Correlation Between Match Performance and Field Tests in Professional Soccer Players

by
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The aim of this study was to investigate possible correlations between aerobic and anaerobic fitness (in field tests) with performance during a 90 min friendly match, through the following variables: total distance covered, maximal running speed, number of high-intensity actions and number of sprints. Eighteen professional soccer players from a Brazilian elite team (age 23 ± 3 years, body mass 77.5 ± 8.9 kg) participated in the study. The athletes performed a Yo-Yo Endurance Test (aerobic fitness) and a Running Anaerobic Sprint Test (six maximal 35 m efforts separated by 10 s of passive recovery, anaerobic fitness). Data were collected during friendly matches using a GPS with 5 Hz technology. To establish the correlation between the variables determined during the matches, the Pearson correlation coefficient was used (significance level of $p \leq 0.05$). A high correlation was found between distance covered in the Yo-Yo endurance test and total distance covered ($r = 0.72$; $p < 0.05$), number of high-intensity actions ($r = 0.78$; $p < 0.05$) and number of sprints ($r = 0.88$; $p < 0.01$) in the soccer matches. The RAST variables did not relate to the standards set during the matches ($p < 0.05$). From the results of the present study, it may be concluded that there is no correlation between RAST and friendly match data variables. However, better results in the Yo-Yo endurance test correlate with total distance, number of high-intensity actions and sprints during matches.

Key words: Yo-Yo Endurance Test, RAST, soccer evaluation, GPS.

Introduction

Soccer is a complex sport (Casanova et al., 2013), and to play this game at a competitive level, players require a high level of aerobic (i.e., mitochondrial metabolic pathways) and anaerobic (i.e., non-mitochondrial metabolic pathways) fitness (Reilly et al., 2000). The aerobic fitness level (i.e., maximal oxygen uptake – $\dot{V}O_{2MAX}$) in professional soccer players is associated with distance covered at high-intensity during a match (Bangsbo, 1994). Several studies have revealed total distance covered to be about 10-12 km at a relative intensity of 75% of $\dot{V}O_{2MAX}$ (Bangsbo, 1994; Helgerud et al., 2001; McMillan et al., 2005), consequently contributing about 90% of the total energy cost of the game (Bangsbo, 1994; Helgerud et al., 2001). High-level aerobic demand in soccer is essential to provide fast recovery after a high-intensity activity (Bishop et al., 2004; Helgerud et al., 2001; McMillan et al., 2005).

Although the energy pathway during a soccer match is provided principally by the aerobic metabolism, the anaerobic pathway is called upon during high-intensity actions such as jumping, kicking, and even movements to mark the opponent (Bangsbo, 1994; Di Salvo et al., 2009; Krustrup et al., 2003; Stolen et al., 2005). The contributions of non-mitochondrial metabolic pathways (phosphagen and glycolytic energy pathways) during a match have been evidenced by the high level of peak blood lactate (~10 mmol·L^{-1}), followed by a decrease in muscle pH (~6.8) (Bangsbo at al., 2007), distance covered at high-intensity (1.1 km covered at a speed above 18 km·h^{-1}) (Burgess et al., 2006) and the number of

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intense actions during the game (between 150 and 250) (Bangsbo et al., 2007). Moreover, activities such as sprints represent about 8-12% of the total distance covered during the game (Rampinini et al., 2007). Thus, repeated-sprint ability (RSA) with short rest intervals appears to be a valid indicator of player's performance, being considered fundamental for sports events with important anaerobic metabolic demand (Bishop et al., 2011).

Due to the importance of both the aerobic and anaerobic energy systems in soccer, many tests have been used to monitor and prescribe training during the competitive season (Chamari et al., 2005). Additionally, the strategy of evaluating physical performance in friendly matches with a global positioning system (GPS) is currently a common procedure employed by sports scientists and performance analysts in elite soccer (Mallo et al., 2015). The physical demands imposed on elite players have been extensively documented in recent years (Bradley et al., 2009; Dellal et al., 2011; Di Salvo et al., 2007; Rampinini et al., 2007). The short time that teams have to carry out physiological assessments, as well as the high financial cost of testing in controlled environments, should be considered (Svensson and Drust, 2005). There is a number of studies focused on identifying the physiological characteristics of players from different levels. However, only few papers can effectively relate the results obtained in field tests with variables correlated to physical demands during the game.

Therefore, the aim of this study was to verify possible relationships between the distance covered, maximal running speed and number of high-intensity actions performed during a friendly soccer match with aerobic and anaerobic fitness in professional players.

Methods

Participants

The study included 18 professional soccer players (age 23 ± 3 years, body mass 77.5 ± 8.9 kg, body height 177 ± 5 cm, percentage body fat mass 11.5 ± 1.5%, VO_{2MAX} 56.8 ± 3.9 mL·kg^{-1}·min^{-1}), belonging to the first division soccer team of the state of Paraná, Brazil. Data collection was performed during the 2014 pre-season. These athletes had been engaged in regular training and competitions for at least 5 years and performed approximately 10 training sessions per week with

average duration of 2 h each. In the study only athletes who had no osteomyoarticular injuries and who were not taking anti-inflammatory drugs were included. During the period of the study, no player was injured. All procedures complied with the declaration of Helsinki regarding human experimentation and were approved by the local Scientific and Ethics Committee. All players were informed of the procedures, including the risks associated with participation in the study, and written informed consent was obtained.

Design and Procedures

Initially, body composition of the participants was evaluated. Following this, all tests were performed on a soccer field. The players performed a Yo-Yo Endurance test (aerobic fitness) and the running anaerobic sprint test (RAST) for determination of anaerobic fitness (separated by 24 – 48 h). Players completed the tests on an official natural grass field, wearing cleats that met the standards required by the sport.

After the initial assessments, data were collected during four friendly matches, according to a schedule established by the authorities between teams of the same level of the Paranaense Football Federation using a GPS (QStarz®, Taipei, Taiwan) with 5 Hz technology (Varley et al., 2012).

Body composition

For the measurement of body mass, a professional scale was used with precision of 100 g (Filizola, São Paulo, Brazil) and to determine body height, a stadiometer (Sanny®) with accuracy to the nearest 0.1 cm. Skinfold thicknesses were measured using a caliper to the nearest 0.1 mm (Cescorf®, Porto Alegre, Brazil). The Faulkner equation was used to calculate body fat percentage: % Body Fat = 5.783 + 0.153 x (SE + TR + SI + AB); where SE = subscapular, TR = triceps, SI = suprailiac, AB = abdominal.

Yo-Yo Endurance Test (YET)

The YET (continuous) is a variation of the Yo-Yo test series (Bangsbo, 1994) consisting of repeated 2 × 20 m runs back and forth between the starting, turning, and finishing lines at a progressively increased speed controlled by audio beeps from a tape recorder. When the participant stops, the final speed and the number of performed 20 m distances at this speed are recorded, including the final run. The test data

were inserted into AVAesporte® software (Sports Systems, MG. Brazil) to obtain the distance-covered values for each athlete. Players performed the test on an official natural grass field, wearing cleats that met the standards required by the sport.

Running Anaerobic Sprint Test (RAST)

The RAST (Zagatto et al., 2009), consisting of six maximal 35 m all out sprints, interspaced by 10 s of passive recovery, was used for determination of anaerobic fitness. During the test, running time was measured using a photocell system (Cefise®, São Paulo, Brazil) located at the start and end of the 35 m track. Prior to the start of the test, the players were weighed, wearing clothes, to determine total body weight. These variables were utilized to calculate power.

$$Power(W)=[weight(kg) \times distance^2(m)]/time^3(s) \qquad (1)$$

Thus, the peak power (PP, the highest power value of the six efforts of 35 m), mean power (MP, the mean power value of the six efforts of 35 m) and minimum power (MinP, the smallest power value of the six efforts of 35 m) were obtained. The same RAST variables were recorded relative to the athletes' body weight (i.e., PPR=PP/weight; MPR = MP/weight). The fatigue index [FI (%)] of the RAST was obtained through the following equation:

$$FI\ (\%) = (PP - MinP) \times 100\ /\ PP \qquad (2)$$

Match Analysis

The friendly matches used for data collection were carried out in Jan/2014, following the same standards as used in official matches, with two periods of 45 min and a 15 min half time interval. The matches took place at 16 h.

Before each match, the players performed a standardized, specific warm-up, typically used in official games. The two evaluated teams were organized tactically, playing the 4-4-2 system. The GPS was positioned on the player's arm, according to the manufacturer's recommendations. All players on the team, except the goalkeeper, received the equipment at the start of the match. There was an agreement between the technicians/coaches to create opportunities for a larger number of substitutions than generally allowed in the rules of soccer, thus,

only the data from players who completed the friendly match, playing both halves of 45 min without being replaced were considered.

For the analysis of motor actions during the soccer game with the GPS, such variables were identified as total distance covered, maximal running speed, high-intensity actions (running) and number of sprints. The criteria for classification of high-intensity sprints and actions were adapted from Aughey and Varley (2013) and the data were analyzed in Qsports® software (QStarz®, Taipei, Taiwan). The values adopted were: 1) high-intensity actions (running): actions in which the player reached a speed between 15.9 and 24 km·h⁻¹; 2) sprints: actions in which the player reached a speed above 24 km·h⁻¹.

Statistical Analysis

Results are presented as mean ± standard deviation and confidence intervals of 95% (95% CI). Initially, the Shapiro-Wilk test was used to confirm the data normality ($n < 50$). To verify the correlation between the results obtained in the YET and RAST with the variables of the soccer matches in the study (total distance covered, maximal running speed, high-intensity actions (running) and number of sprints), the Pearson correlation was used. The correlations were distributed according to R-values, which were classified as very weak (0.0 to 0.2), weak (0.2 to 0.4), moderate (0.4 to 0.7), strong (0.7 to 0.9) and very strong (0.9 to 1.0) (Rowntree, 1981). In all cases a significance level of 5% ($p < 0.05$) was assumed. All data were analyzed using the software package SPSS Statistics 19.0 (SPSS Inc., Chicago, IL, USA).

Results

Individual data of total distance covered, maximal running speed, high-intensity actions (running) and number of sprints in the friendly matches are presented in Table 1.

The distance covered and the maximal velocity corresponding to the YET were 2027 ± 215 m (95% CI 1.382 – 1.510 m) and 13.0 ± 0.5 km·h⁻¹ (95% CI 13.7 – 14.3 km·h⁻¹), respectively. Significant correlations were found between the distance covered (m) in the YET with total distance covered, high-intensity actions (running) and number of sprints performed in the friendly matches (Table 2).

The mean PP, MP and FI (RAST variables)

are presented in Table 3. No significant correlations were found between the performance variables obtained during the matches and RAST variables (Table 3).

Table 1

Physical variables obtained during the soccer matches from the GPS.

Position Tactics	TDC (m)	MaxSpee (km·h⁻¹)	HIA	Nsprints
Fullbacks, Left and Right back	9694.7 ± 1094.0	28.9 ± 1.0	157.8 ± 39.8	27.7 ± 9.9
Midfielders	10120.3 ± 762.0	29.2 ± 0.9	174.0 ± 31.3	33.3 ± 11.7
Forward	9464.8 ± 492.9	28.9 ± 1.3	170.5 ± 46.2	27.8 ± 9.7
Mean ± SD (team)	**9832.7 ± 843.5**	**29.0 ± 0.9**	**167.8 ± 36.1**	**30.2 ± 10.5**

Values in means ± SD. TDC = Total distance covered; MaxSpeed = Maximal running speed;
HIA = Number of high-intensity actions (running); Nsprints = Number of sprints.

Table 2

Distance covered in the YET and correlation coefficients with performance obtained during the soccer matches from the GPS.

	Football match (r)			
	TDC (m)	MaxSpeed (km·h⁻¹)	HIA	Nsprints
Distance covered (m) in YET	r = 0.72*	r = 0.40	r = 0.78*	r = 0.88*

TDC = Total distance covered; MaxSpeed = Maximal running speed;
HIA = Number of high-intensity actions (running); Nsprints = Number of sprints.
* Significant correlation p < 0.05.

Table 3

RAST variables and correlation coefficients with performance in the soccer matches.

RAST	Mean ± SD (CI95%)	Football match (r)			
		DC	axSpeed	HIA	Nsprints
PP (W)	933.5 ± 118.1 (874.7-992.1)	r -0.22	r 0.44	r 0.01	r -0.05
PP (W·kg⁻¹)	12.0 ± 0.8 (11.5-12.4)	r -0.40	r -0.18	r -0.26	r -0.23
MP (W)	761.5 ± 92.4 (715.6-807.5)	r -0.18	r 0.45	r -0.11	r -0.05
MP (W·kg⁻¹)	9.4 ± 0.7 (9.4-10.1)	r -0.32	r -0.20	r -0.05	r -0.21
FI (%)	33.2 ± 5.91 (30.3-36.2)	r 0.66	r -0.11	r -0.11	r -0.07

RAST = Running Anaerobic Sprint Test; TDC = Total distance covered;
MaxSpeed = Maximal running speed;
HIA = Number of high-intensity actions (running);
Nsprints = Number of sprints. * Significant correlation p < 0.05.

Discussion

The main finding of this study was a high correlation between the total distances covered during the aerobic fitness test (YET) and performance during the friendly matches (Table 3). However, no significant correlation was found between performances in the anaerobic fitness test (RAST) with the variables studied during the same match.

As can be seen in Table 3, distance covered during the YET was strongly correlated with most of the performance variables registered during the matches, except maximal running speed ($r = 0.40$; $p = 0.23$). In modern soccer, the aerobic system plays an important role in the player's performance, and this metabolic pathway is the predominant supplier of energy during most of the match (Bangsbo, 1994; Helgerud et al., 2001) and enables rapid recovery of the anaerobic system after high intensity efforts (Bishop et al., 2004; Helgerud et al., 2001; McMillan et al., 2005). The literature describes non-invasive procedures that estimate aerobic fitness of players such as the YET (Krustrup et al., 2003). Metaxas et al. (2005), suggested that professionals involved in the assessment of physical fitness of soccer players used the YET for assessing aerobic capacity throughout the season. It was observed that athletes with better performance in this type of a test could be more effective during a match (Castagna et al., 2006). Furthermore, its applicability is satisfactory, since it is possible to evaluate several athletes simultaneously and it does not require sophisticated equipment being thus low-cost (Fornaziero et al., 2009). In the present study, the high correlation (Table 3) indicates that distance covered in the YET to a large degree explains performance (variables observed) in the friendly soccer matches.

Surprisingly, no correlations were observed between the RAST variables (PP, MP and FI), which could also be considered a repeated sprint ability test (Beck et al., 2014), and total distance covered, maximal running speed, high-intensity actions (running) and number of sprints during the friendly matches (Table 4). A possible explanation for the lack of correlations may be related to the difference between time of efforts, distance and recovery intervals present in the RAST, being different from the actions presented by the players in the match situation.

As reported by Dwyer and Gabbett (2012) the majority of sprints on sports fields last around 1-2 s, usually with speed values ranging above 21 km·h⁻¹. The average sprint distance in soccer players presented by the authors was 5.8 m, with peaks of maximum speed of around 29 km.h-1 (Dwyer and Gabbett, 2012). Carling et al. (2012), in a study with professional players, showed high-intensity distances of 16 ± 4.9 m and 2.7 ± 0.7 s. Bradley et al. (2009) demonstrated that a player performed actions with an intensity above 19.8 km.h-1 every 72 s. As the RAST uses an intermittent effort for the achievement of maximum efforts (~5 s), contribution of the aerobic metabolism (Milioni et al., 2016) in the intervals between the high intensity efforts and sprints could play an important role in maintaining performance, such as removing intracellular inorganic phosphate (Pi) and the resynthesis of phosphocreatine stores (PCr) (Kalva-Filho et al., 2013). In addition, when maximum efforts are repeated with short rest intervals, the aerobic contribution increases during the exercise and can be decisive in maintaining high intensity performance (Girard et al., 2011; Milioni et al., 2016). Thus, it seems possible that the best performance indices in high intensity intermittent efforts are dependent on aerobic fitness (Bishop and Edge, 2006). This could be due to the RAST consisting of forward sprints, without changes of direction, which little resemble efforts in soccer. Furthermore, the actions in the game could be sustained by the contribution of the aerobic metabolism (i.e., a high relationship between aerobic fitness and actions in the match).

Practical implications based on our results may be related to the important focus that must be given to conditioning to develop the aerobic metabolism, since this physical capacity seems to be fundamental in the execution of actions of high physical demands during the games of soccer. Also, the use of the RAST as a predictor of high intensity actions, number of sprints and maximum speed developed should be treated with caution.

We concluded that professional soccer players with better results in the YET covered a greater total distance and performed a larger number of high-intensity actions and sprints

during the matches. On the other hand, the results of the anaerobic indices (through the RAST) did not correlate with performance during the matches.

Acknowledgements

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