

## **Exercise training in normobaric hypoxia in endurance runners. I. Improvement in aerobic performance capacity**

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This study investigates whether a 6-wk intermittent hypoxia training (IHT), designed to avoid reductions in training loads and intensities, improves the endurance performance capacity of competitive distance runners. Eighteen athletes were randomly assigned to train in normoxia [Nor group;  $n = 9$ ; maximal oxygen uptake ( $\dot{V}_{O_2 \max}$ ) =  $61.5 \pm 1.1$  ml·kg<sup>-1</sup>·min<sup>-1</sup>] or intermittently in hypoxia (Hyp group;  $n = 9$ ;  $\dot{V}_{O_2 \max}$  =  $64.2 \pm 1.2$  ml·kg<sup>-1</sup>·min<sup>-1</sup>). Into their usual normoxic training schedule, athletes included two weekly high-intensity (second ventilatory threshold) and moderate-duration (24–40 min) training sessions, performed either in normoxia [inspired O<sub>2</sub> fraction (F<sub>I</sub>O<sub>2</sub>) = 20.9%] or in normobaric hypoxia (F<sub>I</sub>O<sub>2</sub> = 14.5%). Before and after training, all athletes realized 1) a normoxic and hypoxic incremental test to determine  $\dot{V}_{O_2 \max}$  and ventilatory thresholds (first and second ventilatory threshold), and 2) an all-out test at the pretraining minimal velocity eliciting  $\dot{V}_{O_2 \max}$  to determine their time to exhaustion (T<sub>lim</sub>) and the parameters of O<sub>2</sub> uptake ( $\dot{V}_{O_2}$ ) kinetics. Only the Hyp group significantly improved  $\dot{V}_{O_2 \max}$  (+5% at both F<sub>I</sub>O<sub>2</sub>,  $P < 0.05$ ), without changes in blood O<sub>2</sub>-carrying capacity. Moreover, T<sub>lim</sub> lengthened in the Hyp group only (+35%,  $P < 0.001$ ), without significant modifications of  $\dot{V}_{O_2}$  kinetics. Despite similar training load, the Nor group displayed no such improvements, with unchanged  $\dot{V}_{O_2 \max}$  (+1%, nonsignificant), T<sub>lim</sub> (+10%, nonsignificant), and  $\dot{V}_{O_2}$  kinetics. In addition, T<sub>lim</sub> improvements in the Hyp group were not correlated with concomitant modifications of other parameters, including  $\dot{V}_{O_2 \max}$  or  $\dot{V}_{O_2}$  kinetics. The present IHT model, involving specific high-intensity and moderate-duration hypoxic sessions, may potentialize the metabolic stimuli of training in already trained athletes and elicit peripheral muscle adaptations, resulting in increased endurance performance capacity.

maximal oxygen uptake; time to exhaustion; competitive endurance runners

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