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BIOCHEMICAL AND MINERAL PARAMETERS IN SOCCER ATHLETES

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ABSTRACT

The main objective of the study was to evaluate the changes in the biochemical and mineral parameters in soccer athletes of the first state division of Mato Grosso do Sul, Brazil. One hundred male volunteers aged between 18 and 35 years participated in the research divided into experimental group and control group. The analytical determinations of glucose, total, LDL and HDL cholesterol, triglycerides, magnesium, calcium and phosphorus were conducted in accordance with the recommendations of the Brazilian Society of Cardiology. The anthropometric data were needed to establish possible correlations with the corresponding biochemical characteristics. The characteristics of lipid metabolism and glucose were lower ($p < 0.05$) for athletes, although within the range of acceptable values for both groups. The levels of magnesium and phosphorus were higher for the experimental group ($p < 0.05$). The calcium content did not show statistical differences between groups. It was concluded that from the physiological and biochemical points of view the indicators obtained for athletes are more advantageous as compared with healthy individuals with sedentary way of life.

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INTRODUCTION

It is accepted that exercise training, when practiced on a regular basis, is vital for a healthy condition, acting as a non-pharmacological tool and/or preventing numerous illnesses. However, the non-regular exercise may exceed the endogenous antioxidant system's capacity, provoking serious injuries related to oxidative stress (Bastos and Silva, 2012). Brazilian athletes' dietary habits are of a lower carbohydrate and protein ingestion, accompanied by a tendency to hyperlipidic food (Prado *et al.*, 2006). Adding to this, there are nutritional inadequacies, which may lead to anthropometric differences among the players and their tactical positions. As for the main variables, it is assumed elsewhere (Ferreira and Melnikov) that due to the daily training and the proper structure of nutrition, athletes can maintain their biochemical and nutritional parameters within limits considered healthy.

Generally, these parameters have a positive correlation with anthropometric measurements which, in turn, depend on the metabolism energy. Physiological adaptation in response to the physical training is highly specific to the nature of the training activity. As for the minerals involved in the metabolic processes, special attention is paid to sodium, magnesium, calcium and phosphorus contents (Driessens and Verbeeck, 2000). Soccer is an example of endurance exercise because of the length of the matches and it is known for its dynamism involving anaerobic and aerobic bursts of high intensity. Thus, it may happen that soccer athletes change their specific profile of normality, including biochemical and minerals changes (Railley, 2007). The aim of this study is to evaluate the changes in the biochemical and mineral parameters in active soccer athletes in the state of Mato Grosso do Sul (Brazil).

MATERIALS AND METHODS

This is a cross-sectional observational analytic study type with a quantitative approach. It was approved by the Ethics Committee on Human Research of the Federal University of Mato Grosso do Sul (CEP / UFMS) (Protocol 1168). Written informed consent was obtained from all participants. One hundred male volunteers aged between 18 and 35 years participated in the research, divided into two groups:

- Experimental group (ATH) included 50 soccer players, which regularly compete for the state championship of Mato Grosso do Sul. Training frequency was a minimum five times a week for at least 60 minutes. No interruptions exceeding seven consecutive days in the last three months were admitted.
- Control group (CON) was formed by 50 healthy university students. They were classified as individuals who had moderate and/or vigorous physical activity for less than 150 minutes per week. This selection has been made on the basis of the International Physical Activity Questionnaire recommendations – IPAQ (Craig *et al.*, 2003).
- The following anthropometric characteristics were taken into consideration: body mass, height, body mass index (BMI) and body fat percentage (BF). The level of physical activity was given by practice time during week training.

The biochemical evaluations were carried out in accordance with the recommendations of the Brazilian Society of Cardiology (Brazilian Society of Cardiology, 2013). Blood samples were collected in polypropylene syringes by a trained professional and immediately transferred to vacuum tubes free of trace elements (BD Vacutainer Systems-Becton, Dickinson & Co). Serum was separated by centrifugation (3.000×g, 15 min), transferred to demineralized Eppendorf tubes and stored at -18°C for later analytical determinations. These were carried out in a Clinical laboratory of the University School of Medicine. As for statistical analysis, means and standard deviation (SD) were calculated. After confirming the parametric character of the data, the comparison between the experimental and control groups was carried out using the Student's test. The value *p* adopted for the calculations was ≤ 0.05. Data were processed using the software BioEstat 5.0.

RESULTS

The CON group showed a mean age value of 23.5 ± 3.7 years, while a weekly average of physical activity, performed only sporadically, was 48 min. The data for the ATL group are presented in Table 1. The body mass index calculated on the basis of mean body weight (70.6 ± 7.2 kg) and height (1.8 ± 0.1 m) was 22.9 kg/m², the value fitting to athletic performance (Reilly *et al.*, 2000) of 18.5 – 24.9 kg/m² established for healthy subjects (World Health Organization, 2007). As for the percentage body fat, its values were in excellent accordance with the recommendations by the American College of Sports Medicine – ACSM (American College of Sports Medicine, 2014). The weekly average of physical activity, performed periodically, was 24.8±9.3 hours. Soccer players showed statistical significant lower values for total cholesterol, LDL cholesterol and triglycerides, while HDL cholesterol was higher when compared to non-

athletes group. As for magnesium and calcium, their average values matched the data for healthy subjects, and phosphorus levels were shown to be slightly lower. The differences between both groups are presented in Table 2.

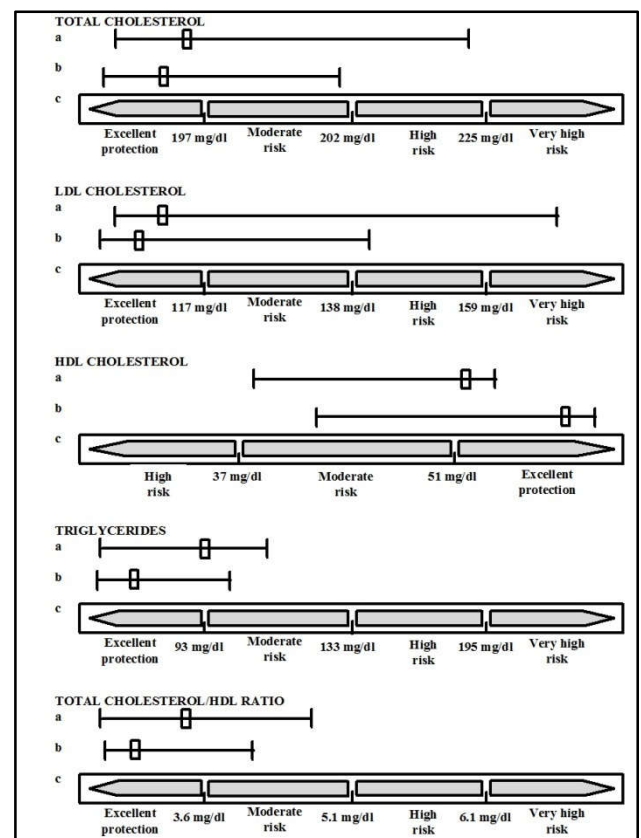
Table 1. Descriptive characteristics of soccer players performing at Campo Grande MS, Brazil (n = 50)

| Characteristics | Mean (±SD) | Minimum and maximum |
|--|------------|---------------------|
| Age (years) | 22.3±3.7 | [18–35] |
| Weekly training (hours) | 24.8±9.3 | [22.3–27.1] |
| Body weight (kg) | 70.6±7.2 | [57.2–88.4] |
| Height (m) | 1.8±0.1 | [1.62–1.91] |
| Body mass index (kg / m ²) | 22.9±1.9 | [18.7–26.7] |
| Body fat (%) | 10.5±3.2 | [6.2–20.6] |

Table 2. Biochemical and mineral data (mean±SD) of soccer players compared with the control group (n = 100)

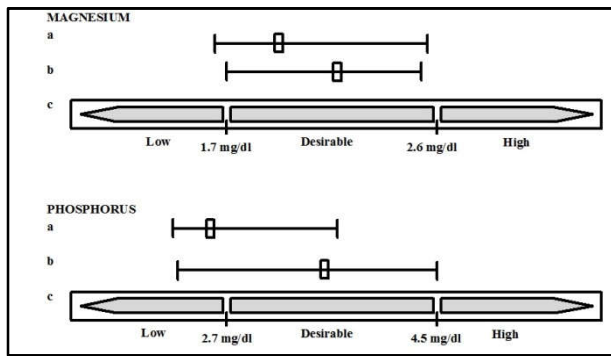
| Variable | Athletes (n=50) | Control (n=50) | <i>p</i> -value |
|-----------------------------|-----------------|----------------|-----------------|
| Biochemistry (mg/dl) | | | |
| Glucose | 85.6±7.6 | 87.5±7.8 | 0.0971 |
| Total cholesterol | 152.6±17.7 | 165.9±25.6 | 0.0244 |
| LDL cholesterol | 86.4±14.6 | 99.2±18.4 | 0.0196 |
| HDL cholesterol | 68.3±5.6 | 52.2±9.7 | 0.0151 |
| Triglycerides | 77.0±10.4 | 92.8±14.7 | <0.0001 |
| Minerals (mg/dl) | | | |
| Magnesium | 2.1±0.2 | 1.9±0.2 | <0.0001 |
| Calcium | 9.4±0.4 | 9.4±0.3 | 0.1188 |
| Phosphorus | 3.5±0.6 | 2.3±0.5 | <0.0001 |

The graphical illustration of these differences are given in Figures 1 and 2.



(*) a – CON group; b – ATL group; c – reference scale (Fischbach and Dunning, 2015).

Figure 1. Comparison of lipids levels^(*) (minimum, maximum and mean) for control and experimental groups



(*) a – CON group; b – ATL group; c – reference scale (Fischbach and Dunning, 2015).

Figure 2. Comparison of magnesium and phosphorus levels^(*) (minimum, maximum and mean) for control and experimental groups

DISCUSSION

As can be seen from Table 1, our experimental group of 50 individuals consisted of young adult players whose anthropometric characteristics were within the range of accepted values (Rienzi *et al.*, 2000; Silva *et al.*, 2003; Chamari *et al.*, 2004; Kelly and Drust, 2008). So from the statistical point of view the cohort were statistically comparable with the healthy individuals characterized elsewhere. It is known that glucose is a very important substrate consumed during a soccer match, mainly for its ability to provide energy with a limited number of biochemical pathways. Thus fast glycolysis (McArdle, 2006) is a major factor in this variety of sport performance which includes fast sprints and efficient kickings. It was suggested (Iaia and Bangsbo, 2010) that the soccer match would always demand higher levels of glucose, because of hepatic and muscle glycogen mobilization during training or matches. However, in accordance to the other sources (Degoutte *et al.*, 2004; Oliveira *et al.*, 2010), glucose concentrations might be also kept unaltered, which is confirmed in the present study (Table 2).

The main parameters of lipid metabolism for both groups are also within the range of acceptable values (Fischbach and Dunning, 2015). Nevertheless one important point seems worth considering: there is a statistically significant difference between the experimental and control groups. Moreover, the indicators of the soccer players' lipid metabolism are more favorable from the physiological and biochemical point of view (Kenney *et al.*, 2012). In another words, these data show that a less active way of life works to the disadvantage of the individuals pertaining to control group, with a possible risk for future metabolism disorders (World Health Organization, 2007; Kahn and Valdez, 2003). The cholesterol-to-HDL ratio provides more information than does either value alone. The higher the cholesterol-to-HDL ratio, the greater the risk for cardiomyopathies (Fischbach and Dunning, 2015). In our study the average values obtained were 3.2 mg/dl for CON group and 2.2 mg/dl for ATH group, respectively, both of which can be classified as providing excellent biochemical protection (Barter *et al.*, 2007). The average calcium levels were similar in both groups, despite the fact that soccer players regularly perform during longer periods of physical exercises. It is possible, therefore, that the change in concentration of this electrolyte could occur acutely, that is, during or immediately after completion of physical exertion and leaving no

permanent metabolic alterations in sportsman's body, as observed elsewhere (Meludu *et al.*, 2002). Thus, this may also be explained by efficient calcium homeostasis control system (Rodwell *et al.*, 2015). As one could anticipate from its being the most abundant cytosolic divalent cation, magnesium interferes with muscle contraction-excitation phenomena, and the activity of the calcium transport system through the sarcoplasmic reticulum membranes depending on the presence of these ions (Nica *et al.*, 2015). Besides, this element binds strongly to nucleoside di- and triphosphates such as ADP and ATP and is therefore directly involved in almost all reactions related to power generation and energy transfer (Crichton, 2008). Moreover, in the phosphorylation processes magnesium-ATP complex is usually the donor of the phosphoryl group.

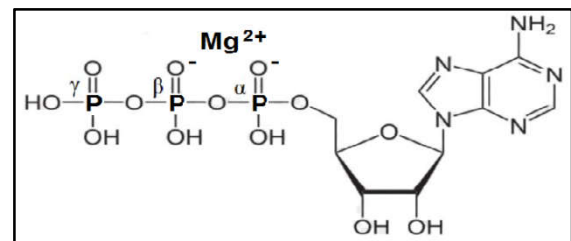


Figure 3. Schematic representation of Mg²⁺- ATP complex

The schematic representation of transition Mg²⁺- ATP complex (Fig. 3) shows that to form a bidentate bond, involving α and β phosphorus through oxygen atoms, one mole of magnesium and one mole of ATP must be simultaneously available. Since humans, and especially athletes, are energy-dependent on ATP it is quite logical that magnesium and phosphorus levels grow in parallel, as follows from the results of this research: 10.5% increment for magnesium and 52.2% for phosphorus.

Conclusion

It was shown that the main parameters of lipid metabolism and glucose are within the range of acceptable values. Since magnesium binds strongly to nucleoside di- and triphosphates such as ADP and ATP, and is directly related to power generation and energy transfer processes, plasmatic levels of this element and phosphorus grow in parallel ensuring a better preparation and resistance of soccer players. The average calcium levels in both groups practically the same.

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