



**HAL**  
open science

## Clarification on altitude training

Grégoire Millet, Franck Brocherie, Raphael Faiss, Olivier Girard

► **To cite this version:**

Grégoire Millet, Franck Brocherie, Raphael Faiss, Olivier Girard. Clarification on altitude training. *Experimental Physiology*, 2017, 102 (1), pp.130-131. 10.1113/EP085936 . hal-01793591

**HAL Id: hal-01793591**

**<https://insep.hal.science//hal-01793591>**

Submitted on 16 May 2018

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Clarification on altitude training

Grégoire P Millet, Franck Brocherie, Raphael Faiss, Olivier Girard

ISSUL Institute of Sport Sciences, University of Lausanne, 1015, Lausanne, Switzerland

We congratulate our colleagues for their careful reading of our work in their Hot Topic Review 'Does 'altitude training' increase exercise performance in elite athletes?' (Lundby & Robach 2016) but strongly believe that they have a selective appreciation of the available literature that requires clarification.

## Living High Training low (LHTL)

The authors report that many LHTL studies in normobaric hypoxia (NH) “*failed to show a positive outcome*”, which in our view is only partially true. In a cross-over design, we (Saugy *et al.*, 2016) recently tested if LHTL in hypobaric hypoxia (HH) would lead to larger performance enhancement than in NH. Our hypothesis was that HH (i.e. natural altitude) would lead to larger enhancement than NH but the results were contrary to this hypothesis. So we cannot support the affirmation by Lundby & Robach that “*natural altitude remains the best approach*”. We acknowledge that observed changes in hemoglobin mass ( $Hb_{mass}$ ) on the same experiment might have been influenced by the training camp conditions. However, again, a fair review would cite our response (Wehrli *et al.*, 2016) detailing the controlled training and environmental parameters along with the high level of reproducibility of the duplicate  $Hb_{mass}$  method used.

## Repeated Sprint Training in Hypoxia (RSH)

The authors question how RSH might lead to “performance gains” as high as 55%. Precisely, improved repeated-sprint performance post-RSH training in the quoted study (Faiss *et al.* 2014) was highlighted by longer exercise duration (or a larger number of completed sprints) before reaching exhaustion (carefully defined as 70% of peak power). While such performance improvement remains very specific (test protocol, participants background, training content), the reader needs to be cognizant that even a small change in an individual’s power produces a large change in time to exhaustion (Allen & Hopkins, 2015). Such specific performance enhancement is in fact discussed carefully in our articles as to avoid any over-interpretation of our data (Faiss *et al.*, 2015). Montero and Lundby (2015) criticize the “criteria for fatigue” we have used and based on fancied ex nihilo calculations, claim that the outcomes we have reported result from “differentiated criteria” between intervention groups. We contend that this has no foundation and have carefully replied to this criticism, explaining how inaccurate their reasoning is (Faiss *et al.*, 2015). Curiously, in their first RSH study (Montero & Lundby, 2016), the authors have used the same criteria. How coherent is this?

This is an Accepted Article that has been peer-reviewed and approved for publication in the Experimental Physiology, but has yet to undergo copy-editing and proof correction. Please cite this article as an Accepted Article; [doi: 10.1113/EP085936](https://doi.org/10.1113/EP085936).

This article is protected by copyright. All rights reserved.

A careful reading of the available literature would mention the *very likely* greater gains in a specific repeated agility test (cumulated times) after RSH compared to similar training near sea-level (Brocherie *et al.*, 2015a). Additionally, in (Brocherie *et al.*, 2015b), the LHTL+RSH group had a twice larger RSA enhancement than the LHTL + RSN group and maintained this positive outcome for three weeks.

We also disagree with Lundby and Robach's interpretation of the study by Gatterer *et al.* (2014) who actually reported a training  $\times$  group interaction on the fatigue slope calculated during repeated sprint exercise. This in fact confirms a better "resistance to fatigue" and Gatterer *et al.* concluded "*this type of hypoxic training led to larger improvements in RSA when compared to normoxia training*". That is the opposite of Lundby and Robach's conclusions.

The authors then cite their recent study (Montero & Lundby, 2016) where 12 different tests in 3 days post-intervention were conducted. We (Girard *et al.*, 2016) pointed out many methodological flaws in this study, questioning how individuals were able to maximally perform so many exhaustive exercise tests in such a small time period without any confounding deleterious influence of residual fatigue, likely to induce negative pacing strategies e.g. no control of the training intensity or of the pacing during RSA test. We concluded that many methodological shortcomings may explain why no additional effect of RSH *versus* RSN was observed.

A rare point agreed with the authors is that the readers/practitioners should critically assess the strength and weaknesses of the different studies and of the different sides of this debate.

Finally, we predict that the authors may change their mind in the future regarding RSH as they did regarding the efficiency of LHTL. A few years ago with the method they use for measuring  $Hb_{mass}$ , a larger than 10% increase in  $Hb_{mass}$  was reported for 250 h of exposure at 2500-3000 m, corresponding to an increase  $> 4\%$  per 100 h in elite endurance athletes (Brugniaux *et al.*, 2006). One of the authors then stated "*LHTL improves  $VO_2max$  and associated power output. This improvement represents a marked increase, especially for elite athletes*". Whereas recently (Robach *et al.*, 2012) they stated "*the positive effects of LHTL on oxygen transport appear to be negligible among elite cyclists who already possess very high aerobic capacities conferred by high  $Hb_{mass}$  and  $VO_2max$* ".

- Allen SV & Hopkins WG. (2015). Age of Peak Competitive Performance of Elite Athletes: A Systematic Review. *Sports Med* **45**, 1431-1441.
- Brocherie F, Girard O, Faiss R & Millet GP. (2015a). High-intensity intermittent training in hypoxia: a double-blinded, placebo-controlled field study in youth football players. *Journal of strength and conditioning research / National Strength & Conditioning Association* **29**, 226-237.
- Brocherie F, Millet GP, Hauser A, Steiner T, Rysman J, Wehrlin JP & Girard O. (2015b). "Live High-Train Low and High" Hypoxic Training Improves Team-Sport Performance. *Medicine and science in sports and exercise* **47**, 2140-2149.
- Brugniaux JV, Schmitt L, Robach P, Nicolet G, Fouillot JP, Moutereau S, Lasne F, Pialoux V, Saas P, Chorvot MC, Cornolo J, Olsen NV & Richalet JP. (2006). Eighteen days of "living high, training low" stimulate erythropoiesis and enhance aerobic performance in elite middle-distance runners. *Journal of applied physiology* **100**, 203-211.
- Faiss R, Holmberg HC & Millet GP. (2015). Response. *Medicine and science in sports and exercise* **47**, 2484.
- Gatterer H, Philippe M, Menz V, Mosbach F, Faulhaber M & Burtscher M. (2014). Shuttle-run sprint training in hypoxia for youth elite soccer players: a pilot study. *Journal of sports science & medicine* **13**, 731-735.
- Girard O, Faiss R, Brocherie F & Millet GP. (2016). Repeated sprint training in hypoxia versus normoxia does not improve performance due to methodological shortcomings? . *international Journal of Sports Physiology and Performance*.
- Lundby C & Robach P. (2016) Does 'altitude training' increase exercise performance in elite athletes? *Exp Physiol* **101**.783-788.
- Montero D & Lundby C. (2015). Enhanced Performance after Repeated Sprint Training in Hypoxia: False or Reality? *Medicine and science in sports and exercise* **47**, 2483.
- Montero D & Lundby C. (2016). Repeated Sprint Training in Hypoxia Versus Normoxia Does Not Improve Performance: A Double-Blind and Cross-Over Study. *Int J Sports Physiol Perform*.
- Robach P, Siebenmann C, Jacobs RA, Rasmussen P, Nordborg N, Pesta D, Gnaiger E, Diaz V, Christ A, Fiedler J, Crivelli N, Secher NH, Pichon A, Maggiorini M & Lundby C. (2012). The role of haemoglobin mass on VO<sub>2</sub>max following normobaric 'live high-train low' in endurance-trained athletes. *Br J Sports Med* **46**, 822-827.

Saugy JJ, Schmitt L, Hauser A, Constantin G, Cejuela R, Faiss R, Wehrin JP, Rosset J, Robinson N & Millet GP. (2016). Same Performance Changes after Live High-Train Low in Normobaric vs. Hypobaric Hypoxia. *Frontiers in physiology* **7**, 138.

Wehrin JP, Hauser A, Schmitt L, Troesch S, Saugy JJ, Cejula-Anta R, Faiss R, Robinson N & Millet GP. (2016). Response. *Med Sci Sports Exerc* **48**, 1426-1427.