

# Hematological Indices Associated with Cross Country Ski Speed at Altitude

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## Introduction

Erythrocyte volume is linked to the oxygen carrying capacity of the blood and is known to be associated with cross-country skiing performance. In the absence of more sophisticated measures, common hematology measures including hematocrit, hemoglobin content, red blood cell count and mean cell hemoglobin have been used to assess athletes. Hematological adaptation of U.S. biathletes to altitude was carefully monitored prior to the 2002 Olympic Winter Games. Plasma volume shifts made interpretation of common measures difficult and questioned their relationship to performance. The purpose of this study was to relate common hematological measures to ski speed during U.S. Biathlon Olympic selection races and to compare these measures among the fastest skiers.

## Methods

Seven of the best, U.S., male, biathletes participated in the investigation. Four venous blood draws were obtained from an antecubital vein in the 3 months prior to competition and results were averaged for analysis. Average ski speed ( $m \cdot s^{-1}$ ) for each athlete was calculated from 4 separate races over a one week period and hematological data were obtained using automated flow cytometry. The relationship between hemoglobin (HB), hematocrit (HCT), red blood cell count (RBC), mean cell hemoglobin (MCH), and average ski speed was tested using a Spearman rank order correlation. Mean scores for hematological measures were compared between the 3 fastest skiers and the 4 others using a Kruskal-Wallis Test. The rejection criterion was set at  $p < 0.05$ .

## Results

RBC was negatively correlated with ski speed ( $r = -.83, p = 0.01$ , Fig. 1), MCH was positively correlated with ski speed ( $r = .76, p = 0.02$ , Fig. 2) and HB and HCT were not significantly related to ski speed ( $r = .14, p = .38$ ;  $r = .11, p = .41$  respectively). MCH was higher in the 3 fastest skiers compared to the others ( $33.2 \pm 1.5$  vs.  $30.6 \pm .34$  pg,  $p = .03$ , Fig. 3) and RBC was lower in the fastest skiers ( $4.9 \pm .23$  vs.  $5.2 \pm .13 \cdot 10^6 \mu L^{-1}$ ,  $p = .07$ , Fig. 4).

Fig. 1 - Relation between Speed and Red Blood Cell Count

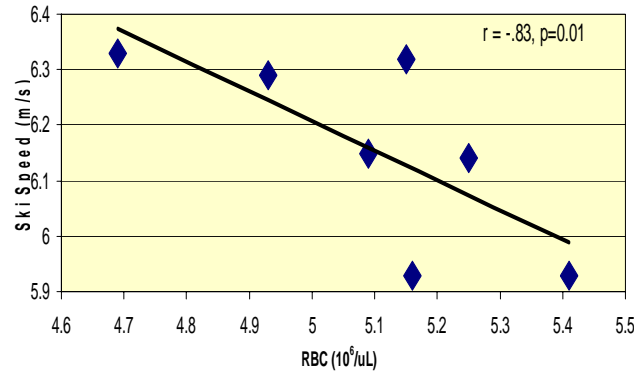


Fig. 2 - Relation between Speed and Mean Cell Hemoglobin

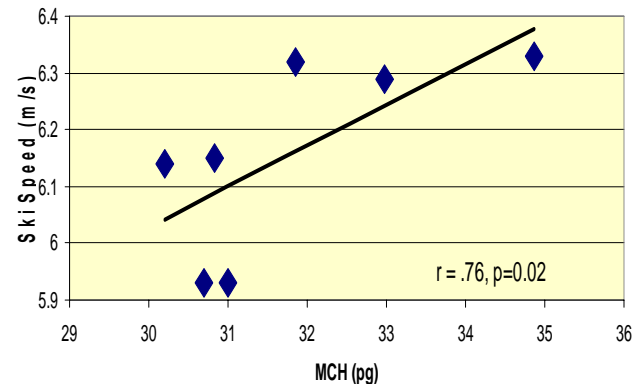


Fig. 3 - Average Mean Cell Hemoglobin

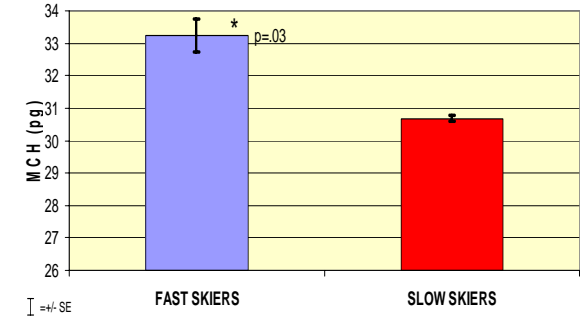
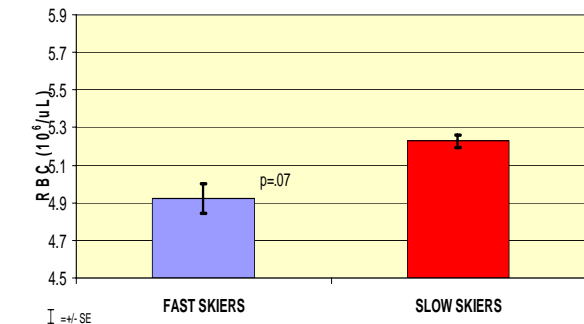


Fig. 4 - Average Red Blood Cell Count



## Conclusions

HB and HCT were not related to ski speed, possibly due to fluctuations in plasma volume. MCH was positively related to ski speed suggesting the average hemoglobin content of a cell may be related to endurance performance at altitude. RBC was negatively associated with ski speed and may reflect a larger plasma volume and decreased blood viscosity in the fastest skiers.

## References

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 Ruiz-Arguelles, G.J., Sanchez-Medal L., Loria, A., Piedras, J. Cordova, M.S. 1980. Red cell indices in normal adults residing at altitude from sea level to 2670 meters. *Am J Hematol* 8(3):265-271