

## 1.10 Hemoglobin Mass and Endurance Performance in Elite Sport

Topics: natural sciences

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### Hemoglobin mass and endurance performance in elite sport

Submitted by: **Jon Wehrlin** (Swiss Federal Institute of Sport Magglingen, Section for Elite Sport, Switzerland.)

Performance and maximal oxygen uptake (VO<sub>2</sub>max) in endurance sports is mainly limited by the oxygen supply to active muscle. Since total amount of hemoglobin (Hbmass) determines in large part the oxygen transport capacity of the blood, Hbmass is a main limiting factor for endurance performance. The importance of a high Hbmass in endurance athletes is also shown by the problem of blood doping in elite sport. It is well known, that senior elite endurance athletes are characterized by about 35% higher Hbmass than untrained individuals. From a sport practical point of view, therefore several key-questions arise: 1) Does Hbmass in senior endurance athletes increase with endurance training over years? 2) Does Hbmass increase more in adolescent endurance athletes with a high load of endurance training than in control subjects between age 16 and 18.5 yrs? 3) Does normobaric and hypobaric altitude training in senior athletes evoke similar Hbmass responses and is there a substantial inter-individual variability in Hbmass response? In the three presentations of our session, these key-questions will be answered and an outlook for further investigations in this relevant field for endurance performance will be addressed.

*Presentations of the Symposium*

### Hemoglobin mass does not change over years in Swiss senior male elite endurance athletes

**Jon Wehrlin, Anna Hauser, Severin Troesch, Thomas Steiner**

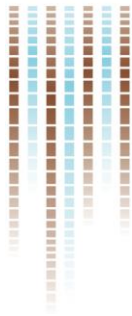
Swiss Federal Institute of Sport, Magglingen, Switzerland.

#### Theoretical Background

In aerobic sport disciplines – such as cross-country skiing or mountainbiking - a main important factor determining aerobic performance is the total amount of hemoglobin, hemoglobin mass (Hbmass). Since endurance athletes are characterized by an about 30-40% higher Hbmass than untrained subjects, the question arises if this is due to endurance training over years (yrs) or other factors like genetic predisposition. Very little is known about the Hbmass changes with training over yrs. From cross sectional data from athletes at age 23 and age 28 (2) as well as Hbmass data measured over one training year (1), it can be hypothesized there is no relevant Hbmass increase over yrs (3).

#### Research Question

Does Hbmass in Swiss national team endurance athletes change with several yrs of endurance training?



## 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  $10.8 \pm 4.5$  over a period of  $5.1 \pm 2.1$  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  $\pm$ SD.

## Results

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

## 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.

## References

1. Prommer N, Sottas PE, Schoch C, Schumacher YO, and Schmidt W. Total Hemoglobin Mass - A New Parameter to Detect Blood Doping? *Med Sci Sport Exerc* 40: 2112-2118, 2008.
2. Steiner T, and Wehrlin JP. Does Hemoglobin Mass Increase from Age 16 to 21 and 28 in Elite Endurance Athletes. *Med Sci Sport Exerc* 43: 1735-1743, 2011.
3. Wehrlin JP, Marti B, and Hallén J. Hemoglobin Mass and Aerobic Performance at Moderate Altitude in Athletes. *Adv Exp Med Biol* 357-375, 2016.

## 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.