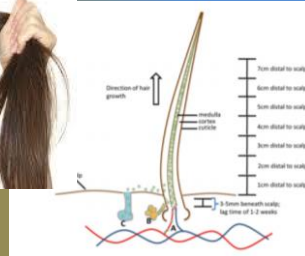
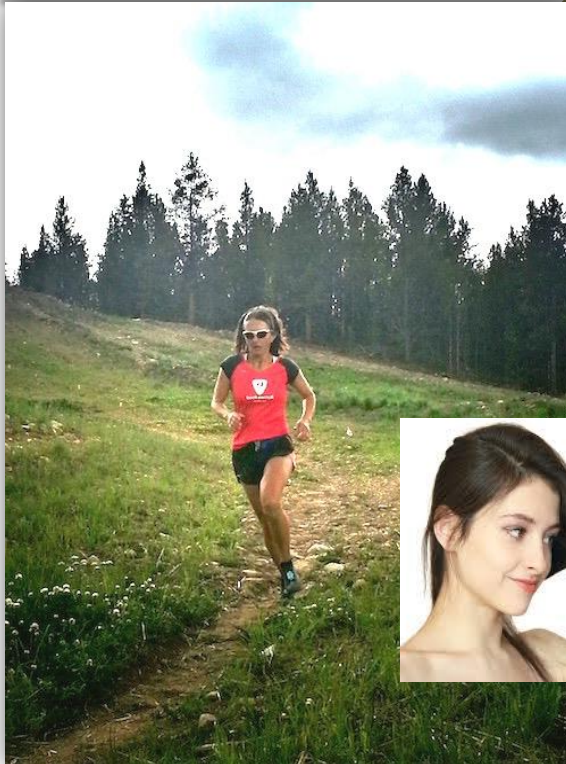




# Increased hair cortisol levels in female endurance athletes through altitude training : A useful diagnostic tool for overtraining

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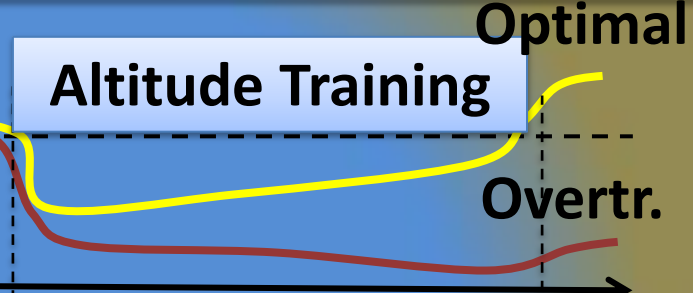
筑波大学  
University of Tsukuba



**Performance**

**Hemoglobin**

**Chronic Stress**



**Blood, Urine, Salivary Cortisol**



Is hair cortisol levels useful for evaluating chronic stress in end Tr ?

# Method

7 female long-distance runners

## Performance index

- $\dot{V}O_2\text{max}$
- Red Cell Volume (**RCV**)
- Total Hemoglobin Mass (**tHb**)

## O<sub>2</sub> Transport

## Stress index

- Hair Cortisol
- Blood Cortisol
- Urine Cortisol

Sea-level  
Training

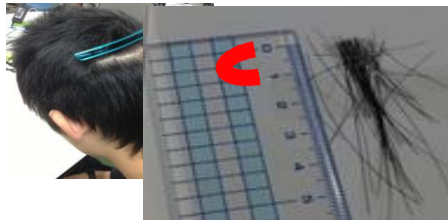
Altitude Training  
(1,800 m)

Sea-level  
Training

27 days

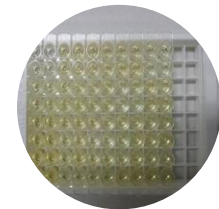
◀ Pre-Hair Cortisol ▶▶ Post-Hair Cortisol ▶▶

Hair Cortisol  
Measurement



Sampling (1 cm)

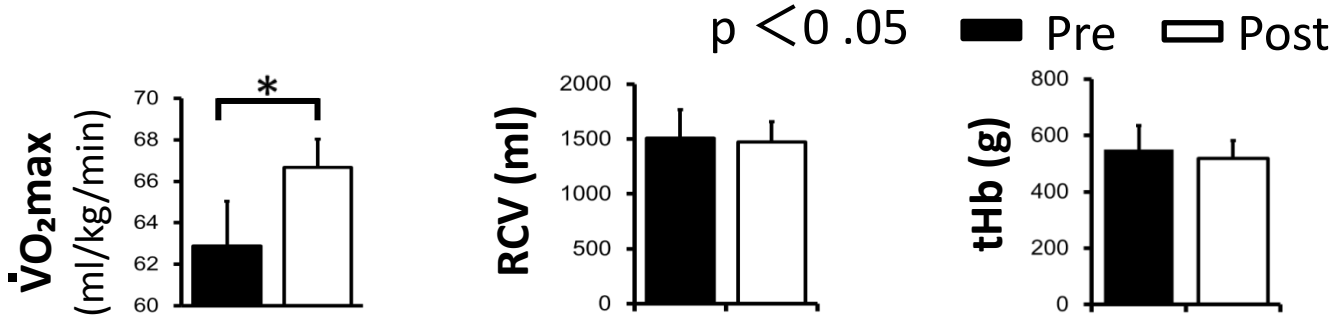
||  
1 month



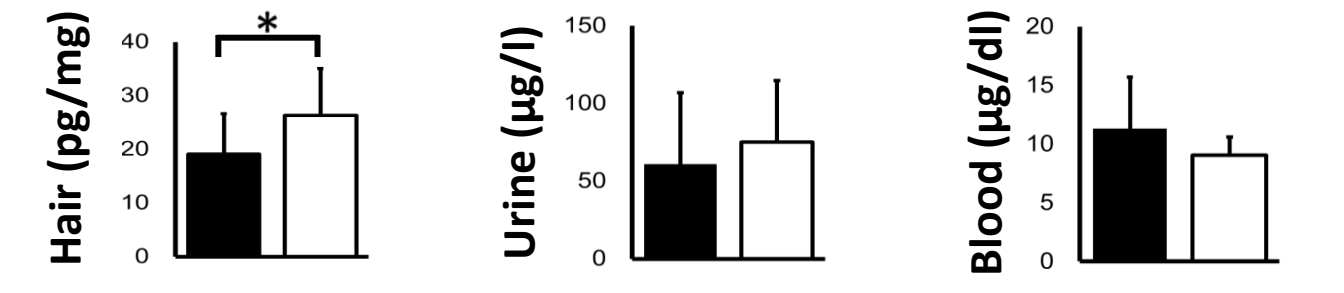
ELISA

# Results

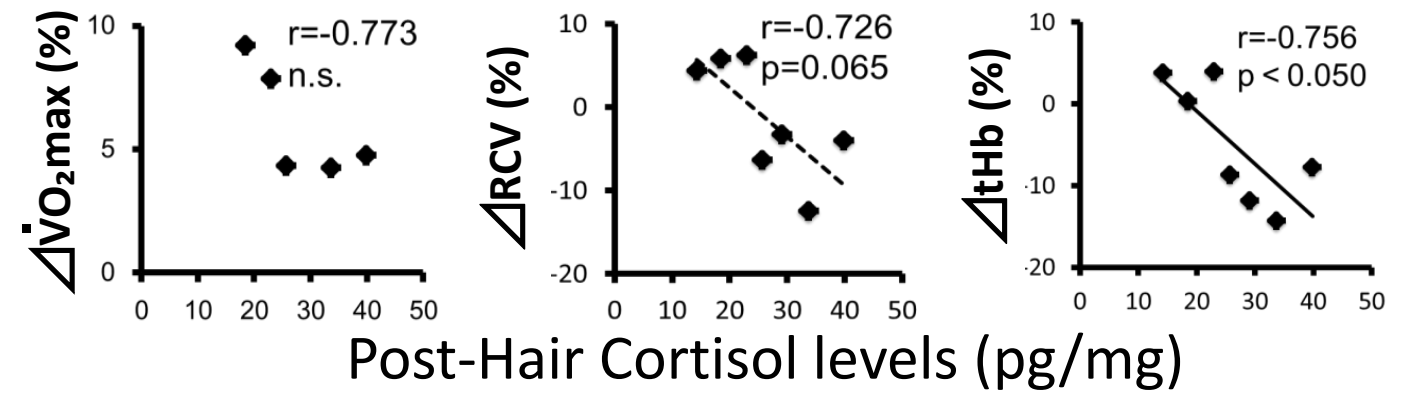
**Performance**



**Stress  
(Cortisol level)**

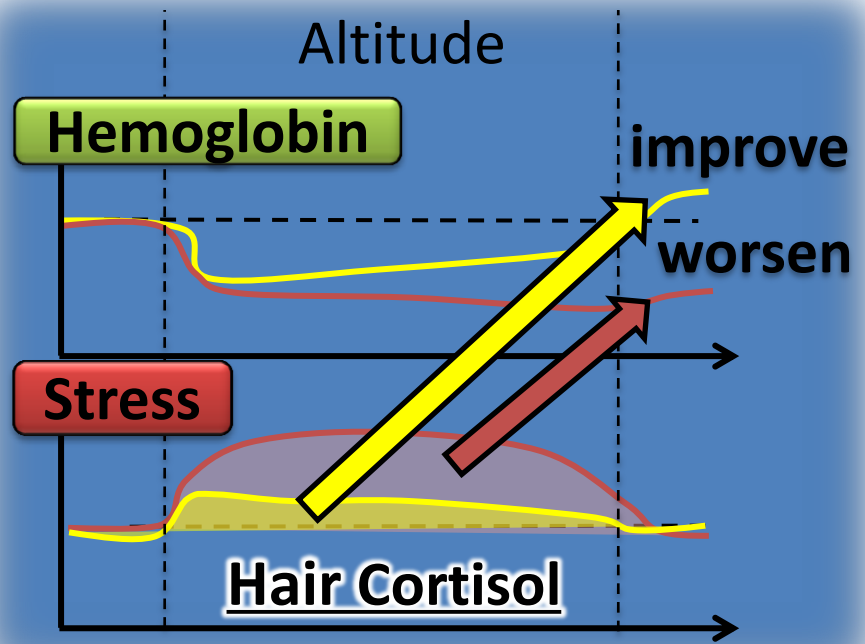
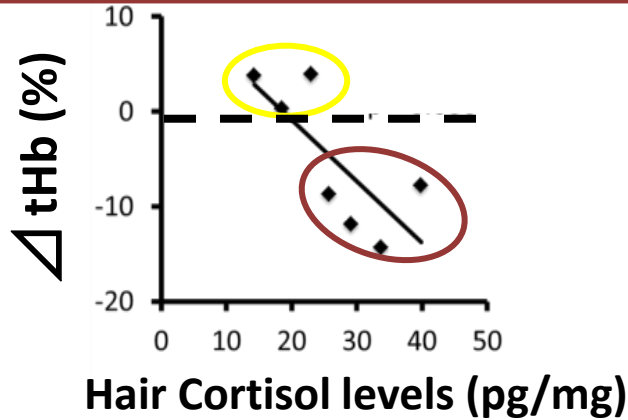


**Performance  
&  
Hair Cortisol**



# Discussion

Higher hair cortisol levels were correlated with decreased Hb levels



Hair Cortisol levels may be useful for assessment of overtraining

# Conclusion

**Hair Cortisol** could be a potential biomarker of **chronic stress** at altitude training in endurance athletes