Journal of Exercise Physiologyonline

October 2013
Volume 16 Number 5

JEPonline

Official Research Journal of the American Society of Exercise Physiologists

ISSN 1097-9751

Hematological Parameters of Elite Soccer Players during the Competitive Period

Thiago Santi Maria[1], Miguel de Arruda[1], Daniel Portella[2], Rodrigo Vargas Vitoria[3], Rossana Gómez Campos[1,4], Cristian Martinez Salazar[4], Vanessa Carrasco[4], Marco Cossio-Bolanos[1,3]

[1]Faculty of Physical Education, State University of Campinas, São Paulo Brazil, [2]Faculty of Physical Education - School - City University of Sao Caetano do Sul / USCS. Professor and researcher GEPEFEX, [3]Department of Physical Activity Sciences, Catholic University of Maule, Chile, [4]Faculty of Education, Humanities and Social Sciences, Department of Physical Education, Sports and Recreation, University La Frontera, Temuco, Chile

ABSTRACT

Santi Maria T, Arruda M, Portella D, Vargas Vitoria R, Gómez Campos RG, Martinez C, Carrasco V, Cossio-Bolanos M. Hematological Parameters of Elite Soccer Players during the Competitive Period. **JEPonline** 2013;16(5):68-76. The purpose of this study was to describe and compare hematologically elite football players during the competitive period according to playing positions and determines the prevalence of anemia. The subjects consisted of 38 professional footballers from a professional club in the National Football League First Division of Brazil. Six groups were formed for hematological comparison: (a) goalkeepers; (b) side defenders; (c) central defenders; (d) central midfielders; (e) side midfielders; and (f) attackers. Data collection began at the start of competition. The anthropometric, hematological, and VO_2 max measures were carried out on the first day. To determine hematological parameters, fasting blood samples were taken from the cubital vein. The One-Way analysis of variance and the Bonferroni adjustment for multiple comparisons were used for statistical comparison between the footballers of different playing positions. No statistically significant differences were found among the playing positions in all three hematological parameters (red blood cell count, hematocrit, and hemoglobin). All players maintained strict compliance of balanced diets.

Key Words: Soccer, Hematological Parameters, Elite Footballers

INTRODUCTION

Elite soccer (football) is often recognized as the most popular sport of sports. It is expanding in all nations of the world (36). Soccer performance is dependent upon technical, biomechanical, and tactical factors that include mental and psychological strategies (37). Years of experience, anthropometric considerations (28), body composition (8,34), muscular strength, balance, aerobic power, and anaerobic capacity are also important in the assessment of elite soccer players (22,34,36). More recently, it is believed that hematological parameters may also play a crucial role in predicting optimal physical performance (30). But, unfortunately, very little attention has been given to the assessment and monitoring of hematological parameters in professional soccer players. It is possible that the stability of the players' hematologic status that associates with good health may be considered as key determinants of athletic performance.

Hematological parameters are influenced by several factors within the apparently healthy population. These factors include training, age, sex, ethnicity, nutrition, and altitude (11,23,30). Any one or all of these factors can have a positive or negative influence on hematocrit (Hct), hemoglobin (Hb), and red blood cell (RBC) count. In particular, all three are often decreased by resistance training (9,30). In a sport like football, where the activity profile and physical demands are directly related to intermittent exercise, very few studies have reported on these hematological parameters in association with elite soccer. Thus, the purpose of this study was to describe and compare the hematological parameters of elite soccer players during competition specific to different playing positions and also to determine the prevalence of anemia.

METHODS

Subjects

Study participants consisted of 38 professional footballers (mean age, 24.6 ± 3.9 yrs; age range, 19 to 33 yrs) of a professional Club in the National Football League First Division Brazil (Sao Paulo) with an average of 7.01 ± 3.9 yrs of professional experience as football players. In general, the number of training sessions per week was 8 to10 sessions·wk^{-1} with at least 2 hrs of training per session. The training program was designed by the Technical Committee of the Football Club, and they considered a training volume of 16 hrs·wk^{-1}. The contents programmed for the competitive period consisted of a physical preparation, technique, tactics, strategy, and developments. All regimens were developed with low intensities (50 to 60% of maximum heart rate, HR max), medium (70 to 80% of HR max) and high intensity (80 to 90% of HR max). In short, the training model for both mesocycles and microcycles was the ATR: accumulation, transformation, and realization.

The selection of the sample was non-probabilistic accidental type, since it considered all of the players listed as professional players within the Club Atlético Ponte Preta (Brazil). The data collection period corresponded to the beginning of competitive Brazilian Football Championship (February, 2010). The evaluations were done as part of routine medical examinations done for biochemical, physical, technical, tactical, and psychological aspects of club members for the all season's program. For this study, 6 groups were formed according to playing positions: (a) goalkeepers; (b) wing backs; (c) central defenders; (d) side wheels; (e) central midfielders; and (f) attackers. Included in the study were only the players who were in good health. None of the players could have cold symptoms and/or sports injuries. Both assessment protocols were approved by the ethics committee of the Faculty of Medicine of the State University of Campinas, Sao Paulo (Brazil). All participating players were informed about assessment procedures and signed an informed consent form.

Procedures

All hematological and anthropometric assessments were evaluated on one day during the period in the morning (from 8:00 to 9:00 am) in a controlled laboratory with a constant temperature between 20°C to 24°C. To determine the subjects' RBC count (x106/µl), Hct%, and Hb concentration ($g \cdot dl^{-1}$), fasting 10 ml blood samples were collected from the cubital vein using sterile plastic containers with anticoagulant (EDTA K3) incorporated in its walls (as suggested by previous studies) (16,17). In all cases, the same evaluator with extensive experience was in charge of the collection procedures. Analysis was determined by automated hematology analyzer's Sysmex XT-2000 (Sysmex Corp, Kobe, Japan). The Technical Error intra-rater measurement showed values lower than 1%.

Each player's height was measured in the laboratory with a stadiometer (Holtain) to the nearest 0.1 cm. Body mass was obtained with an accuracy of 0.1 kg with a calibrated scale (Tanita). Each subject was measured without clothes in the same state of hydration and nutrition (after urination). Four skinfold measurements were taken using a Lange skinfold caliper. The high pressure spring was checked according to the manufacturer's specifications. Measurements were taken at the triceps, sub-scapular, supra-iliac, and calf (mm). The anatomical points were identified and measured in accordance with the suggestions of Wilmore (40). Two measurements were taken from each anatomical point with the intention of checking the reliability of measuring intra-observer (CR reliability coefficient = 98.5%). The fat percentage was determined according to the formula of Siri (35): %CG = (495/DC) - 450. Body density was determined by the equation proposed by Petrosky (26), where: DC = 1.10726863 to 0.00081201 (Triceps + Sub-scapular + Supra-iliac + calf) + 0.00000212 (Triceps + Sub-scapular + Supra-iliac + calf)^2 - 0.00027884(age). The values of fat-free mass and fat mass were obtained from measurements of estimated body fat and total body mass.

To evaluate the Yo-Yo Intermittent Recovery Test (Yo-Yo IR2), the procedures suggested by Bangsbo (6,7) were used. The test consists of repeated 2 x 20 m running in one direction back and forth between the starting line. The running speed was increased and controlled by audio sounds that were emitted from a computer. Between each round, the subjects had a period of 10 secs of active rest, consisting in jogging 2 x 5 m. When the subjects did not pace themselves with the sound or failed to reach the goal in time, the distance traveled was recorded and that distance represented the result. For VO_2 max the following equation was used: VO_2 max ($mL \cdot kg^{-1} \cdot min^{-1}$) = IR2 distance (m) x 0.0136 + 45.3. Several research studies indicate (16,38) reasonable reproducibility of the IR2. However, it should be noted that a test that is exhaustive and includes psychological components may vary to the point of influencing the performance differently from one day to the next. Before performing the test, the subjects performed an appropriate warm-up for a period of 10 to 15 min using soccer shoes designed for natural grass. Throughout the test, the players were encouraged and motivated to perform to the best of their ability.

Statistical Analysis

All results are presented as means and standard deviations (mean ± SD) calculated by standard procedures unless otherwise noted. All calculations were performed using Microsoft Excel and SSPS 19 statistical software (Chicago, IL, USA). A One-Way analysis of variance (ANOVA) was used to examine changes in the mean values for each specific position of the players, and the Bonferroni adjustment for multiple comparisons. All data were normalized via Shapiro Wilks test. Statistical significance was set at $P<0.05$.

RESULTS

Table 1 shows the variables weight, height, % fat, fat mass, fat free mass and VO_{2max} that characterize the study sample. In Table 2 are observed variables of age, professional experience and hematological parameters RBC count, hematocrit and hemoglobin concentration. The results show no significant differences among playing positions in the five variables. Gatekeepers show slightly lower values of hematological parameters in relation to the other positions of play, although not significantly different.

Table 1. Anthropometric and Physiological Characteristics of the Subjects.

	Mean	±SD
Weight (kg)	78.9	6.1
Height (m)	179.4	6.9
Body Fat (%)	10.8	2.5
Fat Mass (kg)	8.7	2.6
Fat Free Mass (kg)	70.1	4.3
VO_2 max ($mL \cdot kg^{-1} \cdot min^{-1}$)	51.5	1.1

Table 2. Parameter Hematological of Elite Professional Soccer Players as a Function of Playing Position.

	N	**Age** (yrs)	**Experience** (yrs)	**RBC count** (x106/µl)	**Hct** (%)	**Hb** ($g \cdot dl^{-1}$)
Goalkeepers	5	23.7 ± 5.6	5.7 ± 4.6	4.9 ± 0.4	43.4 ± 3.3	14.1 ± 0.4
Side defenders	6	22.6 ± 2.6	5.0 ± 3.2	5.2 ± 0.3	45.4 ± 1.4	14.8 ± 0.5
Central defenders	6	26.0 ± 4.5	8.5 ± 4.2	5.1 ± 0.3	44.0 ± 1.7	14.6 ± 0.2
Central midfielders	8	25.6 ± 2.9	7.8 ± 2.3	5.1 ± 0.3	45.1 ± 3.7	14.7 ± 0.9
Side midfielders	6	25.0 ± 3.3	7.2 ± 3.9	5.1 ± 0.1	43.6 ± 1.1	14.2 ± 0.3
Attackers	7	24.3 ± 4.7	7.3 ± 4.9	5.3 ± 0.4	44.9 ± 1.9	14.6 ± 0.6
Total	38	24.6 ± 3.9	7.0 ± 3.9	5.1 ± 0.3	44.5 ± 2.4	14.5 ± 0.6

No significant difference ($P>0.05$).

DISCUSSION

The anthropometric variables and body composition fractionation (two components) of the football players of the present study are generally similar to those of other international studies (8,25,28,34) and show slight superiority in relation to national studies (32,33). However, with respect to age, the players of this study show lower values in relation to international studies (10,25,36). In turn, as to years of professional experience, several international studies (21,24) showed similar values to those found in the present study. Overall, these results confirm that some high level players are relatively homogeneous in terms of their morphological characteristics (5) with slight differences that could be attributed to techniques, procedures, and equipment used for anthropometric assessment, while not ruling out the possibility of ethnic and racial factors that could affect the body size and conditioning aspects of the players.

The present study investigated Brazilian professional soccer players because there was a lack of information regarding hematological parameters during the period of competition relative to playing position. In this sense, no significant differences in RBC, Hct, and Hb were observed when compared among the six playing positions: (a) goalkeepers; (b) side defenders; (c) central defenders; (d) central midfielders; (e) side midfielders; and (f) attackers. In fact, the goalkeepers showed a slight downward trend in hematological parameters in relation to players in other positions, although these differences were not significant. These results suggest that professional football players showed no significant differences in hematological parameters.

In general, studies using athletes in sports such as rugby (4,14) and similar sports (30) show surprisingly average values slightly higher than in the present study of footballers with an average RBC value of 5.1 ± 0.3 x106/µl, Hct of 44.5 ± 2.4%, and a Hb of 14.5 ± 0.6 $g{\cdot}dl^{-1}$. But, the values in the present study were similar to Serbian footballers (23) and Brazilian players (33). No doubt the hematological values across the studies are likely to differ according to the type and intensity of training, while not ruling out the possibility of variations in the testing techniques, equipment, and procedures.

Weight et al. (39), Schumacher et al. (30) and Mayr et al. (18) have made multiple attempts to establish reference values in samples of athletes. However, to date there is no consensus among researchers regarding hematological parameters in athletes of different sports and in positions within a sport. As a result, several studies have reported that the decrease in hemoglobin and hematocrit is a sign of physical exertion and heavy participation, especially in cycling, triathlon, and football (12,19,29). Thus, the decrease is evident in both endurance oriented sports and in sports that require both aerobic and anaerobic contributions to the energy supply for muscle contraction (1).

Hence, the stability of hematologic status indices in individual athletes depends on the administration of the training load (i.e., volume and intensity), since regular monitoring of hematological parameters in elite athletes during a season are seen as a possible occurrence of iron deficiency anemia (3). Given that the life expectancy of RBCs is in the range of 100 to 120 days (2,13), the measurement of hematological parameters can be carried out with a frequency of 4 months. In turn, indicators of hemoglobin and hematocrit are the variables that are directly related to the volume and intensity of training (31), and their reference ranges allow appropriate use (19) in athletes of different sports and in non-athletes as well. Analysis of these parameters should be considered during the assessment of athletes.

Interestingly, even though several studies (20,23,27) have reported a range of 11 to 15% of the players present with anemia over a season, none of the players in the present study was iron deficient. All the players had hemoglobin values >13.0 $g{\cdot}dl^{-1}$ (that is recommended by the World Health Organization) (41). This finding suggests that the players were subjected to an appropriate level of training intensity and duration while developing the technical, tactical, and physical skills to play well. In addition, it is likely that the players' diet and extra supplementation of nutrients helped to offset the deficits of iron.

Limitations

It is important to point out that this study did not attempt to control the type of food, nutrient supplementation, and the degree of hydration of the players. These variables may have led to a bias or lack of reliability in the results. In addition, the selection of the sample of accidental type (non-probabilistic) of players prevented generalization of the results to other considerations. In fact, we suggest that in future studies the assessment of hematological parameters should take place from a longitudinal perspective that should enable more specific and tighter control of the variables.

CONCLUSION

The results suggest that there were no statistically significant differences RBC, Hct, and Hb among the tested Brazilian professional soccer players according to specific playing positions. Also, the three measured hematologic parameters were within the range of normal values, thus demonstrating no cases of anemia among the footballers. It is assumed that these results could be due to the characteristics of the training program developed for players beginning the competitive period, although not ruling out the possibility of strict adherence to balanced diets or supplementation of nutrients by the players. Therefore, from the practical point of view, this information is relevant to the technical committees of football teams to help select and direct the workload during the competitive period.

Address for correspondence: Marco Cossio Bolaños: Av. Erico Verissimo 701. Cidade Universitária. CEP. 13083-851. Campinas, S.P. Brasil, Email: mcossio1972@hotmail.com

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