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## FIS FACT SHEET

**WADA supported Haemoglobin Variation Study in Elite Cross-Country Skiers**  
*conducted in cooperation with the German, Swedish and French Ski Associations*

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### Background

During the Olympic Winter Games in Turin last February, there was a lot of discussion concerning FIS's rules that define an upper Haemoglobin (Hb) limit for a Cross-Country or Nordic Combined skier to be allowed to start in a FIS or an international event. One reason for this discussion was the argument that the Hb concentration of blood could easily be manipulated with, for example, increased water intake or simply by a change in the athlete's position (sitting vs. lying), not to mention hard training or staying at altitude. The question, then, became whether such interventions could explain the large variation in Hb values sometimes observed in Cross-Country skiers.

### Aim

While there are good data available on the topic of Hb concentration in blood in existing scientific literature, few of these investigations have included top level endurance athletes. To evaluate the specific situation in elite Cross-Country skiers, a study has been conducted during the summer and autumn 2006. This study has been carried out by Professor Bengt Saltin and was supported by the World Anti-Doping Agency, WADA. The specific focus of the study was to evaluate the extent to which the Hb level of blood could be affected in elite Cross-Country skiers by interventions that 'mimic' common daily situations for them while in hard training. During the study, the participating elite Cross-Country skiers were subjected to repeated blood sampling from early morning until the afternoon and linked with the specific interventions being studied.

### Participants

Elite Cross-Country skiers of both genders from three countries - France, Germany and Sweden - were studied at sea level and at medium altitude.

### Interventions

The interventions that the participating athletes were subjected to during the blood sampling were: changes in position (sitting vs. lying down), testing with water intake and without water intake, training, and different medium altitudes. In most skiers, blood sampling was repeated two days in a row both at sea level and at altitude.

### Measurements

Blood was taken from an arm vein without stasis in a syringe and immediately analyzed. Hb was determined on three different measuring instruments in duplicate. The haematocrite (Hct) value was, in addition to the estimates obtained together with the Hb determination (with two of the three instruments), also determined by centrifugation.

## Results

All the studied skiers had Hb values well under the upper allowed levels (females 16.0 and males 17.0 g/dl; =g/100 ml), mean values being just above 14.0 g/dl (=g/100 ml) for the females and just below 15.0 g/dl (=g/100 ml) for the males. These values are normal for healthy people.

Female and male skiers reacted similarly to the various interventions in regard to both the pattern and magnitude of changes in Hb concentration. The values presented below are the mean values from all the obtained results regardless of gender.

In the sitting position, Hb was 14.6 g/dl (=g/100 ml) and in the supine (lying down) position, 14.4 g/dl (=g/100 ml). An intake of 0.5 l of water reduced the Hb concentration by 0.3-0.4 g/dl (=g/100 ml).

Hard training lasting 90-120 min elevated the Hb level to 15.2 g/dl (=g/100 ml) with the slightly surprising finding of only 0.1 g/dl (=g/100 ml) lower Hb value when 1 l water was ingested during the training.

At medium altitude, the Hb level was 15.1 g/dl (=g/100 ml) as compared to 14.6 at sea level. Hard training performed at altitude elevated the Hb concentration to 15.8 g/dl (=g/100 ml) and the effect of 2 l of water ingestion reduced the Hb value to 15.2 g/dl (=g/100 ml).

The individual variations were small and of similar magnitude for skiers with low or high Hb levels. None of the skiers with high initial Hb level were found to be above the allowed upper Hb-level in any of the interventions.

## Conclusion

These data demonstrate that the Hb level is a robust and highly reproduceable variable on the individual level.

The observed small variations in the Hb value on the individual level, in spite of quite marked perturbations, do not explain the large Hb fluctuations seen in some skiers. Instead, the finding of only minor variations supports the use of blood profiling as a good method to deter skiers from using various forms of blood manipulation. In the future, a possible development might entail the determination of individual Hb values around which a variation of +/-10% would be allowed, as opposed to universal maximum allowed values.

However, it is critical for the validity and usefulness of the blood Hb tests that blood sampling and handling of the blood are performed properly and in a standardized manner. Moreover, the equipment used for the Hb measurements has to be calibrated regularly during the day of testing.

## Further Reading

FIS Fact Sheet on FIS Medical and Anti-Doping Activities, especially concerning Naturally Elevated Haemoglobin

<http://www.fis-ski.com/data/document/fis-fact-sheet-fis-medical-and-anti-doping-activities.pdf>

FIS Media Info on the CAS decision during the Olympic Winter Games in Turin

<http://www.fis-ski.com/data/document/cas.pdf>

Frequently Asked Questions to Bengt Saltin

<http://www.fis-ski.com/data/document/faq.pdf>

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