



ORIGINAL ARTICLE

Psychophysiological profile and prediction equations for technical performance of football players



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PALAVRAS-CHAVE

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Abstract The objective was to correlate specific technical skills (STS) with the psychophysiological performance. STS from 15 soccer athletes were collected by technical scouting of two matches. Countermovement jump, blood concentration of creatine kinase ([CK]), heart rate variability (HRV) and the scores of DALDA and POMS were also obtained 24 h after both matches. Predictive equations were elaborated, and POMS and DALDA scores were the only variables which fits the models for STS with high coefficient of determination (r^2) for finalization ($r^2 = 0.85$), interception ($r^2 = 0.73$), pass right ($r^2 = 0.32$), tackling ($r^2 = 0.69$) and loss of ball ($r^2 = 0.35$). The psychological variables identified through POMS and DALDA have shown greater influence on the STS.

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Perfil psicofisiológico e equações preditivas de desempenho técnico em jogadores de futebol

Resumo O objetivo foi correlacionar variáveis psicofisiológicas com desempenho técnico específico (STS). As STS foram coletadas durante dois jogos amistosos através de *scout* técnico. Salto contramovimento, concentração sanguínea de creatina quinase ([CK]), variabilidade da frequência cardíaca (HRV) e os escores de POMS e DALDA também foram acessados. Equações preditivas foram testadas e os escores de POMS e DALDA formaram modelos de regressão com significância estatística e coeficiente de determinação (r^2) expressivo para as STS de finalização ($r^2 = 0,85$), interceptação ($r^2 = 0,73$), passe certo ($r^2 = 0,32$), roubada de bola ($r^2 = 0,69$) e perda de posse de bola ($r^2 = 0,35$). Variáveis psicológicas foram capazes de prever o desempenho técnico em STS coletadas em *scout* de partidas de futebol.

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PALABRAS CLAVE

Fútbol;
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Perfil psicofisiológico y ecuaciones predictivas de rendimiento técnico de jugadores de fútbol

Resumen El objetivo fue correlacionar habilidades técnicas específicas (STS) con evaluaciones psicofisiológicas. Las STS de 15 jugadores de fútbol se recogieron mediante técnica de *scouting* de dos partidos. Salto contramovimiento, concentración sanguínea de creatina-cinasa, variabilidad de la frecuencia cardíaca y las puntuaciones de DALDA y POMS se obtuvieron 24 h después de ambos partidos. Se elaboraron ecuaciones predictivas y POMS y DALDA se ajustaron a los modelos con alto coeficiente de determinación (r^2) para finalización ($r^2 = 0,85$), interceptación ($r^2 = 0,73$), pase correcto ($r^2 = 0,32$), quite de balón ($r^2 = 0,69$) y pérdida de balón ($r^2 = 0,35$). Las variables psicológicas identificadas a través de POMS y DALDA han mostrado gran influencia en las STS.

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Introduction

Soccer is a team sport, in which a set of elements interact to their practice can be developed in the highest level (Carling et al., 2012). Despite the consensus that there is an intense contribution of physical, physiological and psychological aspects during its development (Stolen et al., 2005), the variables that show greater expression in the competitive context are technical and tactical (Garganta, 2009). Interestingly, there have been few studies on the relationship between performance, psychophysiological aspects and technical skills in soccer (Rampinini et al., 2008).

During the sports training process, the identification of the athletes profile, the monitoring and control of training effects are relevant for evaluation and, eventually, reorientation of the adopted periodization (Garganta, 2009). To this purpose, different evaluations can be made (Lambert and Borresen, 2006). Previous studies have shown data on the activity of creatine kinase blood concentration ([CK]) (Silva et al., 2013), heart rate variability (HRV) behavior (Buchheit et al., 2010), lower limb power (Stolen et al., 2005), and mood and stress level (Filaire et al., 2001; Nicholls et al., 2009) in soccer and other team sports players. In general, it is observed that the lower limb power is relevant to the motor actions used in the soccer practice, such as maximum sprints (linear and with change of direction), and that physiological and psychometric strategies of training monitoring can enable better control for organizational feedback that can optimize the competitive results (Soares and Greco, 2010).

However, soccer practice is characterized by unpredictability (Filaire et al., 2001), which impacts the matches characterization directly, as well as, training for improving technical-tactical variables. Thus, it is established the notational analysis (Carling et al., 2012), allowing the registration of players and squads profiles, the identification of game patterns (Zubillaga et al., 2007), and also observing the technical and tactical fundamentals during matches (Ramos Filho and Alves, 2006). It is frequently

observed performance measurements in specific technical skills (STS), in addition to tactical systems (Braz and Borin, 2009), which can be arranged by individual and collective actions, offensive and defensively (Soares and Greco, 2010).

Although there are more technical-tactics variables relevance for determining the results in soccer, physical, physiological and psychological aspects can be highlighted, once that they comprise the set of variables which interact with sports performance (Stolen et al., 2005). So, it has already been found relationships between these physical variables, pointing out that: (i) muscular strength may improve the ability to jump and maximum sprinting (Komi, 2006), (ii) the ability to sprint is linked to the change of [CK] and (iii) the HRV must be considered when the training status is evaluated (Wisloff et al., 2004; Buchheit et al., 2011; Thorpe and Sunderland, 2012).

However, the correlation of such aspects with technical variables is very scarce, there is a positive link between physical fitness in specific test and the ability to do short passes, measured through the *Loughborough Soccer Passing Test* (LSPT), as well as between LSPT performance and running time (Rampinini et al., 2008; Benounis et al., 2013). Although the evaluation of the LSPT has its importance, the presenting results are decontextualized from the game itself, and the notational analysis allows measuring the STS during matches (Carling et al., 2012).

So, the better understanding of the relation between psychophysiological profile and players performance in matches would allow improving the quality of information, transferring the science knowledge for the soccer practice (Mackenzie and Cushion, 2013). Therefore, the purpose of this investigation was to correlate technical variables obtained in matches with the psychological, physiological and physical evaluations of professional soccer athletes. Considering that motor action features require great lower limb power (Kraemer et al., 2004), physiological variables can help training correct control and prescription (Silva et al., 2008; Hunkin et al., 2014), and psychological factors can affect players optimal performance during intense

training periods (Laurin et al., 2008; Schmikli et al., 2011), the existence of relationships between psychological variables and STS is hypothesized.

Methods

Subjects

The study took place in Pelotas, Brazil and was conducted with a professional soccer team which played the State Championship, in the first half of 2013. Among 25 players, 15 took part on the study, and they all read and signed an informed consent term (Ethics Committee approval number 005/2012). This difference is due to the fact that among 25 players, only 15 were in all stages of the study, despite that all of them were in preseason, i.e. the first training period of the season.

Experimental design

This study is characterized as correlational and predictive (Gratton, 2010). Its variables are: correct and wrong STS pass, finalization, tackling, interception, loss of the ball, received and committed fouls, recorded in two friendly matches, as well as [CK], HRV parameters, height of vertical jump, and the scores in two psychological questionnaires *Daily Analysis of Life Demands for Athletes (DALDA)* and *Profile of Mood States (POMS)*, described below.

The data was collected 28 days after the beginning of the training period for the main season competition and the evaluations were conducted in the usual environment of the players, the locker room. These steps were planned to be performed at a time when the team was finalizing the preparation process when competitions were about to begin. By that time, there were two friendly matches, all the data and measurements were collected 24 and 48 h after and before the first and second game, respectively.

For STS, recordings of friendly matches took place in the home field, being registered the total amount of time in the games. After the recording, the files were downloaded in specific software (Longomatch[®], version 0.18.11) used to identify information relating to STS, passing for the quantification and classification of these variables, which has made it possible to group them for subsequent analysis.

Procedures

Technical scouting

A Sony DCR-SX43 video camera was installed in the stadium's press room for the recording of the two matches, which took place on a Thursday and on a Sunday. The local team won one of the matches and lost the other. Specific sports video analysis software (LongoMatch[®], version 0.18.11) was used for notational analysis of the games, which allows customizing labels for identification and marking the desired variables while watching the game recording. Subsequently, the software delivers a spreadsheet with the information previously marked, enabling the accounting of game actions.

To identify and locate the player's actions, a previously proposed space division of the field was used (Braz and Borin,

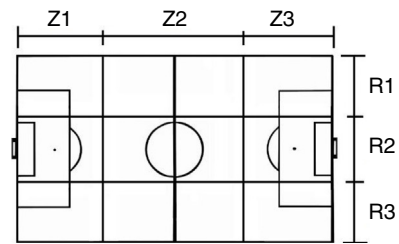


Figure 1 Division of field area in 12 quarters, according to zones (Z1, Z2 and Z3) and regions (R1, R2 and R3).

2009). The field was divided into three longitudinal zones (Z1, Z2 and Z3) and three lateral regions, R1, R2 and R3, as shown in Fig. 1.

The STS studied are organized into two groups: (i) related to the own team: correct and wrong pass, finalization, loss of the ball; and (ii) related to the opponent: fault committed interception and tackling. The passes were divided into correct and wrong and classified in relation to the area of action and side of the field. The finalizations were differentiated among shots on goal, out, blocked, and goal. Was considered "to the goal" every kick or header that, when executed, hurled the ball toward the goal (Braz and Borin and 2009). The finalizations that go out the field, without touching any opponent, were considered "out". However, those that are blocked by any opponent and did not reach the goal were classified as "blocked".

The fouls were categorized according to the presentation or not of yellow/red card to the foul player. The lost balls, interceptions, and tackling were differentiated between zones of action and side of the field, and the criteria adopted for these variables were: any loss of ball possession is going to be taken into consideration, whether by mistake of the player who had it, or intercepted by the opponent.

Tackles or blocking passes in which the player who performed the action does not get the ball, but only interrupts other player's possession or pass, is going to be considered "interception". All tackles interrupting the opponent's pass or possession and consequently, taking the ball from him is going to be considered "tackling".

In all instances of pass (correct or wrong), loss of possession and finalization were specified even if the action happens with or without the presence of an opponent while it was performed. The criteria for this variable, was described as any opponent action in order to prevent or delay the player who is with the ball progress, up to 3 m away, which is inferred visually from the lines on the field.

Physiological data

The [CK] was collected after the athletes remained in relative rest for 5 min. As a standard procedure, it was made aseptically on the index finger of the athlete using alcohol 70%. The individuals had their finger punctured with a lancet (Accu-check, Soft Click) and the blood was collected with the use of capillary (Capilette[®] for Reflotron), with 32 μ l capacity. The blood sample was transferred and analyzed in specific equipment (Reflotron Plus, Roche DiagnosticsTM) (Coelho et al., 2011).

For the lower limb jump height analysis, a contact mat was used to measure the flight time during vertical jump

(Kit MultSprintFull[®], Hidrofit, Belo Horizonte, Brazil). Athletes performed a countermovement jump aiming to achieve the highest possible height, without performing knee flexion during the phase of flight and ground contact on landing. The best of three jumps was considered in the analysis, and this test shows interclass correlation coefficient between 0.88 and 0.99 (Castagna et al., 2013).

The values of the heart rate variability (HRV) were collected with the individual in a supine position and over 5 min with heart rate monitor (Polar RS800CX, Polar Electro OY[®], Finland). After this, data were transferred to Polar ProTrainer 5TM software and analyzed in the HRV software Kubios 2.0 (University of Kuopio, Finland). The HRV data were organized into two domains: time and frequency (Fronchetti et al., 2007). The following variables were considered: time domain, the root mean square of successive differences squared (RMSSD), which demonstrates the parasympathetic dominance, and in the frequency domain, the spectral components of low frequency (LF) (Force, 1996) and high frequency (HF) (Oliveira et al., 2013). The HF spectral component concerns the parasympathetic modulation of RR intervals, while the LF reflects the sympathetic modulation.

Psychological data

To characterize the players' mood and stress levels, two instruments were used, the POMS (Rohlf's et al., 2004; Lambert and Borresen, 2006) and the DALDA, respectively (Lambert and Borresen, 2006). The collection of this information occurred with the athletes in relative rest, and the questionnaire interview was made individually in private scheme. The POMS version adapted by Viana et al. (2001) consists of forty-two items/adjectives related to parameters of fatigue, depression, tension, hostility, confusion and vigor, described by a 0 to 4 score, in addition to the general disruption score determined by the sum of the items described above.

The DALDA contains nine questions in part A and twenty-five questions in part B, which have, for each question, three response options, a = worse than usual; b = normal; c = better than usual, displaying questions regarding daily tension and stress symptoms (Rushall, 1990). For its score, were counted the answers "a" in part A.

Statistical analysis

The concordance between intra and inter evaluators measures of STS variables was calculated with the *Med Calc software* (version 12.7.5.0), using *Kappa Weighted* test (Robinson and O'Donoghue, 2007). For this, independent evaluators conducted new identification data, ten days after the first ones were taken, corresponding to 15% of the total of identified actions at first, being this value above 10% suggested in the literature (Tabachnick and Fidell, 2007). Taking it into consideration, 80 shares of each game were reanalyzed presenting minimum values of 0.975 and 0.945 for comparisons between inter and intra evaluators, respectively.

In addition, data were analyzed with software SPSS 17.0, by assigning a significance level of 5%. The Shapiro-Wilk test was used to test the normality of the data and the descriptive analysis considering mean and standard

deviation as measures of centrality and dispersion, respectively. For comparisons of proportion between zones, regions and presence or not of opponent for each one of STS except finalization, we used the Chi-square test, with the average between the values found in the two events.

Furthermore, was conducted the Student *t* test for independent samples and it was identified that there was no difference between the STS recorded in two matches. Thus, we decided to use the average between the STS recorded in two matches to make the calculation of the coefficient of determination (r^2) and structure the linear regression equations for these variables, with backward procedure being adopted (Field, 2013).

As predictor variables, was used the height of vertical jump, [CK], RMSSD, LF, HF, scores of POMS (tension, depression, hostility, vigor, fatigue and confusion) and the part A of the DALDA. In all analyses, 5% was adopted as standard of a statistically significant difference.

Results

For the STS, 577 actions were registered in the first game and 548 in the second, 290 and 247 passes respectively, 90 and 103 wrong passes, 62 and 47 interceptions, 19 and 17 fouls received, 19 and 21 fouls committed, 50 and 76 tackling, 29 and 20 loss of the balls and 18 and 17 finalizations. Referring to the location, zone and region of the field where they performed the STS during games, Table 1 presents the main results, and the relationship of STS with the areas and regions of the field, as well as presence or absence of opponent while executing the actions. Zone and region columns show in which locations of the field the STS had a higher occurrence, and the column opponent demonstrates if these STS were more accomplished with presence or absence of an opponent in the action.

The values of [CK] and vertical jump were $385.31 \pm 162.64 \text{ UI L}^{-1}$ and $38.31 \pm 5.23 \text{ cm}$, respectively. In the HRV parameters, the RMSSD was $44.92 \pm 17.26 \text{ ms}$, LF $1080.24 \pm 803.35 \text{ ms}^2$, and HF $641.40 \pm 582.65 \text{ ms}^2$. In relation to the psychological data, it was found in the POMS variables: tension = 7.46 ± 2.44 ; depression = 0.46 ± 0.66 ; hostility = 1.88 ± 1.99 ; vigor = 17.38 ± 1.94 ; fatigue = 2.46 ± 1.98 ; confusion = 7.46 ± 1.51 . For the "a" responses of the A part of DALDA, the average was 0.31 ± 0.63 points.

R^2 values and predictive equations for STS are displayed in Table 2. Thus, it was observed that only the psychological variables fit the predictive equations. This result shows that the POMS scores and DALDA exhibits predominant contribution in the prediction of STS referring to the opponent (interception, loss of ball and tackling), and in the pass right and finalizations.

Discussion

The main finding of the present study was the prediction of the performance in STS, from psychometric components in friendly matches. In this context, we highlight the psychological variables in all the predictive models presented.

The team that took part in the study reached 17.5 finalizations per game on average, a similar index to other two

Table 1 Result of the STS according to the zone, region and the presence or not of opponent.

STS	Zone	Region	Opponent
Right pass	Z2 ^{a,b} > Z1 ^c > Z3	Right ^{d,e} > Left ^f > Center	Yes > No ^g
Wrong pass	Z3 ^c = Z2 ^a > Z1	Right ^{d,e} > Left ^f > Center	Yes > No ^g
Interception	Z1 ^{a,c} > Z2 ^b > Z3	Right ^{d,e} > Left ^f > Center	-
Tackling	Z1 ^{a,c} > Z2 ^b > Z3	Left ^{d,f} > Right = Center	-
Fault received	No difference	No difference	-
Fault committed	No difference	No difference	-
Loss of the ball	No difference	No difference	No difference

Z1, defense zone; Z2, midfield zone; Z3, attack zone.

^a Difference between Z2 and Z1 ($p < 0.05$).

^b Difference between Z2 and Z3 ($p < 0.05$).

^c Difference between Z1 and Z3 ($p < 0.05$).

^d Difference between Right and Left ($p < 0.05$).

^e Difference between Right and Center ($p < 0.05$).

^f Difference between Left and Center ($p < 0.05$).

^g Difference between Yes and No ($p < 0.05$).

Table 2 Prediction equations for STS in football.

STS	Prediction equation	r^2	F	p
Finalization	$(-2.833) + (Tension \times 0.630) + (Depression \times 1.630)$	0.85	13.44	0.001
Interception	$(2.952) + (Dalda A \times 4.032)$	0.73	33.81	<0.001
Pass right	$14.274 + (Hostility \times 2.706)$	0.32	5.18	0.044
Tackling	$1.276 + (Hostility \times 1.382) + (Dalda A \times 2.561)$	0.69	10.88	0.003
Loss of the ball	$1.110 + (Tension \times 0.381)$	0.35	5.98	0.033

Scales of POMS: Tension, depression, hostility; DALDA A: "a" responses of the A part of the questionnaire DALDA; STS, specific technical skill. Coefficient of determination (r^2) and structure the linear regression equations for these variables, with backward procedure being adopted.

Brazilian teams with 17.46 (Ramos Filho and Alves, 2006) and 14 (Braz and Borin, 2009) finalizations. For other registered STS, values presented different standards from these other teams in the same Brazilian State level, given that they have presented higher wrong passes and tackling averages and lower committed and received fouls. The different levels of the leagues each team competed and also by the fact that the team analyzed in this study was going through its preseason while the other two were investigated during the competitive season can explain these differences. Furthermore, other physiological and psychological factors can also have determined crucial differences between soccer teams.

Among the physiological factors studied in football, [CK] which is commonly used as a physiological intensity marker (Coelho et al., 2011; Nunes et al., 2012) muscle damage and a marker of overtraining symptoms (Silva et al., 2008). After periods of intense training (Nunes et al., 2012) or after official matches (Ascensao et al., 2008) [CK] is usually high in professional soccer players, presenting an average value of $\sim 800 \text{ UI L}^{-1}$ within 24 h after an official match, a significant increase related to the pregame moment ($\sim 200 \text{ IU L}^{-1}$) (Ascensao et al., 2008).

Interestingly, in the present study, the [CK] verified 24 h after a game, accounts for $385.31 \pm 162 \text{ UI L}^{-1}$, maybe, the friendly character of the match analyzed in this study has resulted in a less stress and strain, suggesting that friendly matches may not require as much physical effort as in official matches for physiological parameters (Rodrigues et al.,

2007). It is important to say that the [CK] values found through the analyzed team are close to reference for Brazilian soccer athletes (Silva et al., 2012), and also, the pick concentration of [CK] can be found between 24 and 72 h after a stimulation (Coelho et al., 2011; Nunes et al., 2012).

Considering psychological variables, POMS questionnaire has been widely used to analyze mood and checking athletes overtraining stages (Lambert and Borresen, 2006; Bresciani et al., 2011; Schmikli et al., 2011). In a study with young soccer players, bad mood was found in the group with decreasing performance, showing significant difference in depression and anger scores, when compared to the control group (Schmikli et al., 2011). In other studies, high scores of fatigue (~ 19 ; ~ 18) and poor performance in the vigor score (~ 9 ; ~ 13) were found in post exercise data (Mashiko et al., 2004; Bresciani et al., 2011); however, athletes in the present study, even having participated in a exhibition game 24 h before the collection of our data, showed lower fatigue and higher vigor scores than the reported in the literature for Brazilian soccer players (Silva et al., 2012). Such findings have common points with another study, where differences in POMS scales at different times of training season were not found (Arruda et al., 2013).

Some other aspects can also help in identifying athletes and non-athletes' mood such as HRV (Nuissier et al., 2007). HRV is a measure that provides data about the constant sympathetic and parasympathetic autonomous nervous system (ANS) interaction on the HR, which represents an

autonomous control on physical, physiological and emotional responses (Appelhans and Luecken, 2006). Thus, the HRV has also been mentioned as non-invasive indicator of emotional stress, whereas an increase on its intensity usually comes together with the increase of sympathetic tone and the reduction of vagal tone (Laborde et al., 2011). So, the relation between sympathetic and vagal tones was investigated among athletes during simulation of stressful events and a sympathetic predominance over the parasympathetic branch during moments of stress was found (Laborde et al., 2011).

Another study that intended to investigate physical education students mood according to the HRV parameters has found that the stress of academic life can lead to fatigue, mood disturbances and even the development of overtraining (Nuissier et al., 2007). Furthermore, it was observed the relation between the POMS depression score with the parasympathetic regulation of HRV, and an association of the POMS vigor score with all parameters of HRV, suggesting that greater vigor scores are associated with greater HRV and, consequently, increased autonomic control of the heart (Nuissier et al., 2007). Furthermore, in the present sample, the values of the HRV parameters were below the ones mentioned in other studies (Nuissier et al., 2007; Laborde et al., 2011), indicating that the recovery time (24h) was enough to recover athletes from the previous days of effort considering the psychophysiological parameters.

The low average of "a" responses in the part A of DALDA, reflects the low level of stressors in the present sample (Halson et al., 2002; Capostagno et al., 2014), which demonstrates the good level of team preparation at the end of the preseason, when related to psychological stress. Interestingly, in predictive equations, DALDA A presented only a correlation with STS commonly undertaken by players in the defensive sector (i.e. interception and tackling). It happens due to the greater sensitivity to stressors agents of negative mood in defenders, when compared to offensive players (Mashiko et al., 2004).

For the technical variables: received and committed fouls, tackling and finalization, the prediction equations were composed by physiological and psychological aspects. It was found a high influence of the parasympathetic activity on the ANS (demonstrated by RMSSD and HF) and bad state of mind (tension, hostility, depression, fatigue and confusion) and positive (vigor) of humor in STS (except for the interception), demonstrating associations between parameters of HRV and POMS reported in literature (Appelhans and Luecken, 2006; Nuissier et al., 2007; Laborde et al., 2011).

Literature demonstrates that the performance in soccer correlates with physical (Kraemer et al., 2004), physiological (Silva et al., 2008; Hunkin et al., 2014) and psychological (Filaire et al., 2001; Schmikli et al., 2011) variables. However, in the present study results only the STS who have had a highlighted relation with psychological scores have shown significant predictive equations (Table 2). This explains why some STS were not predicted by psychophysiological variables. The lack of a postgame collecting and the technical analysis of only two games can be considered as limitations of the study. It is suggested that future researches explore a broader approach, by analyzing more matches throughout a whole competition or season.

It could be concluded that the psychological variables identified through POMS and DALDA questionnaires have shown greater influence the STS, specially finalization, interception and tackling. It is suggested that mood states, plus physical and physiological information, can be relevant tools in training control; however the psychometric components could better predict STS in soccer.

Conflicts of interest

The authors declare no conflicts of interest.

References

- Appelhans B, Luecken L. Heart rate variability as an index of regulated emotional response. *Rev Gen Psychol* 2006;10:229–40.
- Arruda A, Moreira A, Nunes JA, Viveiros L, Rose D Jr, Aoki MS. Monitoramento do nível de estresse de atletas da seleção brasileira de basquetebol feminino durante a preparação para a Copa América 2009. *Rev Bras Med Esporte* 2013;19:44–7.
- Ascensao A, Rebelo A, Oliveira E, Marques F, Pereira L, Magalhães J. Biochemical impact of a soccer match – analysis of oxidative stress and muscle damage markers throughout recovery. *Clin Biochem* 2008;41:841–51.
- Benounis O, Benabderrahman A, Chamari K, Ajmol A, Benbrahim M, Hammouda A, et al. Association of short-passing ability with athletic performances in youth soccer players. *Asian J Sports Med* 2013;4:41–8.
- Braz T, Borin J. Quantitative game analysis of a professional elite soccer team from Minas Gerais state. *J Physical Educ* 2009;20:33–42.
- Bresciani G, Cuevas MJ, Molinero O, Almar M, Suay F, Salvador A, et al. Signs of overload after an intensified training. *Int J Sports Med* 2011;32:338–43.
- Buchheit M, Mendez-Villanueva A, Quod MJ, Poulos N, Bourdon P. Determinants of the variability of heart rate measures during a competitive period in young soccer players. *Eur Appl Physiol* 2010;109:869–78.
- Buchheit M, Voss SC, Nybo L, Mohr M, Racinais S. Physiological and performance adaptations to an in-season soccer camp in the heat: associations with heart rate and heart rate variability. *Scand J Med Sci Sports* 2011;21:e477–85.
- Capostagno B, Lambert MI, Lamberts RP. Standardized versus customized high-intensity training: effects on cycling performance. *Int J Sports Physiol Perform* 2014;9:292–301.
- Carling C, Le Gall F, Dupont G. Analysis of repeated high-intensity running performance in professional soccer. *J Sports Sci* 2012;30:325–36.
- Castagna C, Ganzetti M, Ditroilo M, Giovannelli M, Rocchetti A, Manzi V. Concurrent validity of vertical jump performance assessment systems. *J Strength Cond Res* 2013;27:761–8.
- Coelho D, Morandi RF, Melo MA, Silami-Garcia E. Cinética da creatina quinase em jogadores de futebol profissional em uma temporada competitiva. *Braz J Kinesiol Human Perform* 2011;13:189–94.
- Field A. *Discovering statistics using IBM SPSS statistics*. New York: SAGE; 2013.
- Filaire E, Bernain X, Sagnol M, Lac G. Preliminary results on mood state, salivary testosterone:cortisol ratio and team performance in a professional soccer team. *Eur J Appl Physiol* 2001;86:179–84.
- Force T. Heart rate variability, standards of measurement, physiological interpretation, and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. *Eur Heart J* 1996;17:354–81.

- Fronchetti L, Aguiar CA, Aguiar AF, Nakamura FY, Oliveira O. Changes of heart rate variability during exercise and fitness training. *Rev Min Educ Física* 2007;15:101–29.
- Garganta J. Trends of tactical performance analysis in team sports: bridging the gap between research, training and competition. *Rev Port Ciên Desp* 2009;9:81–9.
- Gratton C. *Research methods for sports studies*. London: Routledge; 2010.
- Halson S, Bridge MW, Meeusen R, Busschaert B, Gleeson M, Jones DA, et al. Markers during intensified training in trained cyclists. *J Appl Physiol* 2002;93:947–56.
- Hunkin SL, Fahrner B, Gastin PB. Creatine kinase and its relationship with match performance in elite Australian Rules football. *J Sci Med Sport* 2014;17:332–6.
- Komi P. *Força e potência no esporte*. São Paulo: Artmed; 2006.
- Kraemer WJ, French DN, Paxton NJ, Häkkinen K, Volek JS, Sebastianelli WJ, et al. Changes in exercise performance and hormonal concentrations over a big ten soccer season in starters and non-starters. *J Strength Cond Res* 2004;18:121–8.
- Laborde S, Brül A, Weber J, Anders LS. Trait emotional intelligence in sports: a protective role against stress through heart rate variability? *Person Individ Diff* 2011;51:23–7.
- Lambert M, Borresen J. A theoretical basis of monitoring fatigue: a practical approach for coaches. *Int J Sports Sci Coach* 2006;1:371–88.
- Laurin R, Nicolas M, Lavalle D. Effects of a personal goal management intervention on positive and negative moods states in soccer academies. *J Clin Sport Psychol* 2008;2:57–70.
- Mackenzie R, Cushion C. Performance analysis in football: a critical review and implications for future research. *J Sports Sci* 2013;31:639–76.
- Mashiko T, Umeda T, Nakaj S, Sugawara W. Position related analysis of the appearance of and relationship between post-match physical and mental fatigue in university rugby football players. *Br J Sports Med* 2004;38:617–21.
- Nicholls AR, Backhouse SH, Polman RC, McKenna J. Stressors and affective states among professional rugby union players. *Scand J Med Sci Sports* 2009;19:121–8.
- Nuissier F, Chapelot D, Vallet C, Pichon A. Relations between psychometric profiles and cardiovascular autonomic regulation in physical education students. *Eur J Appl Physiol* 2007;99:615–22.
- Nunes R, Andrade FC, Coimbra DR, Nogueira RA, Pinto AF, Filho MGB. Monitoramento dos efeitos agudos da carga de treinamento no futebol. *J Phys Educ* 2012;23:599–606.
- Oliveira RS, Leicht AS, Bishop D, Barbero-Álvarez JC, Nakamura FY. Seasonal changes in physical performance and heart rate variability in high level futsal players. *Int J Sports Med* 2013;34:424–30.
- Ramos Filho L, Alves D. Análise do scout individual da equipe profissional de futebol do Londrina Esporte Clube no campeonato paranaense de 2003. *Rev Treinamento Desp* 2006;7:62–7.
- Rampinini E, Impellizzeri FM, Castagna C, Azzalin A, Ferrari Bravo D, Wisløff U. Effect of match-related fatigue on short-passing ability in young soccer players. *Med Sci Sports Exerc* 2008;40:934–42.
- Robinson G, O'Donoghue P. A weighted kappa statistic for reliability testing in performance analyses of sport. *Int J Perform Anal Sport* 2007;7:12–9.
- Rodrigues V, Mortimer L, Condessa L, Coelho D, Soares D, Silami-Garcia E. Exercise intensity in training sessions and official games in soccer. *J Sports Sci Med* 2007;1:57–61.
- Rohlf s I, Carvalho T, Rota TM, Krebs RJ. Aplicação de instrumentos de avaliação de estados de humor na detecção da síndrome do excesso de treinamento. *Rev Bras Med Esporte* 2004;10:111–6.
- Rushall B. A tool for measuring stress tolerance in elite athletes. *J Appl Sport Psychol* 1990;2:51–66.
- Schmikli SL, Brink MS, de Vries WR, Backx FJ. Can we detect non-functional overreaching in young elite soccer players and middle-long distance runners using field performance tests? *Br J Sports Med* 2011;45:631–6.
- Silva A, Papoti M, Pauli JR, Gobatto CA. Preparation of percentile tables through anthropometric, performance, biochemical, hematological, hormonal, and physiological parameters in professional soccer players. *Rev Bras Med Esporte* 2012;18:148–52.
- Silva A, Santhiago V, Papoti M, Gobatto CA. Psychological, biochemical and physiological responses of Brazilian soccer players during a training program. *Sci Sports* 2008;23:66–72.
- Silva JR, Ascensão A, Marques F, Seabra A, Rebelo A, Magalhães J. Neuromuscular function, hormonal and redox status and muscle damage of professional soccer players after a high-level competitive match. *Eur J Appl Physiol* 2013;113:2193–201.
- Soares V, Greco P. A análise técnica-tática nos esportes coletivos: ‘por que’, ‘o quê’, e ‘como’. *Rev Mack Educ Física* 2010;35:501–36.
- Stolen T, Chamari K, Castagna C, Wisløff U. Physiology of soccer: an update. *Sports Med* 2005;35:501–36.
- Tabachnick B, Fidell L. *Using multivariate statistics*. New York: Harper and Row Publishers; 2007.
- Thorpe R, Sunderland C. Muscle damage, endocrine, and immune marker response to a soccer match. *J Strength Cond Res* 2012;26:2783–90.
- Viana M, Almeida PL, Santos RC. Adaptação portuguesa da versão reduzida do Perfil de Estados de Humor: POMS. *Análise Psicol* 2001;19:77–92.
- Wisloff U, Castagna C, Helgerud J, Jones R, Hoff J. Strong correlation of maximal squat strength with sprint performance and vertical jump height in elite soccer players. *Br J Sports Med* 2004;38:285–8.
- Zubillaga A, Gorospe G, Mendo AH, Vilaseñor AB. Match analysis of 2005–06 champions league final with Amisco system. *J Sports Sci Med* 2007;6.