Methods

We retrospectively filtered body weight related Hbmass values (CO-rebreathing), measured during standard performance testing of the Swiss national cross-country and mountain bike teams twice a year, with the athlete inclusion criteria: male, age>23 yrs, minimum measurement duration three years and/or at least six measurements. 22 Athletes fulfilled the criteria and were included in the analyses. The average number of measurements was 10.8±4.5 over a period of 5.1±2.1 yrs. For every athlete mean of the two first and mean of two last measurements were compared and an individual linear model for the development of Hbmass with age was fitted. Individual models were combined to one linear model by averaging all individual slopes and axis sections. All values are mean ±SD.

Results

There was no difference in mean absolute Hbmass (1058±93 vs 1069±93g; p=0.48) and mean relative Hbmass (14.49±0.88 vs 14.64±0.97g/kg bodyweight; p=0.32) between pre- and post-measurements. The mean linear model was: Hbmass=0.009±0.12 · age +14.3±3.2.

Discussion

Our results show, that for elite endurance athletes older than 23 yrs no substantial increase in Hbmass can be expected with sea-level training over the years despite high training loads usually accomplished by these athletes.

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Effect of endurance training on the development of hemoglobin mass in male adolescent endurance athletes

Thomas Steiner, Jon Wehrlin
Swiss Federal Institute of Sport, Magglingen, Switzerland.

It is well known, that adult elite endurance athletes are characterized by about 30-40% higher hemoglobin mass (Hbmass) than untrained subjects (1). However, it is unclear, whether this is due to endurance training, a better genetic predisposition of the athletes combined with a selection process, or other factors (2). Interestingly, Hbmass at age 16 years (yrs) is reported to be not different between endurance athletes and untrained subjects (3).

Research Question

Does Hbmass increase more in adolescent endurance athletes with a high load of endurance training than in control subjects between age 16 and 18.5yrs?

Methods:

We measured Hbmass (CO-rebreathing) in 10 Swiss National Team endurance athletes (AG: cross-country skiers and triathletes) as well as in 12 age matched non endurance training controls (CG) every 0.5 yrs six times from age 16 to age 18.5yrs (T1 - T6) with the optimized carbon monoxide re-breathing technique.

Results

Hbmass increased ($p<0.001$) in the AG and was 797±96 g (T1), 826±110 g (T2), 852±114 g (T3), 876±120 g (T4), 897±116 g (T5) and 902±123 g (T6) as well as in the CG ($p<0.001$) from 766±95g (T1) to 797±90g, 833±100g (T3), 845±94g (T4), 855±95g (T5) and 868±98g (T6). There were no differences between the groups in the initial Hbmass level and in the rate of increase per year between the AG (5.2±2.1%) and the CG (5.6±4.7%). This rates of increase were highly individually different and ranged between 2.5 and 9.3% in the AG and between 1.2 and 16.9% in the CG. Correlation between increase in Hbmass and increase in body weight was $r=0.81$ ($p<0.01$). Body weight related Hbmass increased ($p<0.05$) during the measurement period from 12.7±1.0 g/kg (T1) to 13.1 ±1.3 g/kg (T6) in the AG as well as from 12.1±0.9 g/kg (T1) to 12.6±0.7 g/kg (T6) in the CG ($p<0.05$).

Discussion

Hbmass increases in male adolescents between age 16 to 18.5yrs. The increase in Hbmass is strongly correlated with the increase in bodyweight, but also body weight related Hbmass slightly increases at this age. The increase rates of Hbmass seem to be highly individually different in athletes as well as in untrained controls, while the amount of endurance training has virtually no influence on the development of Hbmass. Other unknown factors like the individual genetic predisposition may be responsible for these different increase rates among the subjects at this age. An estimation of a male athlete's Hbmass level as a senior seems therefore not possible before the end of growth (before 20 yrs).

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Hemoglobin mass response to normobaric and hypobaric altitude training in senior male athletes

Anna Hauser[1], Severin Troesch[1], Thomas Steiner[1], Laurent Schmitt[2], Grégoire Millet[3], Jon Wehrlin[4]

[1]Swiss Federal Institute of Sport, Magglingen, Switzerland., [2]National School of Mountain Sports/National Ski-Nordic Center, Prémanon, France, [3]Institute of Sport Sciences, Faculty of Biology and Medicine, University of Lausanne, Switzerland, [4]Swiss Federal Instiute of Sport, Magglingen, Switzerland.

Theoretical Background

One main physiological adaptation to altitude training is an increase in hemoglobin mass (Hbmass). Recently, a meta-analysis has calculated that an increase in Hbmass of ~1.1%/100 h of hypoxic exposure at ≥2100 m can be expected (1). During the last decades, several types of altitude training have been developed, which can be performed under either hypobaric hypoxia (HH) or normobaric hypoxia (NH). Whether NH and HH can be used equally for an altitude training camp on Hbmass adaptations is still unclear.

Research Questions

Does normobaric and hypobaric altitude training evoke similar Hbmass responses and is there a substantial inter-individual variability in Hbmass response?