International Journal of Sports Physiology and Performance, 2007;2:327-331

Variability of Erythropoietin Response to Sleeping at Simulated Altitude: A Cycling Case Study

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Living at moderate altitude (2000 to 3000 m) and training near sea level improves performance in some but not all athletes.[1] Chapman et al[2] reported that runners who improved their 5-km running performance after altitude exposure (ie, "responders") displayed a greater altitude-induced increase in serum erythropoietin (sEPO) than "nonresponders." The difference in sEPO between groups was statistically significant, although the mean sEPO concentration of the responders after 30 hours at 2500 m was only 3% greater than that of nonresponders (19.0 ± 4.6 vs 18.4 ± 7.3 mU/mL). These authors concluded that the slightly higher sEPO in responders was sufficient to increase red-cell volume, maximum aerobic capacity, and distance-running performance. Whether the improvement in running performance after living high and training low can be solely attributed to accelerated erythropoiesis has recently been debated.[1]

A large individual variation in the sEPO response to hypoxia has been reported[3] that might be attributable to differences in hypoxia-inducible factor 1-alpha (HIF-1α)—the ubiquitous controller of oxygen-regulated gene expression.[4] It is also possible, however, that the training load preceding altitude exposure could influence the sEPO response. High-intensity exercise can stimulate increases in sEPO secondary to arterial hypoxemia.[5] In similar findings, preliminary research at the Australian Institute of Sport has shown a tendency for oxyhemoglobin saturation while sleeping at simulated moderate altitude to be lower after heavy training days than after "recovery" days, with sleeping oxyhemoglobin saturation inversely related to daily training load (kJ) over 2 weeks (Gawthorn,[6] unpublished observation).

We had the unique opportunity to work with one of the best cycling hill climbers in Australia, who allowed us to modifying his training volume to evaluate the influence of training load on the sEPO response to simulated altitude exposure.

Methods

We monitored a professional male cyclist over a 1-month period. The athlete provided informed consent before starting the study, which was approved by the human ethics committee of the Australian Institute of Sport. The study design

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(Figure 1[A]) was for duplicate measures of sEPO after sleeping for 2 nights (8 h/night) in simulated altitude (2800 m) after 2 "light" periods and 2 "heavy" periods of cycling training in and around Canberra, Australia (~600 m). Training distance, time, cadence, and power output were measured with an SRM power meter (Pro-

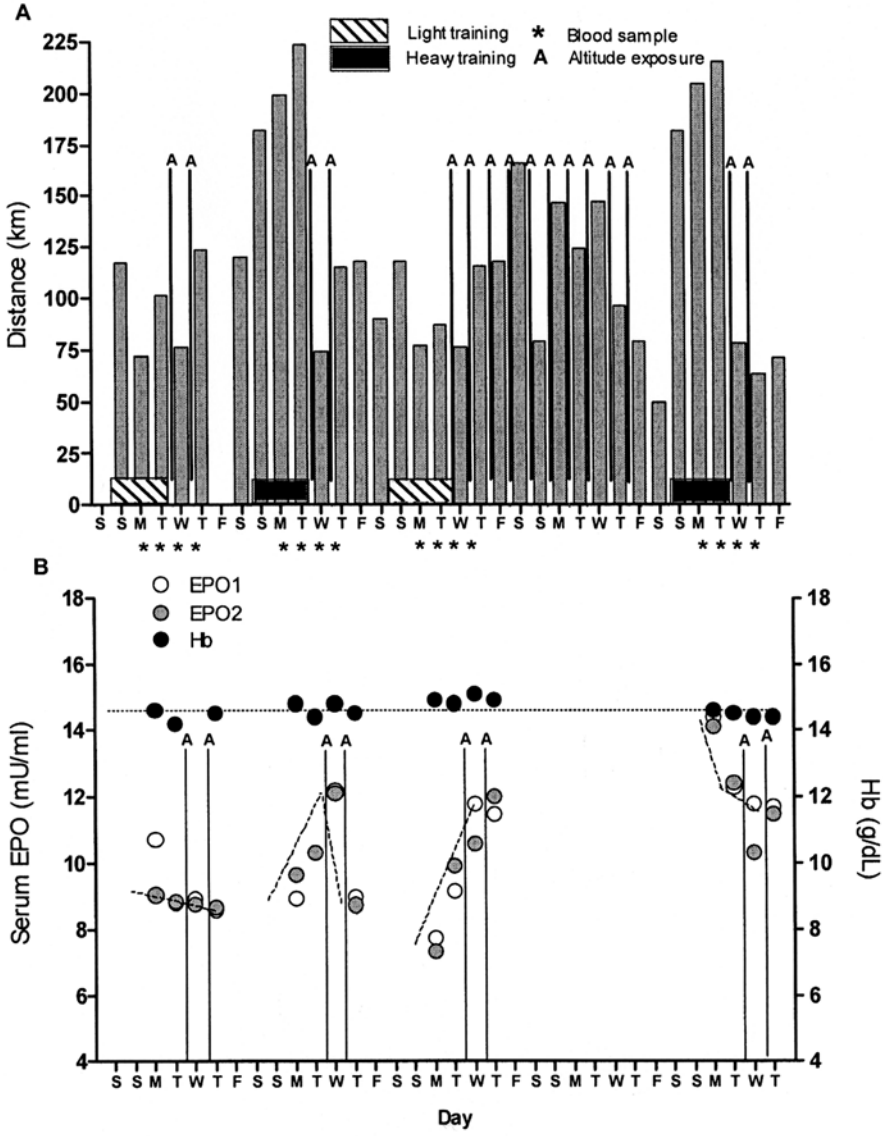

Figure 1 — The upper panel indicates the training volume (km), blood sampling (*), and altitude exposure (A) during each day of the case study. The lower panel shows the hemoglobin-concentration and serum-erythropoietin (EPO; in duplicate—open and closed circles) responses during the case study. The dotted line indicates the trend of both samples.