

"Living high-training low": effect of moderate-altitude acclimatization with low-altitude training on performance

Benjamin D. Levine¹ and James Stray-Gundersen²

¹ Institute for Exercise and Environmental Medicine, Presbyterian Hospital of Dallas 75231; and ² Baylor/The University of Texas Southwestern Sports Science Research Center, The University of Texas Southwestern Medical Center, Dallas, Texas 75235

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Levine, Benjamin D., and James Stray-Gundersen. "Living high-training low": effect of moderate-altitude acclimatization with low-altitude training on performance. *J. Appl. Physiol.* 83(1): 102-112, 1997. The principal objective of this study was to test the hypothesis that acclimatization to moderate altitude (2,500 m) plus training at low altitude (1,250 m), "living high-training low," improves sea-level performance in well-trained runners more than an equivalent sea-level or altitude control. Thirty-nine competitive runners (27 men, 12 women) completed 1) a 2-wk lead-in phase, followed by 2) 4 wk of supervised training at sea level; and 3) 4 wk of field training camp randomized to three groups: "high-low" (n = 13), living at moderate altitude (2,500 m) and training at low altitude (1,250 m); "high-high" (n = 13), living and training at moderate altitude (2,500 m); or "low-low" (n = 13), living and training in a mountain environment at sea level (150 m). A 5,000-m time trial was the primary measure of performance; laboratory outcomes included maximal O₂ uptake (O₂ max), anaerobic capacity (accumulated O₂ deficit), maximal steady state (MSS; ventilatory threshold), running economy, velocity at O₂ max, and blood compartment volumes. Both altitude groups significantly increased O₂ max (5%) in direct proportion to an increase in red cell mass volume (9%; r = 0.37, P < 0.05), neither of which changed in the control. Five-kilometer time was improved by the field training camp only in the high-low group (13.4 ± 10 s), in direct proportion to the increase in O₂ max (r = 0.65, P < 0.01). Velocity at O₂ max and MSS also improved only in the high-low group. Four weeks of living high-training low improves sea-level running performance in trained runners due to altitude acclimatization (increase in red cell mass volume and O₂ max) and maintenance of sea-level training velocities, most likely accounting for the increase in velocity at O₂ max and MSS.

altitude; hypoxia; training; exercise; sports