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Anthropometric, Functional, and Metabolic Profiles of Soccer Players

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ABSTRACT

Araújo SS, Mesquita TRR, Santos RM, Oliveira JEL, Alves ARA. Anthropometric, Functional, and Metabolic Profiles of Soccer Players. **JEPonline** 2012;15(6):37-48. The purpose of this study was to evaluate the functional, anthropometric, and metabolic profiles of 24 soccer players in pre-season Northeast Brazil 2nd division. The metabolic profile was determined from blood samples collected during fasting. Although the anthropometric data are consistent with that of the national players, aerobic power (VO_2 max 51.2 mL·kg^{-1}·min^{-1} ± 6.8) was lower. Anaerobic power (9.5 W·kg^{-1} ± 2.8) was close to the national mean, but anaerobic endurance was not. Urea, creatinine, albumin, and total protein were adequate when compared to similar athletes. The values for tissue injury enzymes, AST and ALT, were relatively high. The lipid profile values were consistent with the population references, but the athletes with an elevated lipid profile showed normal percent body fat (BF%). We concluded that the BF% is not a strong predictor of health alone.

Key Words: Football, Body Composition, Biomarkers, Physical Performance.

INTRODUCTION

The preparation for and the implementation of the stage known as the “pre-season” are based on an accurate control of anthropometric, physiological, psychophysical (i.e., mental preparation and motivation), and biochemical variables (10). As an example, Prado et al. (25) point out that advance knowledge of the anthropometric characteristics is important for establishing team goals, both immediate and long term. With an accurate player profile in hand, the coach can change the player’s position to one that is tailored to his/her morphology. Moreover, the coach can effectively design tactical specifics to help the team’s performance be more efficient.

Soccer demands a wide range of motor skills and various physical attributes that include anaerobic metabolism, aerobic power, agility, speed, and coordination that gives rise to a variety of training methods, Reilly, Bangsbo, and Franks (26) have argued that a high aerobic capacity (e.g., VO_2 max >60 $mL \cdot kg^{-1} \cdot min^{-1}$) is one of the major determinants of an athlete’s performance. In fact, on the field, cardiovascular effort can reach an intensity ranging from 80-90% of maximal heart rate at 70 to 80% of VO_2 max (3).

The serum concentrations of cellular metabolic markers change depending on the workload imposed, which can lead to tissue microdamage with a negative effect on physical performance. According to Monteiro et al. (22), the levels of serum enzymes such as alanine aminotransferase (ALT) and aspartate aminotransferase (AST) induced by strenuous exercise are an important indicator of tissue damage, inadequate recovery periods, and/or deficient nutrients. In regard to the latter factor, Guerra and colleagues (14) indicate that diet must be monitored, particularly since too much protein intake intensifies oxidation and increases fat (both of which promote the synthesis and excretion of urea).

Soccer performance depends mainly on cellular nutrients preventing the onset of fatigue (14). Thus, for the replenishment of ATP in skeletal muscle, carbohydrate and lipid oxidation are the dominant processes for providing energy. Ultimately, lipids are present in adipose tissue and muscle in the form of triglycerides (TG), high-density lipoprotein cholesterol (HDL-c), low density lipoprotein cholesterol (LDL-c) and very-low density lipoprotein cholesterol (VLDL-c). The verification of lipid indices according to Kokkinos and Fernhall (18) is essential, due to the strong relationship between serum lipoproteins and levels of physical activity.

Therefore, for soccer players, coached, and trainers, physiological and biochemical evaluations are important tools for controlling variations in the parameters related to the qualities inherent to the sport and the physical behavior of serum biomarkers that will later reflect athletic performance. In this context, the present study sought to evaluate the anthropometric, metabolic and functional profiles of players on a team affiliated with Division 2 of the 2009 pre-season Northeastern Brazilian Soccer Confederation. We also sought to relate body composition with lipid profile.

METHODS

Subjects

Twenty-four male professional soccer players (4 goalkeepers, 4 central defenders, 5 defensive midfielders, 5 side defenders, 3 midfielders, and 3 offensive players) participated in this study. The players were evaluated during the pre-season (pre-competitive) period. The athletes were informed of the procedures and, then, they signed a consent form. This study was approved by the Ethics in Research Committee of University Tiradentes-Sergipe, Brazil (N. 211211) according to the declaration of Helsinki.

Procedures

Anthropometric Assessment

Initially, the subjects were evaluated for their anthropometric parameters (Table 1). Body mass (BM) was measured with a digital scale (Plenna, mod. Wind), height was measured with a portable stadiometer (WSC, mod. WOOD), and body fat percentage was measured with skinfold calipers (Cescorf). These procedures, as described in Heyward and Stolarczyk (15), were recommended and validated by the International Society for the Advancement of Kinanthropometry. Body mass index (BMI) was measured by weight (W, in kg) and height (H, in m). Body fat percentage (BF%) was determined by the Faulkner equation, which is based on the triceps, suprailiac, subscapular, and abdominal skinfold measurements (15).

Running-based Anaerobic Sprint Test (RAST)

To determine anaerobic power, the Zacharogiannis, Paradisis and Tziortzis (35) elaborated test was used. The RAST consisted of six 35-meter sprints at maximum speed with 10-sec passive recovery periods between each sprint. From the data collected, the following variables were determined: peak power (PP, in watts$\cdot$kg^{-1}), mean power (MP, in watts$\cdot$kg^{-1}) and fatigue index (FI, in %).

20 m Shuttle-Run Test

To quantify cardiorespiratory fitness, we measured the subjects' progressive and maximum running performance. The subjects were divided into groups of 6, and each group ran at ~1-min stages of increasing speed, beginning at 8.5 km$\cdot$h^{-1} and increasing in 0.5-km$\cdot$h^{-1} increments (for a total of 21 stages). Each stage comprised of 7-15 laps of 20 m each. The stages were marked by a tone, and the test ended when the subject failed to maintain the pace. Completing the last stage was required in order to obtain the relative VO_2 max (mL$\cdot$kg$^{-1}\cdot$min^{-1}) and maximal aerobic speed, vVO_2 (km$\cdot$h^{-1}) as described by Léger et al. (19).

Blood Collection and Analysis

The subjects were instructed to fast for 8 hr. The subjects were also requested to state that they were not using any drugs or ergogenic substances. At 7:00 a.m., blood was drawn from the antecubital vein and placed in 5-ml vacuum tubes (Vacuette); the whole-blood samples were separated by centrifugation, and the plasma fractions were immediately frozen and stored for later analysis in a Bio-200L spectrophotometer (Bioplus). Plasma total cholesterol (TC), HDL-c and TG concentrations were measured with enzymatic colorimetric enzymatic kits (Katal Biotecnológica Ind. Com. Ltda., Belo Horizonte, Brazil). The LDL-c and VLDL-c concentrations were calculated using the following equations (12):

Equation 1: LDL-c = TC – (HDL-c + VLDL-c)
Equation 2: VLDL-c = TG/5

We measured urea (UR) concentration enzymatically, with the commercial Urea UV PP kit (cat. 416, Gold Analisa Diagnostica Ltda.) in accordance with the manufacturer's specifications. Total protein (TP) was measured by colorimetry with the K031 kit (Bioclin). Albumin (ALB) was measured by colorimetric method with bromocresol green, according Westgard et al. (34). The enzymes alanine aminotranferease (ALT) and aspartate aminotransferase (AST) were measured by the decreasing UV kinetic method (5), and creatinine (CRE) was measured by Labtest method (27). The glomerular filtration rate (GFR) was estimated using the following equation (7):

Equation 3: GFR = (140-age) x BM/72 x Creatinine.

Where age is in yrs, BM is in kg and creatinine is in mg$\cdot$dL^{-1}.

Statistical Analyses

The data were analyzed using descriptive statistics. We calculated the mean and standard deviation (SD), considering minimum and maximum values in a confidence interval of 95% (CI 95%), to estimate the accuracy of the parameters being analyzed. The Kolmogorov-Smirnov test was used to test for normal distribution of the data. We calculated Pearson's correlation coefficients between the abnormal serum lipid levels and body fat percentage. Differences with $p<0.05$ were considered to be significant.

RESULTS

Anthropometric and body composition characteristics, although presenting normality in the distribution curve, highlights the BM with a wide variability, when checked the minimum and maximum limits (Table 1).

Table 1. Anthropometric Characteristics of the Football Players.

			CI (95%)	
	Mean	**SD**	**Min**	**Max**
Age (yrs)	25.0	4.4	23.1	26.9
Body mass (kg)	76.7	9.9	72.5	80.9
Height (m)	1.79	0.1	1.76	1.81
Body mass index ($kg \cdot m^{-2}$)	24.0	2.2	23.1	24.9
Body fat (%)	11.9	2.9	10.7	13.2

SD = Data are expressed as mean.

Table 2 shows the anthropometric variables of several studies conducted in Brazil with football players either in the pre-season or during the competition season. For comparison with this study, the data shown are homogeneous in the cases presented, and identical to those of players of this Northeastern team.

Table 2. Anthropometric Characteristics of Football Players in Brazilian Studies.

Study	N	Age	Body mass	Height	Body Fat %	BMI
Balikian et al. (4)	25	22.1 (8.3)	76.1 (9.8)	1.79 (0.07)	12.2 (3.7)	N.D.
Pellegrinotti et al. (18)	25	23.8 (3.2)	76.6 (6.5)	1.79 (0.06)	10.7 (1.4)	N.D.
Daros et al. (19)	230	< 21	73.7 (6.4)	1.78 (0.06)	N.D.	23.1 (1.6)
Fonseca et al. (20)	25	22.7 (4.4)	73.9 (6.6)	1.78 (0.06)	9.4 (2.3)	N.D.
Casajús (21)	15	25.8 (3.2)	78.6 (6.6)	1.80 (0.1)	8.6 (0.9)	N.D.

The values are means with SD in parentheses; N.D. = not determined.

Table 3 lists the physical qualities of the soccer players in this study during the pre-season. The anaerobic physical values (PP, MP, and FI) had higher variability than the aerobic values (VO_2 max and vVO_2); a condition that suggests that the latter values are relatively homogenous within our subjects. The results revealed poor anaerobic performance compared with other studies (4). Yet, in contrast, aerobic performance was within the average range for soccer players (10).

Table 3. Values for Power, Anaerobic Endurance and Cardiorespiratory Fitness in 24 Soccer Players during the Pre-Season.

			CI (95%)	
	Mean	**SD**	**Min**	**Max**
Peak Power	9.5	2.8	8.9	9.7
Mean Power	5.8	1.9	7.1	7.8
Fatigue Index	37.3	7.7	34.0	40.5
VO_2 max	51.2	6.8	49.7	53.2
vVO_2	16.8	4.1	12.4	12.9

SD = Data are expressed as mean; VO_{2max} = Maximal Oxygen Uptake; vVO_2 = Velocity associated with VO_{2max}.

Table 4 shows the results of the biochemical tests, which include: a lipid profile comprised of serum TC, TG, HDL-c, LDL-c and VLDL-c; metabolic wastes and renal function, comprised of urea (UR), creatinine (CRE) and glomerular filtration rate (GFR); and protein metabolism and enzyme activity, comprised of total protein (TP), albumin (ALB), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and the AST/ALT ratio. These biochemical markers are highly sensitive to the volume and intensity of training over the season. Thus, the values will vary during the season, which reflects changes in morphology, metabolism and body mass in response to changes in the training process. An examination of the results in Table 4 shows that, even in this early stage in the training cycle, our research group was highly heterogeneous, showing wide variety.

Table 4. Results of Biochemical Tests in 24 Soccer Players in the Pre-Season.

			CI (95%)	
	Mean	**SD**	**Min**	**Max**
TC ($mg \cdot dL^{-1}$)	177.2	40.5	160.1	194.3
TG ($mg \cdot dL^{-1}$)	94.5	60.3	69.1	120.0
HDL-c ($mg \cdot dL^{-1}$)	58.2	13.7	52.4	64.0
LDL-c ($mg \cdot dL^{-1}$)	100.1	35.2	85.2	115.0
VLDL-c ($mg \cdot dL^{-1}$)	18.9	12.1	13.8	24.0
UR ($mg \cdot dL^{-1}$)	35.0	7.5	31.8	38.2
CRE ($mg \cdot dL^{-1}$)	0.90	0.1	0.9	1.0
GFR ($mL \cdot min^{-1}$)	136.2	19.3	128.1	144.4
TP ($g \cdot dL^{-1}$)	7.0	0.4	6.9	7.2
ALB ($g \cdot dL^{-1}$)	4.1	0.1	4.0	4.1
AST ($U \cdot L^{-1}$)	37.2	14.8	31.0	43.5
ALT ($U \cdot L^{-1}$)	39.2	21.7	30.1	48.4
AST/ALT	1.01	0.2	0.9	1.1

SD: Data are expressed as mean; TC = Total Cholesterol; TG = Triglycerides; HDL-c = High-density Lipoprotein Cholesterol; LDL-c = Low-density Lipoprotein Cholesterol; VLDL-c = Very Low-density Lipoprotein Cholesterol; UR = Urea; CRE = Creatinine; GFR = Glomerular Filtration Rate; TP = Total Protein; ALB = Albumin; AST = Aspartate Aminotransferase; ALT = Alanine Aminotranferase.

Although the body fat levels of the subjects were within the normal range for the general population, there was a high prevalence of high total cholesterol and fractional components, including LDL-c, TG, and VLDL-c (Table 5). These results are striking, as they constitute important risk factors for coronary heart disease and show a correlation between the lipid parameters and BF% for these athletes.

Table 5. Number of Players with Scores Above or Below the Reference Values with Regard to Total and Fractional Cholesterol Levels and Their Pearson Correlation with BF%.

Threshold	N	Prevalence (%)	Body Fat %	Pearson
TC (>200 $mg \cdot dL^{-1}$)	7	29.2	14.5 (2.4)	0.73
TG (>150 $mg \cdot dL^{-1}$)	4	16.7	12.0 (3.1)	-0.53
HDL-c (<40 $mg \cdot dL^{-1}$)	1	4.2	14.8 (0.0)	0.19
LDL-c (>120 $mg \cdot dL^{-1}$)	5	20.8	15.1 (2.8)	0.10
VLDL-c (>40 $mg \cdot dL^{-1}$)	2	8.3	11.3 (1.9)	0.90*

*P<0.05; TC = Total Cholesterol; TG = Triglycerides Lipoprotein Cholesterol; HDL-c = High-density Lipoprotein Cholesterol; LDL-c = Low-density Lipoprotein Cholesterol; VLDL-c = Very Low-density Lipoprotein Cholesterol.

DISCUSSION

The purpose of this study was to determine the physiological and metabolic profiles and, then, to characterize the body composition of the professional soccer players from a 2009 pre-season Northeastern Second Division soccer team of the Brazilian championship.

Body composition

While certain morphological and physiological characteristics are more appropriate for the professional athlete versus the non-professional athlete, it is essential that the morphological features fall within a specific range for the successful execution of the various motor tasks required for high-level performance (13). Clearly, the results of this study of 24 soccer players are consistent with studies conducted at the national and international level (Table 2). These studies include Balikian et al. (3), who studied professional athletes in the 2nd division of the S. Paulo soccer championship; Pellegrinotti et al. (24) who examined professional, junior, and youth players; Daros et al. (9), who evaluated professional players; Fonseca et al. (11), who studied professionals in the Rio Grande do Sul championship; and Casajús (6), who investigated 15 male soccer players from the Spanish First Division (La Liga). Moreover, the above studies, as well as the present study reported BF% data that were in line with required standards (8-12%) (23).

However, it is important to appreciate that optimum values are difficult to define. Apparently this is due primarily to the use of different methodologies by the investigators. Yet, there is a consistent relationship between characteristics and the position that the player takes in the field. According to Casajús (6), these differences are highlighted when considering the different categories and levels of performance also emphasizes that a soccer player's typical body composition is characterized by a muscular make up, and whose morphological configuration is nearer to that of sprinters. Gil et al. (13) considered the players' maturity and genetic predisposition to be essential to dimorphism between groups of similar age.

Aerobic Variables

VO_2 max is an important limiting factor of high-level aerobic performance (24). Aerobic metabolism is the primary energy system in soccer (26) and, therefore, is highly important to a player's recovery during a game. An examination of the VO_2 max values measured in our subjects compared to values reported by other groups verify the importance of this variable between professional and amateur players. Santos (29) studied 84 Porto players (Portugal) and found that 2nd division players had VO_2 max and vVO_2 values of 53.8 ± 3.0 $mL \cdot kg^{-1} \cdot min^{-1}$, and 18.3 $km \cdot h^{-1}$, respectively. Although higher than those of the present study (Table 2), VO_2 max values were significantly lower than for division 1 athletes. Casajús (6) reported high values (i.e., VO_2 max of 65.5 ± 8.0 $mL \cdot kg^{-1} \cdot min^{-1}$ and vVO_2 of 16.1 ± 1.4 $km \cdot h^{-1}$), which were higher than the various studies, including the current study. Neither age nor playing category was a predominant factor, given that Asano, Bartolomeu-Neto, and Oliveira Júnior (2) reported VO_2 max values of 57.8 ± 7.6 $mL \cdot kg^{-1} \cdot min^{-1}$ in pre-season players under 18 yrs of age. Professional players in Parana, Osiecki, and colleagues (23) found VO_2 max and vVO_2 values of 62.7 ± 2.6 $mL \cdot kg^{-1} \cdot min^{-1}$ and 17.7 ± 0.7 $km \cdot h^{-1}$, respectively.

Aoki (1) proposed an appropriate range for VO_2 max of 55 and 60 $mL \cdot kg^{-1} \cdot min^{-1}$. However, it is important to point out that these values are consistent with those found in players from national teams, including the German runner-up team of 1982 (29), who averaged 59.5 ± 5.4 $mL \cdot kg^{-1} \cdot min^{-1}$. Ekblom (10) proposed values between 65 and 67 $mL \cdot kg^{-1} \cdot min^{-1}$ to be ideal for an efficient soccer player. These disparate results demonstrate the variability in the degree of aerobic fitness among players as well as the difficulties in defining control parameters for training. Santos (29), reported variability of VO_2 max based on specialization in the field. However, Reilly, Bangsbo, and Franks (26) believe it possible to design training programs in the zone of intensity for increasing VO_2 max without harming the skills relevant to sport, especially speed and anaerobic power.

Anaerobic Variables

The explosive, active nature of soccer (e.g., heading the ball, jumping, fighting for the ball, and sprinting) requires the recruitment of fast-switch muscle fibers, which uses lactic and alactic anaerobic metabolism. For this energy system, the Wingate test is considered the gold standard for comparing the performance of anaerobic athletes in various sports (35). However, the predominant movements used in this test have almost none of the specificity of the movements used in soccer. The RAST test, in addition to being applicable to the motor movements of soccer, offers information about control indicators, including peak anaerobic power (PP), mean power (MP), and minimum power, which can be expressed in absolute terms (as watts) or normalized (as $watts \cdot kg^{-1}$) to the players' body mass (32). In this sense, anaerobic endurance was assessed by the capacity to perform the tasks required by the test.

The anaerobic variables (PP, MP, and FI) of the subjects were below the range of professional athletes (Table 3). As observed by Pellegrinotti et al. (24), with professional football player belonging to the Rio Branco Sport Club Americana, 12.1 ± 1.2 $W \cdot kg^{-1}$, 10.4 ± 0.9 $W \cdot kg^{-1}$, and 27.0% ± 8.1. Spigolon et al. (32), with professional players of the XV de Novembro Sport Club Piracicaba, had a performance of 13.8 ± 1.2 $W \cdot kg^{-1}$, 9.3 ± 1.0 $W \cdot kg^{-1}$, and 32.4% ± 4.1. Cunha et al. (8) studied professionals of the 2nd division of the São Paulo soccer championship using the Wingate test and found values of 11.4 ± 0.7 $W \cdot kg^{-1}$, 8.4 ± 0.7 $W \cdot kg^{-1}$ and 42.6% ± 7.7. High mean power ensures that the athlete can perform well during high-intensity activity, which is needed in a competitive soccer match. It is evident that, in practice, the motor skills of soccer players are not higher than those of other athletes, as these skills require physical qualities that enable the performance of the technical movements and skills required by the sport. Thus, data regarding anaerobic variables are important for planning and monitoring training and should be targeted to the efficiency of energy systems, including muscular ATP-phosphocreatine (ATP-PC) and glycolysis (lactic).

Metabolic Waste and Renal Function

According to Bangsbo (4), muscle glycogen stores decline after a soccer game and especially during the week of training. Additionally, Prado et al. (25) reported that players have poor diets that do not include the necessary main macronutrients. Thus, protein catabolism is initiated, and the body begins to metabolize proteins in the gluconeogenesis. According to Machado et al. (21), this increased intake of amino acids leads to the synthesis of ammonia, which is metabolized by the liver to produce urea, a soluble metabolite that can be excreted by the kidneys.

The subjects' UR, CRE, and GFR values in the present (Table 4) are in line with those reported in the literature, as well as with reference values for the non-athlete population. In Brazilian professional soccer, Machado et al. (21) found UR and CRE values of 90.0 ± 9.0 $mg \cdot dL^{-1}$ and 3.6 ±1.8 $mg \cdot dL^{-1}$, respectively. These values are substantially higher than the values in the present study. According to authors (21), it is postulated that return to training leads proteolysis and amino acid oxidation.

A team affiliated with the São Paulo Soccer Federation was measured during season (30) and were found to have the following serum values at the beginning, middle, and end of the season, respectively, UR: 21.17 ±4.35 $mg \cdot dL^{-1}$, 19.49 ± 5.09 $mg \cdot dL^{-1}$, and 22.19 ± 5.66 $mg \cdot dL^{-1}$; CRE: 1.14 ± 0.31 $mg \cdot dL^{-1}$, 1.24 ± 0.26 $mg \cdot dL^{-1}$, and 1.54 ± 0.52 $mg \cdot dL^{-1}$; GFR: 119.92 ± 28.38 $mL \cdot min^{-1}$, 99.98 ± 26.18 $mL \cdot min^{-1}$, and 84.36 ± 25.29 $mL \cdot min^{-1}$. These results reveal changes in these metabolites and renal function as the season advanced, which may be due to the burden of training and competition as well as increased protein intake (21). The competitive level of the athlete is also a relevant factor. This was demonstrated by the work of Monteiro, Bassini, and Cameron (22), who found higher CRE and UR levels in a 1st division soccer team compared to players of a 3rd division team.

Enzyme Activity and Plasma Proteins

It is well established that a combination of intense training and poor diet will alter the athlete's serum biochemical profile and, in particular, the enzymes that are elevated with tissue injury, including AST and ALT (22). In the subjects in the present study, these enzymes were at the upper limit of adult reference values (Table 4). They are also above the average for patients with heart failure reported in a study by Vasconcelos, Almeida, and Bachur (33). Because these enzymes are not organ-specific, the elevated serum levels may reflect damage to various tissues, including skeletal muscle, liver, heart, and kidney.

The AST/ALT ratio is used to diagnose various liver diseases. A ratio below 1.0 can indicate acute viral hepatitis; whereas, other hepatocellular diseases cause the ratio to go above 1.0 (33). However, the magnitude of changes in the AST/ALT ratio is not conclusive for diagnosing liver or muscle damage, as their respective enzyme concentrations can be conditioned to factors such as age, level of physical activity, and diet (20). Compared to the players studied by Monteiro, Bassini, and Cameron (22), the AST and ALT values found in the present study are considerably higher. These findings reinforce the need for diagnostic evaluations as a prevention factor and health monitoring, as well as the need to adapt the workload to the athlete, especially at the beginning of the season.

According to Lemon (20), intense training increases the excretion of nitrogen, which, when coupled with low protein and energy (carbohydrates) intake, leads to a negative nitrogen balance. ALB, TP and UR are among the analyses associated with this condition. In the current study, these biomarkers analyzed were in accordance with the standard for the general population. As albumin constitutes about 5% of the amino acids available to the tissues, its deficiency enhances the decomposition of liver proteins (28). According to Monteiro, Bassini, and Cameron (22), the deficiency is a reflection of poor diet and physical recovery. Thus, in consideration of the subjects in the present study who were measured in the pre-season, this condition may compromise the upcoming full season.

Circulating Lipids

The analysis of circulating lipids in the subjects revealed that they are within the range of the general population (Table 4). However, athletes with TC, TG, HDL-c, LDL-c, and VLDL-c values (Table 5) out of the reference criteria nonetheless had a BF% within the population mean (15). This finding is important in that it reinforces the need for differential evaluation of these parameters. In fact, in athletes, the level of exercise has a significant impact on lipids and lipoprotein levels. According to Kelley and Kelley (16), who suggested a negative correlation exists between physical performance and high levels of TC, TG, VLDL-c, and LDL-c, (and who proposed further increases in HDL-c values) indicate that the exercise loads during different periods of fitness influence the adipocytes and intramuscular store of lipids.

It has been reported that soccer training provides positive effects on the blood lipid profile in all its fractions (17). Such effects may be seen acutely, as reported by Sotiropoulos et al. (31), who found values below those of the present study before a game (TC, 155.9 ± 17.8 $mg{\cdot}dl^{-1}$, TG 67.7 ± 14.7 $mg{\cdot}dl^{-1}$, HDL-c 48.5 ± 11.1 $mg{\cdot}dl^{-1}$, LDL-c 88.4 ± 16.4 $mg{\cdot}dl^{-1}$), and significant decrease at the end of a match (TC, 144.5 ± 16.7 $mg{\cdot}dl^{-1}$, TG, 60.6 ± 16.6 $mg{\cdot}dl^{-1}$, HDL-c, 54.1 ± 7.5 $mg{\cdot}dl^{-1}$, LDL-c, 78.0 ± 14.9 $mg{\cdot}dl^{-1}$). This highlights the beneficial effects of exercise on lipoprotein metabolism. Because these effects generate changes in homocysteine, fibrinogen, LDL-c particle size, and C-reactive protein, they are considered a strong indicator of coronary artery disease (18).

CONCLUSIONS

These data highlight the need for regular monitoring of serum lipid concentrations in soccer players as an essential measure for optimizing their health and enhancing their physical performance. The anthropometric values of a small team in the Brazilian northeast were similar to the national average. Compared with the published studies, the players in our study had a widely varying aerobic capacity. With regard to anaerobic endurance, the players had values below the expected range. With respect to renal function, the values were within normal limits (as was the transferase enzyme activity), although some athletes in the group had levels as high as patients with heart failure. With respect to lipid metabolism, the subjects fell within normal limits. However, we observed a high prevalence of borderline values for both total cholesterol and its fractions. We found that BF% is not a good predictor of health patterns in these athletes. Our study reiterates the importance of performing this type of evaluation and repeating it throughout the season, preferably by a multidisciplinary team of professionals.

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REFERENCES

1. Aoki MS. ***Fisiologia, treinamento e nutrição aplicados ao futebol.*** Jundiaí: Fontoura, 2002.

2. Asano RY, Bartolomeu Neto J, Oliveira Júnior HP. Avaliação das potências aeróbia e anaeróbia em jogadores de futebol da categoria sub 18. ***Revista Cereus.*** 2009;1(1):1-10.

3. Balikian P, Lourenção A, Ribeiro LFP, Festuccia WTL, Neiva CM. Consumo máximo de oxigênio e limiar anaeróbio de jogadores de futebol: comparação entre as diferentes posições. ***Revista Brasilera de Medicina do Esporte.*** 2002;8(2):32-36. DOI: 10.1590/S1517-86922002000200002.

4. Bangsbo J. Quantification of anaerobic energy production during intense exercise. ***Medicine and Science in Sports and Exercise.*** 1998;30:47-52.

5. Bergmeyer HU, Hørder MR, Rej R. IFCC methods for the measurement of catalytic concentration of enzymes. ***Journal of Clinical Chemistry and Clinical Biochemistry.*** 1885;24(7):481-495.

6. Casajús JA. Seasonal variation in fitness variables in professional soccer players. ***Journal of Sports Medicine and Physical Fitness.*** 2001;41:463-469.

7. Cockcroft DW, Gault MH. Prediction of creatinine clearance from serum creatinine. ***Nephron.*** 1976;16:31-41.

8. Cunha LA, Balikian Júnior P, Silvério-Netto JE, Freitas IF, Picarro IC. Variáveis fisiológicas anaeróbias de futebolistas em diferentes níveis competitivos. **Revista *Brasileira de Educação Física, Esporte, Lazer e Dança.*** 2008;3(2):29-38.

9. Daros LB, Osiecki R, Dourado AC, Stanganélli LCR, Fornaziero AM, Frisseli A. Análise comparativa das características antropométricas e de velocidade em atletas de futebol de diferentes categorias. ***Revista de Educação Física.*** 2008;19:93-100.

10. Ekblom B. Applied physiology of soccer. ***Sports Medicine.*** 1986;3(1):50-60.

11. Fonseca PH, Fuke K, Leal DB, Marins JCB. Antropometria de atletas profissionais de futebol: calculando o percentual de gordura. ***Caderno de Educação Física.*** 2008;7(12):9-14.

12. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. ***Clinical Chemistry.*** 1972;18:499-502.

13. Gil SM, Gil J, Ruiz F, Irazusta A, Irazusta J. Anthropometrical characteristics and somatotype of young soccer players and their comparison with the general population. ***Biology of Sport.*** 2010;27:17-24.

14. Guerra I, Soares EA, Burini RC. Aspectos nutricionais do futebol competitivo. ***Revista Brasileira de Medicina do Esporte.*** 2001;7(6):200-206. DOI: 10.1590/S1517-86922001000600003.

15. Heyward V, Stolarczyk LM. ***Avaliação da composição corporal aplicada.*** São Paulo: Manole, 2000.

16. Kelley GA, Kelley KS. Impact of progressive resistance training on lipids and lipoproteins in adults: a meta-analysis of randomized controlled trials. ***Preventive Medicine.*** 2009;48:9-19. DOI:10.1016/j.physletb.2003.10.071.

17. Knoepfli-Lenzin C, Sennhauser C, Toigo M, Boutellier U, Bangsbo J, Krustrup P, Junge A, Dvorak J. Effects of a 12-week intervention period with football and running for habitually active men with mild hypertension. ***Scandinavian Journal of Medicine and Science Sports.*** 2010;20(S1):72-79. DOI: 10.1111/j.1600-0838.2009.01089.x

18. Kokkinos PF, Fernhall B. Physical activity and high density lipoprotein cholesterol levels: what is the relationship? ***Sports Medicine.*** 1999;28:307-314.

19. Léger LA, Mercier D, Gadoury C, Lambert J. The multistage 20-meter shuttle run test for aerobic fitness. ***Journal of Sports Sciences.*** 1988;6:93-101.

20. Lemon PWR. Beyond the zone: protein needs of active individuals. ***Journal of the American College of Nutrition.*** 2000;19(5):513S–521S.

21. Machado M, Sampaio-Jorge F, Dias N, Knifis FW. Effect of oral creatine supplementation in soccer players metabolism. ***Revista Internacional de ciências Del Deporte.*** 2008;4(10):44-58.

22. Monteiro AN, Bassini A, Cameron LC. Perfil hematológico e de reservas de macronutrientes em jogadores de futebol em fase de pré-temporada. ***Fitness Performance Journal.*** 2006;5:129-133.

23. Osiecki R, Glir FG, Fornaziero AM, Cunha RC, Dourado AC. Parâmetros antropométricos e fisiológicos de atletas profissionais de futebol. ***Revista de Educação Física.*** 2007;18(2):177-182.

24. Pellegrinotti IL, Daniel JF, Cielo FBL, Cavaglieri CR, Bartolomeu Neto J, Montebelo MIL, et al. Análise da potência anaeróbia de jogadores de futebol de três categorias, por meio do Teste de Velocidade Para Potência Anaeróbia (TVPA) do Running Based Anaerobic Sprint Test (RAST). ***Arquivos em Movimento.*** 2008;6:3-15.

25. Prado WL, Botero JP, Guerra RLF, Rodrigues CL, Cuvello LC, Dâmaso AR. Perfil antropométrico e ingestão de macronutrientes em atletas profissionais brasileiros de futebol, de acordo com suas posições. ***Revista Brasileira de Medicina do Esporte.*** 2006;12(2):61-65. DOI: 10.1590/S1517-86922006000200001.

26. Reilly T, Bangsbo J, Franks A. Anthropometric and physiological predispositions for elite soccer. ***Journal of Sports Sciences.*** 2000;18(9):669-683.

27. Roscoe MH. The estimation of creatinine in serum. ***Journal of Clinical Pathology.*** 1953;6:201-207.

28. Santos NSJ, Draibe SA, Kamimura MA, Cuppari L. Albumina sérica como marcador nutricional de pacientes em hemodiálise. ***Revista de Nutrição.*** 2004;17(3):339-349. DOI: 10.1590/S1415-52732004000300007.

29. Santos JAR. Estudo comparativo, fisiológico, antropométrico e motor entre futebolistas de diferente nível competitivo. ***Revista Paulista de Educação Física.*** 1999;13(2):146-159.

30. Silva ASR, Santhiago V, Papoti M, Gobatto CA. Comportamento das concentrações séricas e urinárias de creatinina e uréia ao longo de uma periodização desenvolvida em futebolistas profissionais: relações com a taxa de filtração glomerular. ***Revista Brasileira de Medicina do Esporte.*** 2006;12(6):327-332. DOI: 10.1590/S1517-86922006000600006.

31. Sotiropoulos A, Papapanagiotou A, Souglis A, Giosos G, Kotsis G, Bogdanis GC. Changes in hormonal and lipid profile after a soccer match in male amateur players. ***Serbian Journal of Sports Sciences.*** 2008;2(1-4):31-36.

32. Spigolon LMP, Borin JP, Leite GS, Padovani CRP. Potência anaeróbia em atletas de futebol de campo: diferenças entre categorias. ***Coleção Pesquisa em Educação Física.*** 2007;6:421-428.

33. Vasconcelos LABA, Almeida EA, Bachur LF. Avaliação clínica e laboratorial hepática em indivíduos com insuficiência cardíaca congestiva. ***Arquivos Brasileiros de Cardiologia.*** 2007;88(5): 590-595. DOI: 10.1590/S0066-782X2007000500015.

34. Westgard JO, Barry PL, Hunt MR, Groth T. A multi-rule Shewhart chart for quality control in clinical chemistry. ***Clinical Chemistry.*** *1981;*27:493-501.

35. Zacharogiannis E, Paradisis G, Tziortzis S. An evaluation of tests of anaerobic power and capacity. ***Medicine and Science in Sports and Exercise.*** 2004;36(5):S116**.**