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Letter-to- the Editor

Hemoglobin and hematocrit during an 8 day mountainbike race: A field study

Dear Editor-in-Chief

Considering the fact that mountainbike (MTB) marathon and ultraendurance events also as MTB stage races have become very popular during the last decade knowledge is sparse about the effects on hematological system due to prolonged strenuous exercise. Endurance trained athletes generally show an increased blood volume mainly due to plasma volume (PV) expansion, which already exerts after a few days of prolonged exercise, accompanied by lower hemoglobin (Hb) and hematocrit (Hct) levels. On a short term basis dehydration caused by prolonged exertive exercise leads to enhanced concentrations of Hb and Hct due to decreased PV. In contrast to acute exercise it has been well documented as a long term adaptation that regular endurance training over long term periods or repeated bouts of strenuous exercise, e. g. repetitive cycling races or cycling stage races over several consecutive days, lead to a fall in both Hb and Hct levels due to a progressive enlargement in particular in PV. Changes in hematological parameters are known to considerably influence physical performance, especially in aerobic endurance sports such as mountainbiking. An increase in PV normally results in enhanced aerobic performance due to reduced blood viscosity, thereby optimized microcirculation and improved oxygen delivery capacity to the working muscle (Schumacher et. al., 2000). Hematological parameters Hb and Hct are highly sensible to acute effects. The effects of prolonged exercise on hematological status are mainly dependent on total load (mode and duration) of exercise, as well as thermal stress (temperature and humidity) and fluid intake (FI) (Convertino, 1991; Fellmann et. al., 1999; Neumayr et. al., 2002; Sawka et. al., 2000; Schumacher et. al., 2000). The Transalp Challenge (TAC) is one of the hardest MTB marathon races in the world (besides Cape Epic/SA and Transrockies/USA), covering eight consecutive stages. The key data of TAC 2004 are: 22.500 m (altitude difference), 662 km (distance), which reflects a daily average of 2.812,5 m along with 82.75 km. Therefore, the aim of this study was to determine development and changes in haematological variables Hb, Hct and PV during this MTB stage race.

Six MTB athletes (5 male, 1 female - non professional, reliably not being doped) participated in the field study (Table 1), which was performed according to the Declaration of Helsinki. When exclusively professional cyclists are studied the risk of obtaining falsified data influenced by any kind of doping should be considered. Blood samples were drawn (E0: baseline levels pre race, post exercise values 5 to 10 minutes after individual finish of stages E1, E4, E6) after five minutes of rest in supine position to determine Hb and Hct levels (Miniphotometer plus LP 20, Lange/Germany). Blood samples derived from capillary finger tip. The amount of daily FI including breakfast was recorded by questionnaire immediately after individual finishes (down to an accuracy of 125 ml). Relative changes in PV (Δ%PV) were calculated from pre- and post exercise values of Hb and Hct according to the equation of Strauss et. al. (1951): $\Delta\%PV = 100 \times [(Hb_{pre}/Hb_{post}) \times (1\text{-}Hct_{post}/1\text{-}Hct_{pre})]$. Parameters were analysed by using SPSS software package, version 11.0 (Chicago, Illinois, USA). Changes in both Hb (ΔHb) and Hct (Δ%Hct) were calculated by paired t test, correlations were computed by Pearson`s correlation coefficient (r). Values are presented as means ± SD. P-values < 0.05 were considered to indicate statistical significance.

This field study detected a significant increase in Hb and Hct after the first stage of TAC 2004 while the impact on calculated PV is pronounced. In the course of the race values of both Hb and Hct decreased significantly, PV was calculated to be expanded. Schmidt et. al. (2000) found a similar decline in PV for submaximal load (10.5 %).

The results of the present study reflect that fluid substitution was not effective enough to prevent exercise induced dehydration during E1 (Table 2). Thus, heat elimination by the redistribution of blood flow and body water losses due to sweat and respiration induced a PV decline leading to increased levels of Hb and Hct. (Convertino 1991; Mounier et. al., 2003; Sawka et. al.,

Table 1. Anthropometric data and fluid intake since breakfast (FI for E0, E1, E4, E6). Data are means (± SD). BM = body mass, FI = fluid intake.

	Male (n = 5)	Female (n=1)	Total (n = 6)
Age (y)	29.0 (5.6)	30.0	29.2 (4.6)
BM (kg)	74.6 (12.4)	50.0	70.5 (13.8)
Height (m)	1.82 (.08)	1.61	1.81 (.11)
FI/day (L)	4.63 (1.17)	3.19	4.39 (1.20)
Track time/day (h)	05:21:42 (0.02)	05:14:58	05:20:35 ± 0.02
FI/runtime (L/h)	.86 (.60)	.61	.82 (.61)
FI/BM (L/kg)	.06 (.07)	.06	.06 (.08)
FI/BM x runtime (L/ kgxh)	.01 (.01)	.01	.01 (.01)

Average peak of temperature was 27.5 °C, whereas average peak of relative humidity was 69 %.

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Table 2. Changes in Hb (ΔHb) and relative changes in Hct (Δ%Hct) and calculated PV (Δ%PV) show acute and long term effects during the course of the Transalp Challenge 2004 (n = 6). Values are (means ± SD).

	Stages				Acute effects	Long-term effects	
	E0	E1	E4	E6	E0→E1	E1→E4	E1→E6
FI/day (L)		4.33 (.93)	4.83 (1.21)	4.33 (1.44)			
Hb (g/dl)	12.17 (.75)	14.33 ** (1.75)	11.50 ** (1.87)	11.00 ** (1.55)			
Hct (%)	42.33 (3.78)	43.17 (3.37)	36.83 ** (3.13)	35.67 ** (4.46)			
ΔHb (g/dl)					2.17 ** (1.17)	-2.83 ** (1.60)	-3.33 ** (1.86)
Δ%Hct (%)					.83 (1.47)	-6.33 ** (2.73)	-7.50 ** (3.15)
$PV_{calc.}$ (%)		87.32 * (6.90)	107.29 (15.10)	107.82 (15.29)			
Δ%PV (%)					-12.68 * (6.90)	7.29 (15.10)	7.82 (15.29)

Changes in Hb and Hct are highly correlated for E 1 (r = .903, p = 0.01), E 6 also shows a high correlation, but very close to lower limit (r = 0.724, p = 0.05). * $p < 0.05$, ** $p < 0.01$ compared with baseline.

2000; Schmidt et. al., 2000; Schumacher et. al., 2000). In contrast to exercise induced short term effects this field study further points out a significant decline in Hb and Hct during the course of the TAC 2004. Additionally, decrease in Hct was not that markable in former publications as presented in this study: -5.1 % (Schmidt et. al., 2000) and -4.31 % (Mounier et. al., 2003). While long term decreases in Hb and Hct are pronounced, enhancement in PV is calculated not to reach statistical significance. Mounier et. al. (2003) found a similar PV expansion of 8.5 %. Although this field study was only performed on six subjects hemodilutive effects are clearly shown. Convertino (1991), Fellmann et. al. (1999) and Sawka et. al. (2000) found that PV expansion was maximal on the fourth day of a 7-day ultra endurance race. Until E4 of the TAC 2004 Hb and Hct show a continuous and pronounced fall while PV expansion is pronounced. Hb and Hct readings remained nearly at this lower level while PV remained narrow to this higher level until the end of this MTB race. This field study was done under authentic conditions of the TAC 2004. The authors are absolutely conscious of the fact that method used is not gold standard. The decision had to be made in the light of several unexpected operational and organisational difficulties in participation and accomplishment of this huge 8 days lasting MTB race. It can be concluded that during E1 of the TAC 2004 hemoconcentration was detected to be the acute effect of strenuous endurance impact on hematological parameters. Furthermore, hemodilution was shown as a long term effect of repeated MTB endurance strains.

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