

"Live High-Train Low" Paradigm: Moving the Debate Forward

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Letter to the Editor-in-Chief

"Live high-train low" paradigm: Moving the debate forward.

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Dear Editor-in-Chief,

The recent article by Bejder and Nordsborg [1] on the weakness of scientific evidences supporting that hypobaric or normobaric "live high-train low" (LHTL) method improves sport-specific exercise performance has the merit of recalling the importance of careful methodological design [7] for future altitude-related research. While we agree that double blinding, inclusion of a normoxic control group, implementation of a lead-in period, adequate sample size and statistical power are paramount to minimize the potential biases (*e.g.*, placebo or nocebo effect, training content or trainability influence), several comments would merit consideration.

First, the choice of the articles inserted in a systematic review or a meta-analysis is paramount since the main purpose is to draw valid conclusion only from a comprehensive data set and not from a "cherry-picked" one. Two of the three self-called *"well-controlled conducted normobaric LHTL studies"* supporting the view of the authors [1] should be interpreted with caution as latent drawbacks have been previously pinpointed [4,5,8]. The common limit between these studies relies on inadequate training prescription in the LHTL groups which may have participated to physical and/or mental fatigue development (with possible expansion to overreaching/overtraining), thereby hampering time-trial performance.

Second, limiting the analysis on time trials only is a somewhat reductionist approach as several "performance" parameter (*e.g.*, VO_{2max}, time to exhaustion, economy/efficiency) have been shown to positively respond (*i.e.*, ~1-4% which is markedly greater than the ~0.5% smallest worthwhile change for endurance time) to LHTL training, thereby indicating a likely time trial performance improvement (*e.g.*, multiplying time to exhaustion results by a factor of 1/15) [2]. In this view, the quality and quantity of published data over the past 50 years also support the benefits of LHTL to enhance (elite) athletes' sea level endurance performance. Thus, the discussion remains open.

Third, since the recent debate about the existence of different physiological responses between hypobaric (HH) and normobaric hypoxia (NH), it has been argued that sleeping in HH during LHTL would induce greater performance gains than sleeping in NH [2]. However, the latest LHTL-related studies seem to indicate that sleeping pattern is more altered in HH *vs*. NH [9], while evoking a similar mean increase in hemoglobin mass [6]. This merits further focus on the topic.

In conclusion, should we spend our time and money on LHTL? Since altitude training is commonly used by elite endurance athletes (*e.g.*, even in Norwegian cross-country skiers, altitude training is for long an important component of training), it is important that the scientific community provides a clear message on the effectiveness of the different hypoxic methods. Despite the above-mentioned concerns, the conclusions from Bedjer and Nordsborg [1] that challenge previous reviews (see Millet et al. [8]) supporting the ergogenic effect of LHTL are of interest and should be viewed as a stimulator for better altitude-related research. Of course, negative results studies are important and contribute to the body of knowledge that nourishes the debate. However, based on the new advancements in hypoxic training, it is time for investigating the combination of different hypoxic methods such as "live high-train low and high" to optimize athletes performance development [3]. Beyond the scientific debate, we do not forget that we have to help elite sport stakeholders to make evidence-based decisions.

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