*short report*
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# EVALUATION OF ERYTHROPOIETIN IN ENDURANCE RUNNERS

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**ABSTRACT**

**To evaluate the role of erythropoietin (Epo) in the erythroid abnormalities often found in athletes, Epo was evaluated by radioimmunoassay in endurance runners (ER). In a first study, 46 experienced ER, 11 with iron deficiency (ID group), were studied during a training period. In ID and non-ID runners, serum Epo (SEpo) levels were similar to sedentary controls (ID= 19.1±4.9 U/L, non-ID= 19.7±5.5 U/L and controls 19.7±9.2 U/L). In a second study, serum and urine erythropoietin (UEpo) levels were evaluated in 17 ER during a 6-hour race. Samples were taken before the race (pre-race), immediately following (6-hour) and 4 days after (post-race). No differences were observed in SEpo levels (pre-race= 19.8±4.1 U/L, 6-hour=21.2±4.9 U/L and post-race =21±4 U/L), but UEpo increased following the race (pre-race=15.4±9.6 U/L, 6-hour=26.1±6.2 U/L and post-race=14.1±6.5 U/L)(p< 0.0001) and this UEpo increase was related to urine creatinine changes (rs=0.79, p< 0.00001). In conclusion, SEpo in ER does not differ from sedentary values and does not vary with competition; however, UEpo increases during a long-distance race. These data may be important for a correct evaluation of Epo abusers and sports anemia.**

*Key words: sports anemia, erythropoietin, exercise, exercise-induced anemia*



Sports anemia should be singled out from among the hematological abnormalities observed in long-distance runners, although other sports may also induce similar changes. Several etiopathologic mechanisms are involved in sports anemia, such as hemolysis and iron deficiency.[1]

Erythropoietin (Epo) is believed to be the main regulator of erythropoiesis.[2] Investigation of Epo physiology in athletes should therefore provide further knowledge about the physiopathology of sports anemia. Recombinant Epo is available for treatment, and misuse of Epo could boost athletic performance by increasing the amount of erythroid cells.[3]

In the present work, variations in serum and urine Epo were evaluated in well-trained endurance runners.

## *Materials and Methods*

### *Subjects*

*Study I (Table 1).* A prospective study was performed in 46 endurance runners (ER) during a training period. Eleven (7 men and 4 women) had iron deficiency (ID group) (serum ferritin < or equal to 13 $\mu$g/L in females and 33 $\mu$g/L in males). In 11 cases without ID an 18-month follow-up study was carried out.

*Study II.* During a 6-hour race, erythropoietin and other variables were evaluated before (pre-race sample), immediately after (6-hour sample) and 4 days after the competition (post-race sample) in 17 healthy ER (15 men and 2 women, aged from 22 to 62 years, training 65-100 km/week).

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*Methods*

In Study I, serum Epo (SEpo) levels were compared among the ID group, the non-ID group and reference controls (72 healthy sedentary people). In Study II, SEpo, urine Epo (UEpo) and urine creatinine levels were evaluated. Changes in albumin concentrations were used to calculate plasma volume.[4] Urine Epo and SEpo were determined by a commercial radioimmunoassay (Epotrac, Incstar, Stillwater, MN, USA).

*Statistical methods*

A variance analysis (for paired or non-paired data) was carried out to compare the different groups. The relationship between UEpo and urine creatinine was studied by Spearman´s test.

Table 1. Characteristics of long distance runners.

| | total | no ID | ID |
|---|---|---|---|
| No. | 46 | 35 | 11 |
| Distance (km/week) | 107±28<br>60-190 | 107±30<br>60-190 | 106.8±23<br>75-160 |
| Age (years) | 34.2±7.5<br>25-49 | 33.7±8<br>25-46 | 35.2±6.4<br>32-49 |
| Hb (g/dL) | 14.2±1.0<br>12.0-15.8 | 14.3±9.0<br>12.4-15.8 | 13.6±1.1<br>12.0-15.4 |
| SEp (U/L) | 19.7±5.5<br>11-34 | 19.1±4.9<br>11-34 | 21.7±7<br>11-32 |

SEp: Serum erythropoietin. Results are expressed as mean±standard deviation, maximum and minimum values.

***Results***

*Study I.* The SEpo of both the ID and non-ID athletes was within the range observed in sedentary people (SEpo 19.7±9.2, 6.5-34 U/L) (Table 1). In the follow-up study, there was no significant change in either SEpo or Hb.

*Study II.* A non-significant difference in SEpo could be demonstrated in both the 6-hour and the post-race samples (p= 0.34, Table 2). Changes in plasma volume (96±4%, 87-101%) and variations in SEpo were not related (rs= –0.14, p=0.6).

A significant variation in UEpo was demonstrated (p<0.0001), and UEpo increased in the 6-hour sample (p<0.05). A positive relationship between UEpo and urine creatinine was also found (rs= 0.79, p<0.00001) (Figure 1).

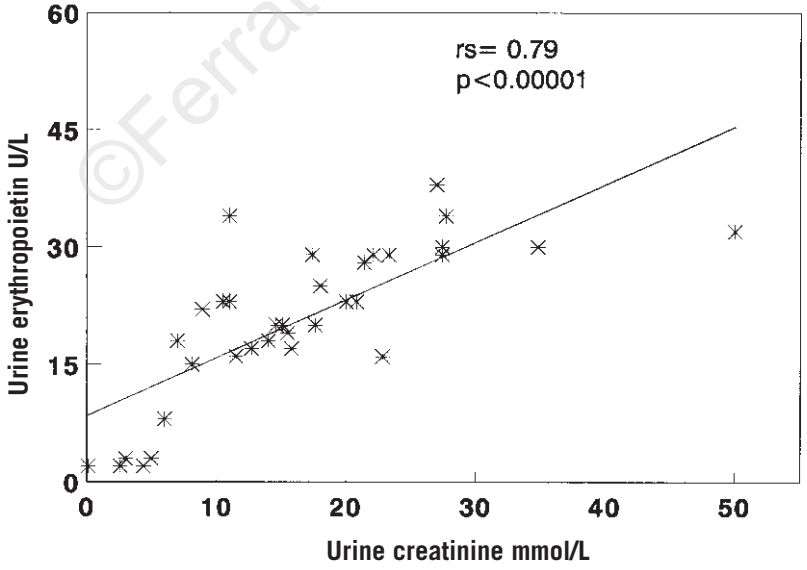


Figure 1. Correlation between urine erythropoietin and creatinine.

Table 2. Changes in serum and urine erythropoietin levels during a 6-hour race.

| | pre-race | 6-hr | post-race |
|---|---|---|---|
| No. | 17 | 17 | 17 |
| SEp (U/L) | 19.8±4.1 14-29 | 21.2±4.9 16-34 | 21±4 15-30 |
| UEp (U/L) | 15.4±9.6 2-34 | 26.1±6.2 16-38 | 14.1±6.5 2-27 |
| Urine creatinine (mmol/L) | 9±5.7 0.1-23.3 | 23.5±8.7 14.6-50 | — |

SEp: Serum erythropoietin; UEp: urine erythropoietin; Post-race: 4-day post-race check. Results are expressed as mean±standard deviation, maximum and minimum values.

### *Discussion*

In the present work, changes in UEpo and SEpo were studied in ER. Serum Epo did not change either during the training period or in a follow-up study. In addition, there were no significant changes in SEpo before or after a 6-hour run. However, UEpo increased and a relationship with urine creatinine was demonstrated. Runners with iron deficiency had SEpo similar to non-ID runners, but none presented severe anemia.[2]

Studies in sportsmen have shown variable results in relation to modifications in Epo. During training, SEpo in ER was the same as in sedentary healthy controls, as seen in our study and those of others.[5-7] However, SEpo was not similar in all athletes. For instance, SEpo levels were higher in endurance skiers and runners than in swimmers and canoeists.[6]

Erythropoietin changes in endurance athletes habe not been extensively studied during competition. Some authors found a significant increase after running,[7,8] while others[5,6] reported SEpo levels to be unchanged or decreased after blood reinfusion.[9] In spite of this, when all studies are evaluated together, any increase in SEpo after long-distance running seems to be almost negligible.

Changes in UEpo during competition are obviously of interest for identifying Epo misusers. We demonstrated a moderate increase in UEpo in long-distance runners which is related to the rise found in urine creatinine.[10] Urinary increases in Epo and creatinine may be explained either by an increase in glomerular filtration or by changes in renal secretory properties.

In conclusion, SEpo levels in ER are similar to reference sedentary controls. On the other hand, UEpo increases after an endurance race, and this rise is probably due to renal abnormalities related to long-lasting exercise.



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