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IRON STATUS IN ELITE SOCCER PLAYERS DURING THE SPORT SEASON

Michailidis, Y

Department of Physical Education and Sport Sciences, Democritus University of Thrace, Komotini, Greece

ABSTRACT

Introduction: The aim of the study was to investigate the changes of some indicators of iron status in elite soccer players throughout a competitive season. **Methods:** The study sample population included 16 male professional soccer players (age 27.00 ± 4.76; wt 77.91 ± 6.72 kg; ht 1.80 ± 0.08 m; BMI 24.06 ± 1.60; % body fat 10.14 ± 1.97 %; fat free mass 69.33 ± 6.12 kg). Measurements were performed at the beginning of the season, after the re-building period, at the middle, and at the end of the season. The indicators that were measured included: hematocrit, hemoglobin, serum iron, and ferritin. **Results:** Hematocrit and serum iron decreased significantly during the season ($p < 0.05$). Ferritin decreased after the re-building period ($p < 0.05$) and then increased at the end of the season ($p < 0.05$). Hemoglobin didn't change significantly ($p > 0.05$). **Conclusion:** Iron depletion is very common in elite soccer players. This study shows that ferritin may be related to the training phase during the sport season.

Keywords: energy soccer, ferritin, hemoglobin, hematocrit, iron depletion

INTRODUCTION

Soccer is one of the most popular sports in the world. Millions of people participate in soccer games at varying levels of competence and across every nation in the world. It is fact that cardiorespiratory endurance is a basic ability of the soccer players because at top level they covered almost 10-12 Km (1).

Aerobic capacity is the maximum capacity of an individuals' body to transport and use oxygen during incremental exercise, which reflects the physical fitness of the individual. As seen from the definition, it depends on several biological systems such as oxygen uptake, transport and consumption. Iron plays an important role in these mechanisms and is therefore necessary for a team's medical staff to regularly check and monitor iron levels in professional soccer players (2,3) .

However, there is no sole, reliable biochemical indicator that is consistently diagnostic of iron deficiency except the bone marrow iron aspirates. Intuitively, combining several iron status indicators provides the best assessment of iron status. While there are several indicators for estimation of iron, each can be indicative of different things. The concentration of hemoglobin is related to a player's ability to uptake atmospheric oxygen into the lungs and for carrying it to the tissues. The iron concentration in serum provides information about the amount of iron that is available to be banded by the tissues. The total iron binding capacity indicates how much total iron can transfer serum. The transferrin saturation is an indication of how saturated the transport system is; while the concentration of ferritin reflects the quantity of stored iron within tissues (4).

An athletes' training can affect the amount of iron in their bodies (5,6) and consequently their aerobic capacity. For this reason, it is necessary to measure an athlete's iron status in regular phases.

The objective of this study was to investigate the changes of the status of iron in the blood of professional soccer players during a season.

METHODS

Subjects

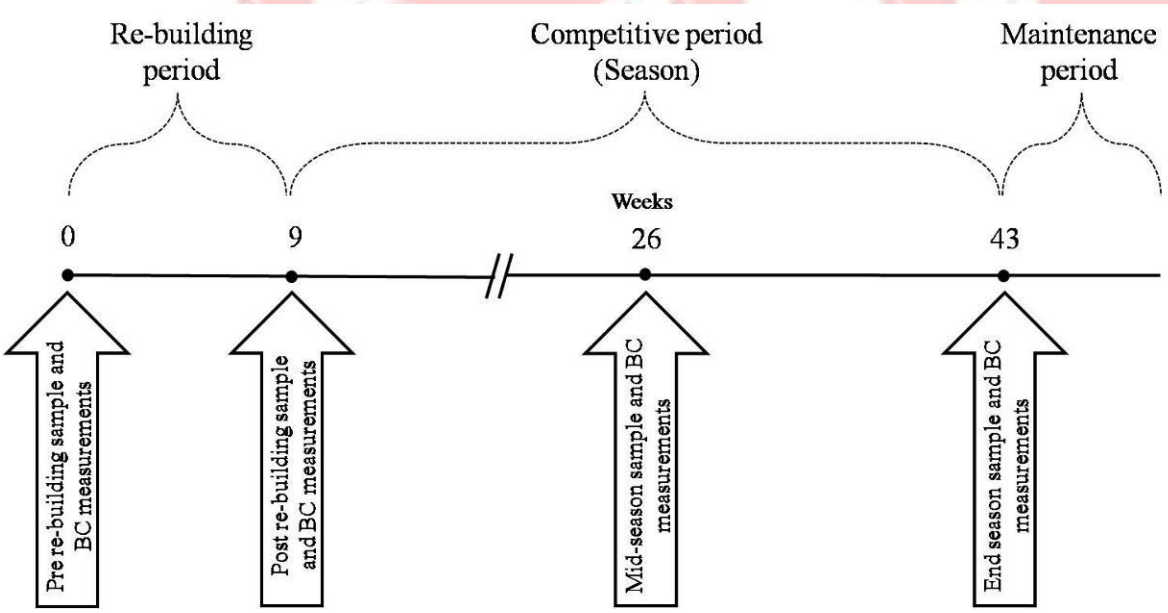
The study sample consisted of 16 senior professional soccer players that had each participated in at least 3 years at first division of Greek League. After receiving a detailed explanation of the study's benefits and risks, each subject signed an informed consent document that was approved by the local ethics committee. Physical and physiologic characteristics of the participants are presented in Table I. On average players trained 6 times per week and participated in up to 35 competitive matches in a season. All the test measures (anthopometric and hematologic) were performed before the beginning of re-building period, just after the re-building period, at the middle of the season, and at the end of the season (Figure 1). The sampling collections were performed 24 h after each of the different matches, at 8:00 AM, in fasting state.

Table 1. Physical characteristics

Parameter	Mean ± SD
Age (years)	27.00 ± 4.76
Body mass (Kg)	77.91 ± 6.72
Height (m)	1.80 ± 0.08
BMI	24.06 ± 1.60
%BF	10.14 ± 1.97
FFM (Kg)	69.33 ± 6.12

BMI-body mass index; % BF- % body fat; FFM- fat free mass

Figure 1. – Procedure of sampling and anthropometric measurements.



Note: BC - Body Composition.

Anthropometrics

Body mass was measured to the nearest 0.1 kg (BC-418 Segmental Body Composition Analyzer, Tanita, Japan) with subjects barefooted, only wearing their underclothes. Body fat percentage (BF%) was calculated from 7 skinfold measures (average of 2 measurements of each site) using a Harpenden calliper (John Bull, British Indicators, St Albans, United Kingdom) on the right side of the body as described by Jackson and Pollock (1978) (7). Fat free mass (FFM) values were obtained from the measures of estimated body fat and body mass. Standing height was measured to the nearest 0.1 cm (Stadiometer 208, Seca).

Blood collection, Hematocrit, Hemoglobin, Serum Iron, and Ferritin measurements

Blood samples (8 ml) were drawn via venipuncture using a safety butterfly needle from an antecubital arm vein, with each participant always in a semirecumbent position. Blood was collected into vacutainer tubes containing SST-Gel and Clot Activator. Blood was allowed to clot at room temperature and subsequently centrifuged (1.500 g, 4^{o}C, 15 min) to promote serum separation. The resulting serum was used for ferritin and serum iron (Fe) measurements. Samples were stored and frozen at -75^{o}C until analyzed.

Hematocrit and hemoglobin concentrations were measured in a Sysmex K-1000 (Kobe, Japan) autoanalyzer. Ferritin was determined using enzyme immunoassay kits from DRG (Marburg, Germany) in an Anthos 2000 (Salzburg, Austria) photometer and the same photometer was used for determination of serum iron. Each parameter was determined on a single day in order to eliminate inter-assay variability.

Iron depletion, iron deficiency, and iron deficiency anemia (IDA) were defined according to population references for iron status measures in males (8,9,10) .

Statistical analysis

Data normality was verified with the One-sample Kolmogorov-Smirnov test; therefore, a nonparametric test was not necessary. Data were analyzed through one-way repeated measures analysis of variance (ANOVA) to examine changes in mean values of hormones over the course of the soccer season. When a significant effect was found, post hoc analysis was performed using the Bonferroni test. The level of significance was set at $p \leq 0.05$. The data were analyzed using the statistical package SPSS, PC program, version 13 (SPSS Inc., USA).

RESULTS

The statistical analyses for hematocrit demonstrated differences ($F_{3,45} = 3.390$, $p < 0.05$) between the 4 measurements. Hematocrit decreased significantly at the end of the season (-3.02 %). The statistical difference observed between the measurements at the end of the season with all the other measurements was also significant ($p < 0.05$). Figure 2 presents the changes at the value of hematocrit.

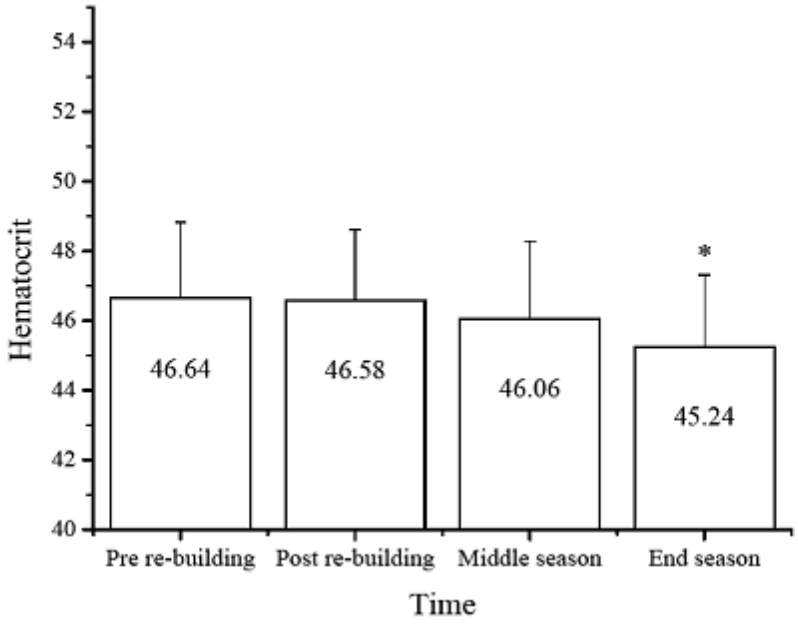
No significant differences were revealed by ANOVA for hemoglobin ($F_{3,45}=1.333$, $p>0.05$) and the changes presented in Figure 3.

Significant differences in serum iron (Fe) concentration were found by ANOVA ($F_{3,45} = 4.399$, $p < 0.01$). Serum iron concentration decreased after the re-building period for 24.4 % and at the end of the season for 17.35 %. Also at the middle of the season Fe concentrations were less than the beginning values (-9.80 %). The changes of Fe concentration are presented in Figure 4.

According to the results obtained in ANOVA, ferritin concentration showed significant changes along the season ($F_{3,45} = 18.621$, $p < 0.001$). The value of ferritin at the end of the season differed significantly with all the other measurements ($p < 0.05$). Also significant differences were found between the measurements after and before the re-building period and at the middle of the season ($p < 0.01$ and $p < 0.05$, respectively). The beginning value 126.55 decreased 17.6 % at the second measurement, then increased but remained less than the first measurement (-6.62) and at the end of the season increased 17.19 % above the beginning value. Figure 5 presents the changes at the concentration of ferritin.

The percentages of players with iron depletion and iron deficiency in each of the measurements are presented in Figure 6. None of the players presented with anemia during the season.

Figure 2. Hematocrit value.



* Significant difference with all the other measurements

Figure 3. Hemoglobin concentration.

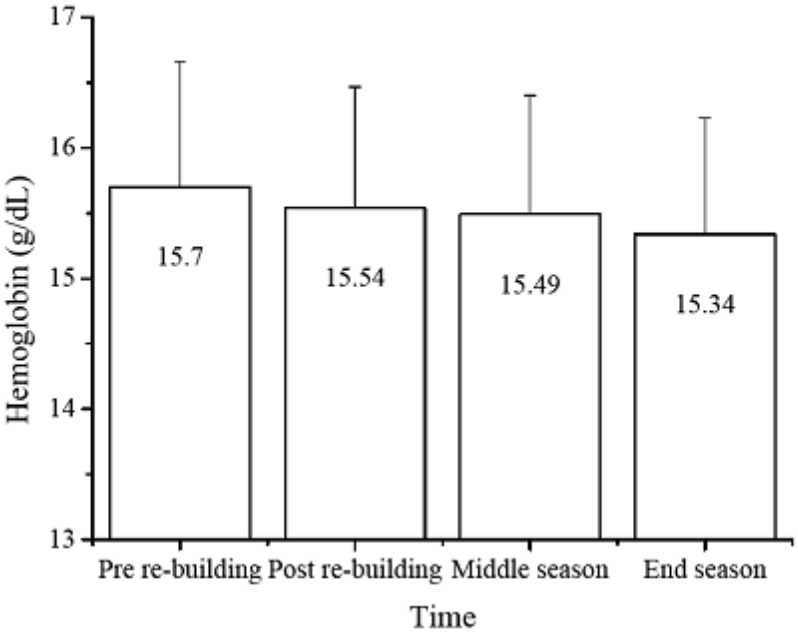
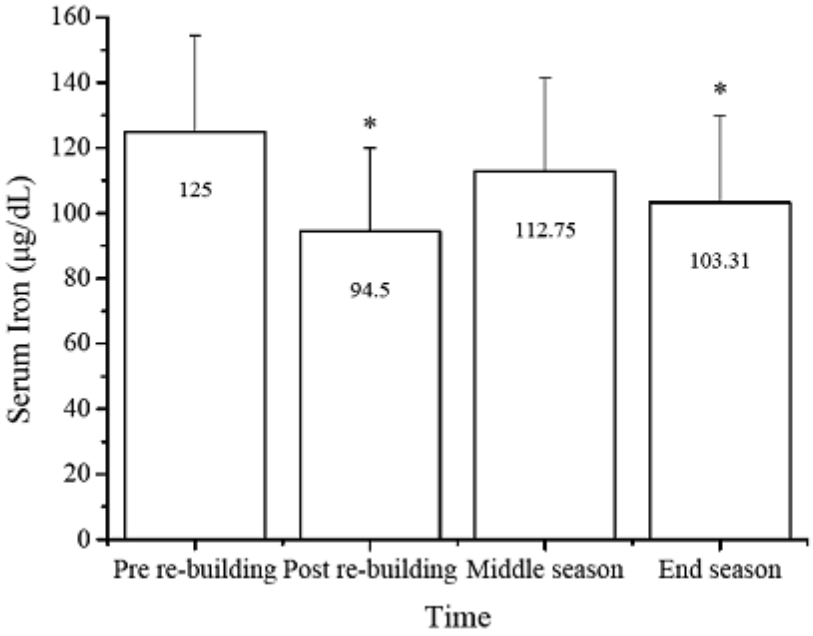
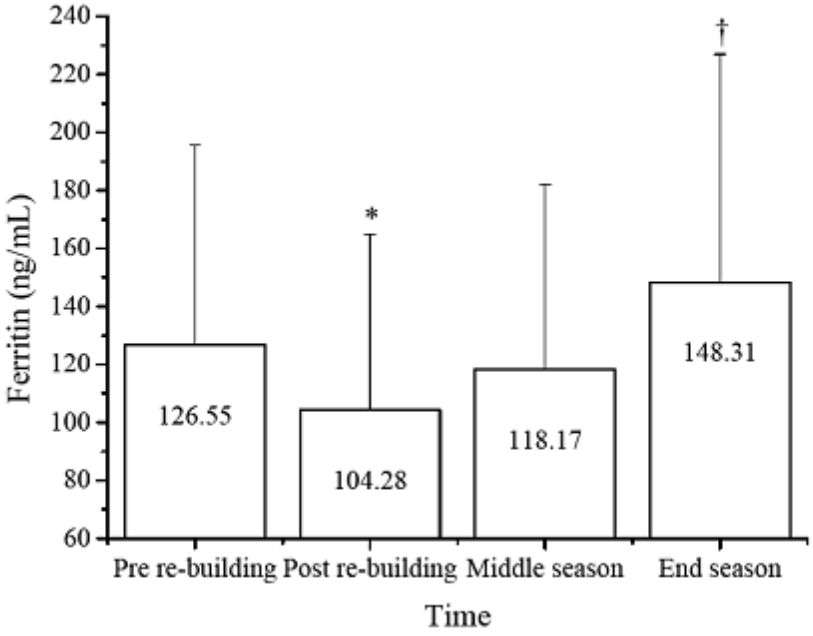


Figure 4. Serum Iron concentration.



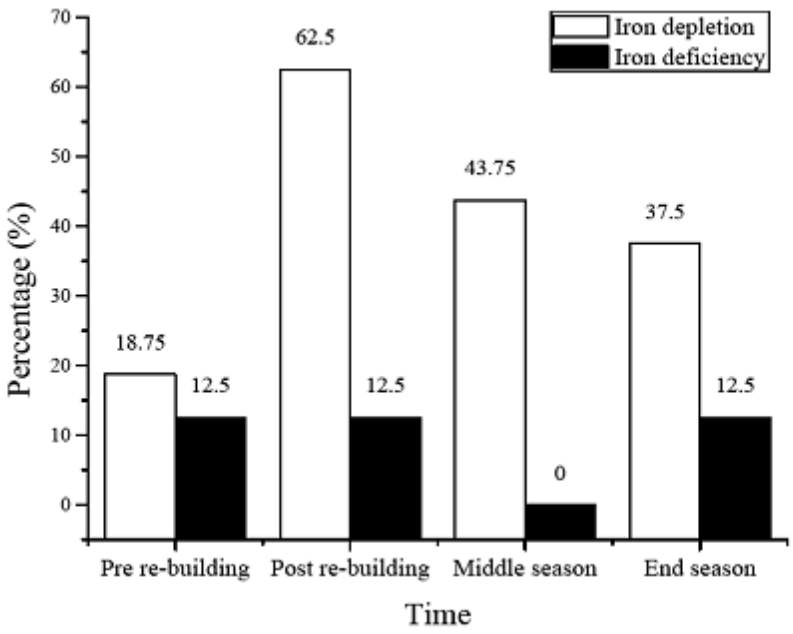
* Significant difference with the measurement Pre re-building

Figure 5. Ferritin concentration



* Significant difference with all the other measurements.
† Significant difference with Pre re-building and middle season measurements.

Figure 6. Percentages of iron depletion and iron deficiency among the players.



DISCUSSION

Iron deficiency in athletes can occur in several ways. When an athlete runs the pressure at the capillaries of the sole can lead to breakage of the erythrocyte membrane. After that the hemoglobin loses the ability to uptake and transfer oxygen4. Furthermore, it has been reported that athletes can exhibit increased losses of erythrocytes through the gastrointestinal tube (6). The above reasons necessitate regular monitoring of athletes to guard against lack of iron that can lead to iron deficiency or anemia (11).

In the present study, hematocrit decreased gradually during the season reaching the largest decrease at the end of the season. This change in hematocrit reflects the high intensity effort of players during play and during racing activities. These findings are consistent with reports from other investigations (12,13). However, a rate of decrease in hematocrit may be due to the phenomenon of aimataraiosis seen in endurance athletes with increasing plasma volumes (14).

Hemoglobin was observed with a decreasing trend during the season but the changes were not found statistically significant. Even after the period of preparation, the concentration was not significantly affected. Similar findings were reported by Ostojic and Ahmetovic (2008) (15). However, in the literature there are studies that show significant reduction in hemoglobin during the season (12). The lack of significant differences in the present investigation may be due to the limited sample compared with the study of Malcovatti et al. (2003) (12). Also factors such as diet and characteristics of training can influence the hemoglobin values (15).

Serum iron decreased during the season with the smallest value observed immediately after the re-building period. This finding is likely related to the increased volume of training and the diet of each player. Reduction

in levels of this parameter is similar to that reported by Malcovatti et al. (2003) (12). It should be noted that this variable can be changed quickly and intensely.

Finally, the concentration of ferritin decreased immediately after the re-building period. Then gradually increased and at the end of the season ferritin concentration was above the beginning value. These changes in the parameter may indicate a strong relationship between ferritin and the training phase. The decline in concentration may also be associated with the volume of training. In the literature a decrease in ferritin after intense training was also reported by Malcovati et al. (2003) (12).

The iron deficiency is one of the most common nutritional deficiencies in athletes, especially in endurance sports (2,16). In this study the percentage of soccer players with iron deficiency was 12.5%; while the larger percentage of iron depletion appeared after the preparation period at 62.5%. Resina et al. (1991) (17) reported that approximately 15% of elite players are diagnosed with iron depletion. Additional in this study some soccer players diagnosed with iron deficiency before the re-building period, suggesting an unbalanced diet by them.

Because iron deficiency is a common problem of the elite soccer players, they should regularly monitor with blood tests. Also the players have to be educated by a dietitian, how to make a balance diet.

This study results suggest a large proportion of professional soccer players have with iron depletion. Moreover, with the exception of hemoglobin that showed a downward trend, the other three indicators changed significantly during the season with ferritin seemingly related to the training phase.

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