

# "Living high-training low" altitude training improves sea level performance in male and female elite runners.

Stray-Gundersen J, Chapman RF, Levine BD. *J Appl Physiol.* 91(3):1113-1120, 2001

## Protocol:

- 27 days of living at 2,500 m (Park City)
- High-intensity training at 1,250 m (Salt Lake City)

## Results:

- 3% improvement in VO<sub>2</sub>max
- 3,000m performance time improved 1.1%
- 1/3 of the runners achieved personal best times
- Hemoglobin increased 1 g/dl over the course of the camp

**Stated Conclusion:** We conclude that 4 wk of acclimatization to moderate altitude, accompanied by high-intensity training at low altitude, improves sea level endurance performance even in elite runners.

**Notes:** The purpose of this study was to evaluate the effect of Live High Train low on ELITE athletes at the very peak of their form (or so they had thought !), - right after the US Championships.

**Abstract:** Acclimatization to moderate high altitude accompanied by training at low altitude (living high-training low) has been shown to improve sea level endurance performance in accomplished, but not elite, runners. Whether elite athletes, who may be closer to the maximal structural and functional adaptive capacity of the respiratory (i.e., oxygen transport from environment to mitochondria) system, may achieve similar performance gains is unclear. To answer this question, we studied 14 elite men and 8 elite women before and after 27 days of living at 2,500 m while performing high-intensity training at 1,250 m. The altitude sojourn began 1 wk after the USA Track and Field National Championships, when the athletes were close to their season's fitness peak. Sea level 3,000-m time trial performance was significantly improved by 1.1% (95% confidence limits 0.3-1.9%). One-third of the athletes achieved personal best times for the distance after the altitude training camp. The improvement in running performance was accompanied by a 3% improvement in maximal oxygen uptake (72.1 +/- 1.5 to 74.4 +/- 1.5 ml x kg(-1) x min(-1)). Circulating erythropoietin levels were near double initial sea level values 20 h after ascent (8.5 +/- 0.5 to 16.2 +/- 1.0 IU/ml). Soluble transferrin receptor levels were significantly elevated on the 19th day at altitude, confirming a stimulation of erythropoiesis (2.1 +/- 0.7 to 2.5 +/- 0.6 microg/ml). Hb concentration measured at sea level increased 1 g/dl over the course of the camp (13.3 +/- 0.2 to 14.3 +/- 0.2 g/dl). We conclude that 4 wk of acclimatization to moderate altitude, accompanied by high-intensity training at low altitude, improves sea level endurance performance even in elite runners. Both the mechanism and magnitude of the effect appear similar to that observed in less accomplished runners, even for athletes who may have achieved near maximal oxygen transport capacity for humans.