soccer team, match running performance was dependent upon competitive standard, playing formation and playing position.

Kew-words: association football; time-motion analysis; match demands; match preparation.

Introduction

Knowledge of the physical demands of professional soccer match-play is required to construct optimal training programs to respond to these needs (Carling, 2011). Time-motion analyses of running performance is employed to evaluate external load in soccer match-play (Castagna, Varley, Povoas, & D'Ottavio, 2017) and provide information for coaches and conditioning practitioners in the decision-making process for player fitness and match preparation (Bradley et al., 2009; Carling, 2010). The current literature is vast and has helped characterize the general demands of match-play and determine a myriad of variables that potentially affect match running performance (Carling, 2013). The latter notably include competitive level, frequently characterized by analysis of the various divisions in national championships, final ranking of teams or level of play (i.e., professional, semi-professional and amateur), team formation and playing position (Barros et al., 2007; Bradley et al., 2011, 2013; Carling, 2011; Di Salvo et al., 2007; Di Salvo, Pigozzi, Gonzalez-Haro, Laughlin, & De Witt, 2013).

In Brazilian professional soccer players however, the literature regarding match running demands is scarce (Aquino, Munhoz, Vieira, & Menezes, 2017). According to Dellal et al. (2011), cultural differences in playing style in various countries affect the match running output of players at professional standards. Therefore the running demands in competition in professional Brazilian soccer may not be similar to another countries and information is needed to characterize the demands specific to the country. In addition, only one study has investigated the influence of playing position on running output in matches in Brazilian professional soccer (Barros, et al., 2007). The results in a 1st Brazilian Division team showed that the distances covered by external defenders, central midfielders and external midfielders were greater than forwards while the latter covered

greater distances than central defenders. However, data was limited to distances covered and no information was provided on performance at other competitive standards across elite Brazilian soccer or on the effects of commonly used team formations (e.g., 1–4–4–2 and 1–4–3–3). Indeed, no studies in the elite Brazilian game or other national leagues generally have examined the relative contribution of these variables to match running performance. This information would help coaches and practitioners identify the main variable that explains the variance in the running demands in soccer competition and, therefore, which should be focused upon in physical conditioning regimens.

Therefore, the aims of this study in a reference Brazilian professional soccer team were: i) to examine the effects of independent variables including standard of play determined by the division the team participated in, and team formation and playing position on match running performance; and ii) to verify the relative contribution of the independent variables to the variance in match running performance, in particular maximal running speed and the frequency of high-intensity activities.

Methods

Experimental Design

We used an observational design to verify the effects of competitive standard, team formation and playing position on match running performance in one reference team during 48 matches in three consecutive seasons: 1st São Paulo State season 2016 [January to April], 3rd Brazilian season 2016 [May to September] and 4th Brazilian season 2015 [June to November]. The 1st São Paulo State division is the top state-level tournament in the country (Aquino et al., 2016). The 3rd and 4th Brazilian divisions are the lower national leagues. The matches (2 x 45') were performed in official stadiums (FIFA standard;

natural grass; ~100 x 70 m), between 11:00 AM to 08:00 PM and the mean temperature was 25.2 (5.3) ºC (77.4 (9.5) ºF).

Participants and match analysis data

Match running performance data (318 observations) was collected from 36 male outfield players (mean (SD): 27.72 (3.94) yrs; 180.59 (6.25) cm; 76.79 (7.35) kg) from the same reference team when it participated in three professional divisions in Brazil: 1st São Paulo State season 2016 (n = 90 observations), 3rd Brazilian season 2016 (n = 129 observations) and 4th Brazilian season 2015 (n = 99 observations). The reference team was champion in 4th Brazilian season 2015 and reached the quarter-finals phase in the 3rd Brazilian and 1st São Paulo State seasons in 2016. Global Positioning System (GPS) Sports® devices (QSTARZ – 1 Hz, Taipei, Taiwan) were employed (Aquino, et al., 2017). GPS technology has been extensively used for the measurement of match running performance in team sports and its accuracy and reliability have been determined (Barbero-Alvarez, Coutts, Granda, Barbero-Alvarez, & Castagna, 2010; Buchheit et al., 2011; Coutts and Duffield, 2010). While the low frequency of the present devices used in our study (1 Hz) can potentially underestimate the total distance covered in high-intensity running compared to optical computerized tracking (Randers et al., 2010), quality-control analyses we performed demonstrated good reliability (coefficient of variation < 5%). All players wore the same unit during the entire competition season (Jennings, Cormack, Coutts, Boyd, & Aughey, 2010). The GPS unit was attached in each players' shorts before matches commenced. Players that completed the entire match (i.e., ≥ 90 minutes) were considered.

This study was approved by the local University ethical guidelines (School of Physical Education and Sport, Ribeirão Preto, Brazil; protocol number: 61884716.9.0000.5659)

and was conducted in accordance with the Declaration of Helsinki. All players signed a consent form to participate in the investigation.

Measures

Dependent variables included: total distance covered in meters (TD), maximum running speed in $km \cdot h^{-1}$ (MRS), mean speed in $km \cdot h^{-1}$ (S_{MEAN}) and frequency of high-intensity activities (HIA: $\geq$ 15.0 $km \cdot h^{-1}$: Bradley, Di Mascio, Peart, Olsen, & Sheldon, 2010; Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007). Measures were analysed using QSports software (Taipei, Taiwan).

Independent variables: match running performance data was analysed as independent variables according to competitive standard, team formation and playing position. Team formations (1–4–4–2 [n=68 observations]; 1–4–3–3 [n=250 observations]) and playing positions (central defenders [n=88 observations]; external defenders [n=65 observations]; central midfielders [n=81 observations]; external midfielders [n=17 observations]; forwards [n=67 observations]) were determined by one CBF-qualified coach who was a member of the reference club's coaching staff. The coach visualized recordings of each match to verify that team formation remained consistent through the entire match. Matches in which a dismissal occurred were not included for analysis as this can substantially influence running output (Carling, 2011).

Statistical Analysis

A magnitude-based inferential (MBI) statistical approach adopted analysis based on previous recommendations for studies with athletic performance (Buchheit, Simpson, & Mendez-Villanueva, 2013; Hopkins, Marshall, Batterham, & Hanin, 2009; Winter, Abt, & Nevill, 2014) (confidence level = 90%; number of independent inferences = 1; maximum risk of harm = 0.5%; minimum chance of benefit = 25%; benefit/harm odds ratio = 66). Raw data outcomes in standardized Cohen units were used. Quantitative chances of higher or lower differences were assessment qualitatively as follows: < 1 %, almost certainly not; 1 − 5 %, very unlikely; 5 − 25 %, unlikely; 25 − 75 %, possibly; 75 − 95 %, likely; 95 − 99 %, very likely; > 99 %, almost certain. If the chance of higher or lower differences was > 5 %, the true difference was assumed as unclear. Otherwise the effect was deemed clear (Hopkins, et al., 2009). For simplicity and greater impact of the present results in the field only likely chances (> 75%) that the differences were true (Lacome, Simpson, Cholley, Lambert, & Buchheit, 2017).

Results

Data regarding match running performance according to competitive standard, team formation and playing position respectively are presented in Table 1-2 (descriptive statistics) and Figure 1-2 (MBI). In lower national divisions (3rd and 4th Brazilian), the players covered more TD compared to the top state division (1st São Paulo) (*almost certain*) and also reported greater values for S_{MEAN} (*likely* to *almost certain*) and HIA frequency (*very likely*) (Figure 1A). Analysis of matches played in the 1–4–3–3 formation demonstrated higher values for all match running performance variables (i.e., TD, MRS, S_{MEAN} and HIA) compared to the 1–4–4–2 formation (*likely* to *almost certain*) (Figure 1B).

Table 1. Mean (standard deviation) of match running performance according to standards divisions (1st São Paulo State Division season 2016 [n = 14 matches]; 3rd Brazilian Division season 2016 [n = 19 matches]; 4th Brazilian Division season 2015 [n = 15 matches]) and team formations (1–4–4–2 [n = 68 observations]; 1–4–3–3 [n = 250 observations]).*

Variables	Competitive Standard Divisions			Team Formation	
	1st São Paulo State	3rd Brazilian	4th Brazilian	1–4–4–2	1–4–3–3
TD (m)	8518.3 (1090.2)	9108.2 (809.6)	9375.4 (1219.5)	8537.4 (1251.6)	9518.0 (1197.1)
MRS ($km \cdot h^{-1}$)	28.1 (3.4)	28.7 (3.2)	28.3 (4.4)	27.3 (4.5)	29.2 (3.7)
S_{MEAN} ($km \cdot h^{-1}$)	4.6 (0.6)	5.0 (0.6)	4.9 (0.7)	4.6 (0.6)	4.9 (0.7)
HIA (a.u.)	45.9 (23.3)	57.2 (24.1)	53.3 (32.2)	39.8 (22.0)	55.6 (32.0)

*TD = total distance covered. S_{MEAN} = mean speed. MRS = maximal running speed. HIA = frequency of high-intensity activities. a.u. = arbitrary units.

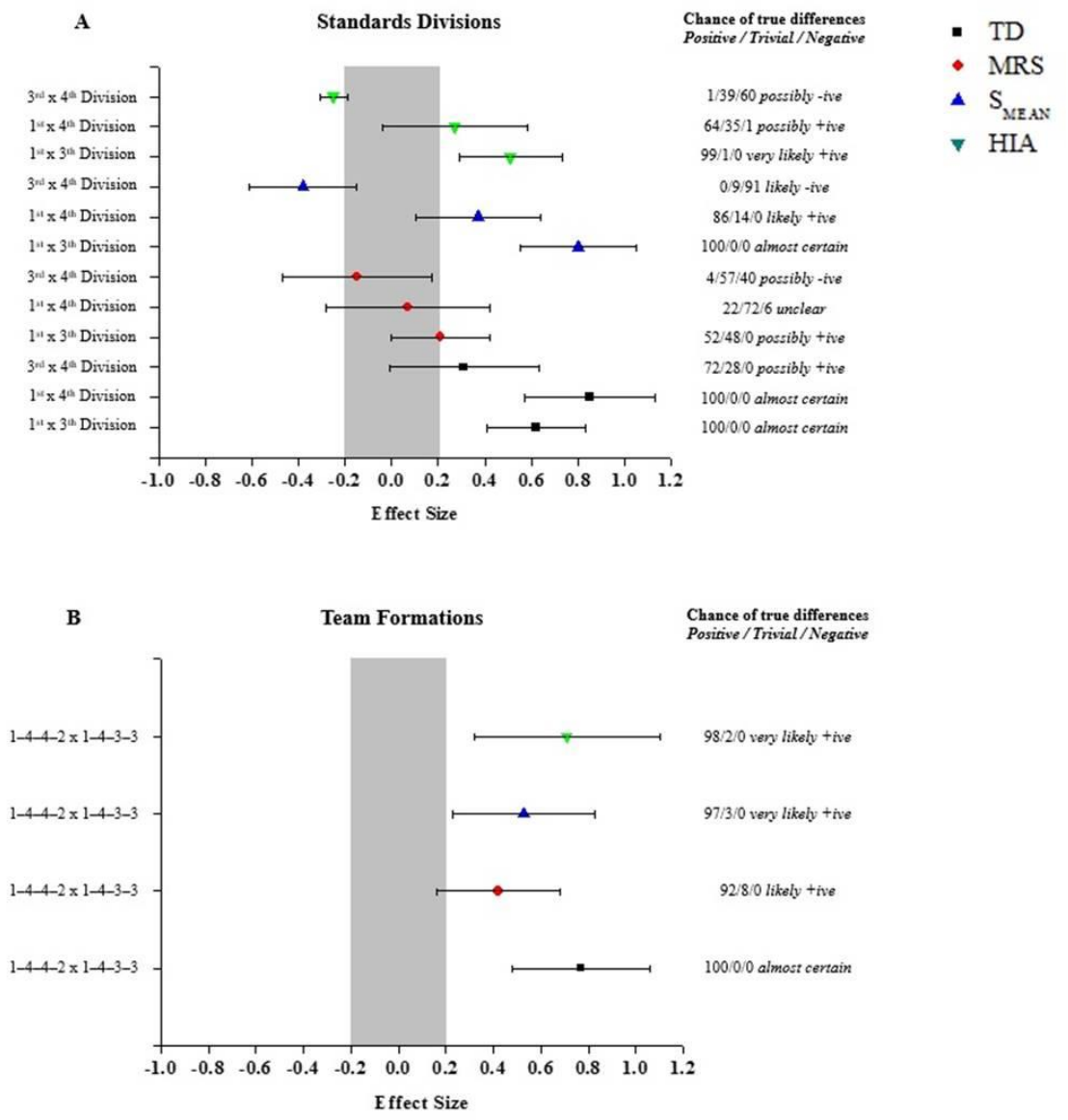

Figure 1. Magnitude-based inference of standards divisions and team formations on match running performance in Brazilian male soccer players.* TD = total distance covered. S_{MEAN} = mean speed. MRS = maximal running speed. HIA = frequency of high-intensity activities.

In relation to playing position, results highlight that: i) external defenders, central/external midfielders and forwards covered more TD compared to central defenders (*likely* to *almost certain*) and external defenders covered more TD than central midfielders and forwards (*likely* to *almost certain*) (Figure 2A); ii) external defenders, external midfielders and forwards achieved higher MRS compared to central defenders (*very likely*

to *almost certain*). External defenders reached greater MRS than central midfielders (*almost certain*) but lower than external midfielders (*likely*). External midfielders and forwards showed greater values of MRS compared to central midfielders (*likely* to *almost certain*) (Figure 2B); iii) external defenders, central/external midfielders and forwards reported greater values for S_{MEAN} than central defenders (*likely* to *almost certain*). External defenders showed higher S_{MEAN} compared to central/external midfielders and forwards (*likely* to *almost certain*) (Figure 2C); iv) external defenders, central/external midfielders and forwards achieved higher HIA than central defenders (*almost certain*). External defenders also reported greater HIA compared to central midfielders (*likely*) while external midfielders showed higher HIA than central midfielders (*very likely*) but less than forwards (*likely*) (Figure 2D).

Table 2. Mean (standard deviation) of match running performance according to playing positions (central defenders [n=88 observations]; external defenders [n=65 observations]; central midfielders [n=81 observations]; external midfielders [n=17 observations]; forwards [n=67 observations]).*

Variables	Playing Positions				
	Central Defenders	External Defenders	Central Midfielders	External Midfielders	Forwards
TD (m)	8256.4 (698.8)	9670.0 (739.5)	9201.6 (1141.5)	9583.8 (1432.8)	9050.7 (1030.5)
MRS ($km \cdot h^{-1}$)	27.1 (3.2)	29.9 (2.2)	26.8 (4.0)	30.4 (2.3)	30.2 (3.7)
S_{MEAN} ($km \cdot h^{-1}$	4.4 (0.6)	5.2 (0.5)	5.0 (0.7)	5.0 (0.8)	4.9 (0.5)
HIA (a.u.)	34.6 (14.5)	66.0 (25.0)	52.4 (31.3)	66.1 (25.9)	61.0 (23.3)

*TD = total distance covered. S_{MEAN} = mean speed. MRS = maximal running speed. HIA = frequency of high-intensity activities. a.u. = arbitrary units.

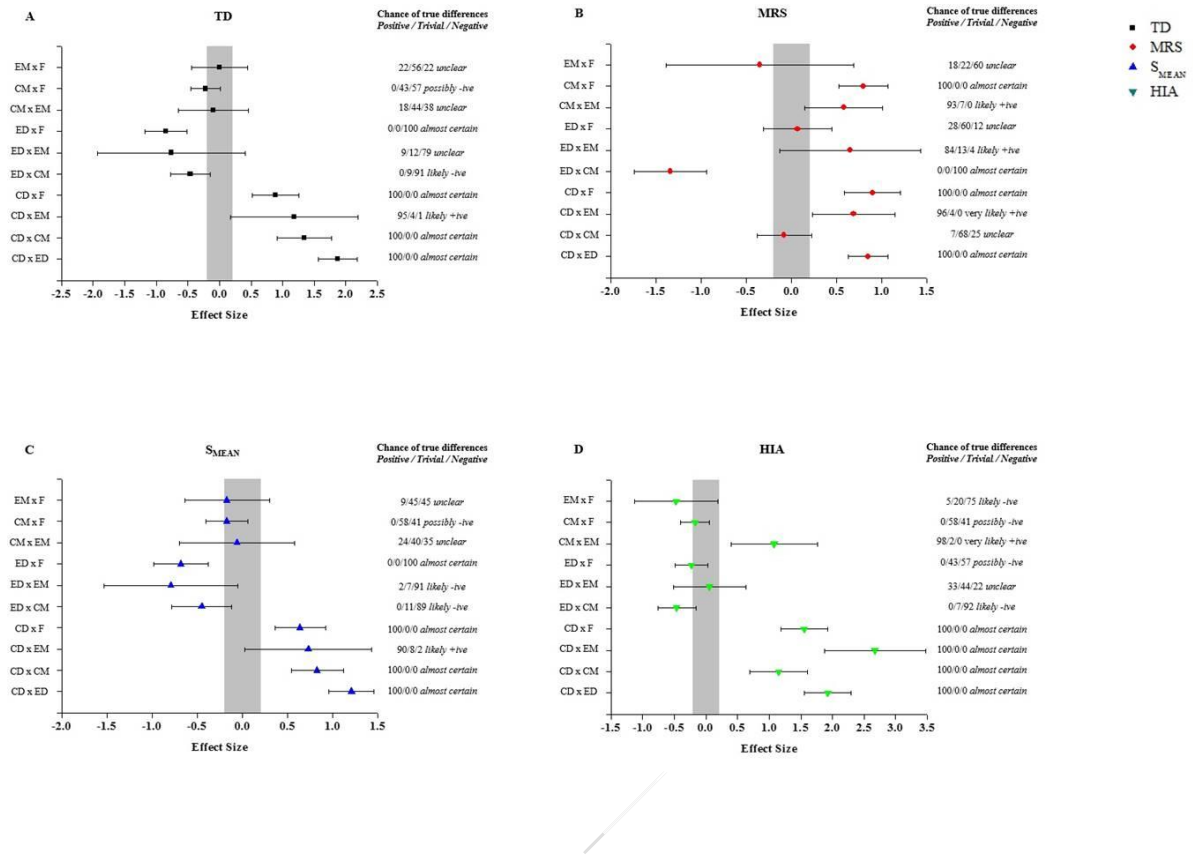

Figure 2. Magnitude-based inference of playing positions on match running performance in Brazilian male soccer players.* CD = central defenders. ED = external defenders. CM = central midfielders. EM = external midfielders. F = forwards. TD = total distance covered. S_{MEAN} = mean speed. MRS = maximal running speed. HIA = frequency of high-intensity activities.

Table 3 reports the results of the multiple linear regression analyses. All regression coefficients were significant ($p < 0.05$). According to the relative contribution of independent variables, playing position explained 24% of the variance of MRS and 29% of HIA, while team formation explained 16% and 25% respectively. In addition, different possibilities for each independent variable were included. For instance, the minimum values of MRS and HIA can be observed if the central defender played in 1–4–4–2 formation (26.3 $km \cdot h^{-1}$ and 30.5 arbitrary units, respectively). On the other hand,

maximum values were observed if the forwards played in 1–4–3–3 formation (MRS: 30.1 $km \cdot h^{-1}$; and HIA: 68.7 arbitrary units).

Table 3. Simulated maximum running speed (MRS: $km \cdot h^{-1}$) and frequency of high-intensity activities (HIA: arbitrary units) for the player depending of team formations and playing positions.*

	MRS		**HIA**	
Playing Positions	Team Formations			
	1–4–4–2	1–4–3–3	1–4–4–2	1–4–3–3
Central Defenders	26.3	27.7	30.5	47.0
External Defenders	26.9	28.3	35.9	52.4
Central Midfielders	27.5	28.9	41.4	57.9
External Midfielders	28.1	29.5	46.8	63.3
Forwards	28.7	30.1	52.2	68.7

* Team formations: 1 = 1–4–4–2, 2 = 1–4–3–3; Playing Positions: 1 = Central Defenders, 2 = External Defenders; 3 = Central Midfielders, 4 = External Midfielders; 5 = Forwards. Model: MRS = 24.196 + 0.601*(playing positions) + 1.448*(team formations). Model: HIA = 8.538 + 5.434*(playing positions) + 16.505*(team formations).

Discussion

To the best knowledge of the authors, this was the first study to simultaneously examine match running performance in a reference professional soccer team taking into account competitive standard, team formation and playing position. The main findings were: i) match running performance was dependent upon all three factors. Greater running demands were observed when the team participated in lower national (3rd, 4th Brazilian) compared to top state divisions (1st São Paulo). Running output was higher for all performance variables in the 1–4–3–3 compared to the 1–4–4–2 formation. External

defenders/midfielders and forwards positions reported greater running outputs than central defenders/midfielders, especially in the frequency of HIA; ii) according to the predictors of match running performance, playing position had a higher relative contribution to the variance in MRS and HIA compared to team formation.

Match running performance has previously been compared across different competitive standards. Researchers have used a range of methods to determine competitive levels (Sarmento et al., 2014): final ranking, playing standard (i.e., professional, semi-professional and amateur), quality of teams, and upper and lower placed teams. This might explain contrasting findings in the literature. Research has shown for example that lower distances were covered in total and high-intensity running ($\geq$ 19.8 km·h^{-1}) in higher (e.g., English Premier League) compared to lower-standard divisions (e.g., English Championship, League 1) (Bradley, et al., 2013; Di Salvo, et al., 2013). In contrast, other studies demonstrated greater physical running demands at higher standards of play (Bangsbo, Norregaard, & Thorso, 1991; Mohr, Krustrup, Andersson, Kirkendal, & Bangsbo, 2008; Mohr, Krustrup, & Bangsbo, 2003; Rampinini, Impellizzeri, Castagna, Coutts, & Wisloff, 2009). Bradley et al. (2010) described no significant differences between elite domestic vs. international players for high-intensity running distance ($\geq$ 14.4 km·h^{-1}) and maximal running speed (MRS). Further possible explications for these divergent results can be attributed to methodological issues and particularly speed zone delimitations to classify high-intensity running activities (Mackenzie and Cushion, 2013). Additional factors influencing running demands also include physical fitness (Krustrup et al., 2003), skill-related performance (Bradley, et al., 2013; Rampinini, et al., 2009), situational variables (Aquino, et al., 2017), team formations (Bradley, et al., 2011; Carling, 2011) and playing position (Barros, et al., 2007; Di Salvo, et al., 2007). Ideally

in future studies, the relative impact of these variables on running output should be simultaneously investigated.

In Brazilian professional male soccer, this is the first study to directly compare match running performance in a reference team performing in top state league (1st São Paulo State) and lower level national divisions (3rd and 4th Brazilian). Previous studies have analysed only one division; Barros et al. (2007): 1st Brazilian Division and Aquino et al. (2017): 4th Brazilian Division. Our findings demonstrate greater physical demands (i.e., higher values of TD, MRS, S_{MEAN}, HIA) in the reference team in lower compared to upper divisions. This finding is in accordance with results reported by Bradley et al. (2013). In addition, Rampinini et al. (2009) reported lower total and high-intensity running distances in successful compared to unsuccessful teams in the same division. With these findings we can speculate that in upper divisions, players do not utilize their entire physical fitness potential as often as peers participating in lower divisions (Bradley, et al., 2013).

The findings presented here confirm previous evidence that team formations partly govern match running performance (Bradley, et al., 2011; Carling, 2011). In our study, teams playing in a 1–4–3–3 formation reported greater values for TD, MRS, S_{MEAN} and HIA compared to teams employing a 1–4–4–2 formation. In the English Premier League, Bradley et al. (2011) reported no significant differences between these team formations. However, magnitude-based inferences (MBI) were used here for statistical analysis. These are typically more sensitive and relevant to comparisons of athletic performance than any statistically significant effect (Buchheit, et al., 2013; Hopkins, et al., 2009). Tactical explanations can be forwarded to explain these differences. In a 1–4–3–3 formation the three midfielders support both the defenders and forwards, potentially

resulting in increased physical running demands. In addition, forwards in the 1–4–3–3 formation often assume defensive functions without ball possession, contributing to the midfield sector, also possibly resulting in greater physical output. However, the present study did not differentiate between defensive and offensive running efforts made by players according to whether their team was in or out of possession and further research is necessary.

Variations in running performance are also related to the demands specific to playing position (Barros, et al., 2007; Dellal, Wong, Moalla, & Chamari, 2010; Di Salvo, et al., 2007; Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009; Vigne, Gaudino, Rogowski, Alloatti, & Hautier, 2010). However, only one study in Brazilian soccer (1st Brazilian Division) has reported data in relation to playing position (Barros, et al., 2007). Here, external defenders/midfielder and forward positions reported greater match-play running demands compared to central defenders/midfielders. These results are, in part, similar to those reported in other studies (e.g., Italian Serie A League: Rampinini, et al., (2007); England Premier League: Di Salvo, et al., (2009); Spanish Premier League: Di Salvo, et al., (2007)). Despite a plethora of research on performance characteristics according to playing position, to the best of our knowledge, no studies have examined the relative contribution of playing position on match running performance. Here, results demonstrate that playing position is the most important factor to explain differences in high-intensity activity i (i.e., MRS and HIA). Therefore, Brazilian coaches and practitioners would potentially need to adopt a position-specific approach to player conditioning in their teams.

Our study has some limitations; therefore the results should be interpreted with caution. First, other common team formations used in professional soccer could not be evaluated (e.g., 1–3–5–2, 1–4–1–4–1, 1–4–2–3–1). We also did not consider the influence of opposition team formation on the reference team's performance. Carling (2011) demonstrated that players (generally organized in the 1–4–3–3/1–4–5–1 formats) covered a greater distance running ≥ 14.4 $km \cdot h^{-1}$ in matches against 1–4–4–2 compared to 1–4–2–3–1 formations. Second, analysis of tactical and skill-related performance was not included. Third, all the analysis were performed in the same reference team and results are a reflection of this team. Thus, additional studies are warranted to examine the effects of competitive standard, team formations and playing positions on running, technical and tactical performance in a larger sample of Brazilian teams.

Practical Applications

This is the first study to simultaneously verify the effects of competitive standard, team formations and playing positions in Brazilian soccer players. Sports scientists and performance analysts use data on match running performance to mainly aid coaches and practitioners in decision-making processes for structuring the elements of training and subsequent match preparation (Bradley, et al., 2009; Carling, 2010). Our research suggests two main practical applications for Brazilian soccer players:

1) The running demands are highest in lower national divisions, compared to higher standard counterparts. Therefore, physical conditioning programs need to be adapted accordingly.
2) A combination of playing position and team formation could be used to develop a model to predict future MRS and HIA in soccer. Playing position is the variable with the greatest relative contribution to the variance in high-intensity efforts (i.e.

MRS and HIA). Therefore, a position-specific approach to player conditioning should be adopted.

Conclusions

This study provides a comprehensive evaluation of match running performance in a professional team when competing in three standards of soccer and differences according to team formation and playing position. The findings showed greater physical running demands in the team when playing in lower divisions and when it employed a 1–4–3–3 formation. Highest running outputs were observed in external defenders/midfielders and forwards positions and playing position had the largest relative contribution to variance in high-intensity efforts (specifically MRS and HIA) during match-play.

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Legends

Figure 1. Magnitude-based inference of standards divisions and team formations on match running performance in Brazilian male soccer players.* TD = total distance covered. S_{MEAN} = mean speed. MRS = maximal running speed. HIA = frequency of high-intensity activities.

Figure 2. Magnitude-based inference of playing positions on match running performance in Brazilian male soccer players.* CD = central defenders. ED = external defenders. CM = central midfielders. EM = external midfielders. F = forwards. TD = total distance covered. S_{MEAN} = mean speed. MRS = maximal running speed. HIA = frequency of high-intensity activities.