Training and Racing at Altitude

Exercising at altitude presents a novel experience for most athletes. Due to the lack of atmospheric pressure oxygen is not transferred as quickly as at sea level when exercising. This results in large reductions in Vo2max or how much oxygen your body can take on board.

Being prepared for this experience is vital to success at altitude. Training at altitude can improve performance when racing at altitude. Seal level performance for training at altitude is more nuanced and needs to be considered with the individual's response to training at altitude, rather than inferring 'it will work for everyone who does it'.

We will quickly review some specific points that have been empirically verified by scientific research that will best enable you to perform well at altitude.

There are several aspects to consider:

1. At 1800m the adaptation period is around 1week. For every 400m above this another week is needed for the body to adapt. Start of low and progressively increase elevation. When using altitude tents, an average 150 hours of altitude to start reaching a performance level, with an average of 250 hours to altitude training, to reach maximum output. Ensure you record O2 saturation levels during use inside the tent, and keep these between 87-99% range, measured at the start of entering the altitude tent and on waking in the tent, and record these values. The actual optimal range will depend on subjective and objective fatigue measures as discussed below and could only be as low as 96% for instance.

2. Inter-individual responses- not every individual responds in the same way as the next, meaning there are responders to altitude and non-responders. This may be partially genetically based, but is also indicative of homeostasis (or how 'in balance') your body is. If you go to altitude sick then your body will struggle under the load to recover. Thus you need to be well rested and ready for work. Using bio-feedback and fatigue measures can assist with seeing if an individual is ready for this exposure such as heart rate variability (HRV) and submaximal fitness tests (LSCT)

3. Going to altitude then returning to sea level, then returning to altitude after a month, or 2, break is best for optimising adaptation to racing at altitude

4. People who live at altitude are much better prepared than sea level dwellers owing to chronic exposure

5. 1800-2500m is the optimal range for living and training at altitude

6. 3-4 weeks of altitude training to improve sea-level performance has been recommended

7. Using altitude training repeatedly over time offers the best outcomes for performance

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8. Training needs to start off with lower intensity and volume for the first week (can be done at altitude rather than sea level when doing low intensity, however be mindful of individual response to the training and related measures like HRV and LSCT), then build load each week thereafter, consider longer recovery intervals between interval workout bouts then when done at sea level (1.5-2 times the usual recovery period duration). Interval work can be done at sea level or below 800m to assist with performance output during the session. Always, recovery rate needs to be measured and training adjusted to individual responses (HRV, LSCT, etc.)

9. Timing of competition after altitude training needs to consider a taper period from altitude training to the key event, rather than training heavily into the event, as recovery from altitude is required. High intensity training post altitude training is indicated for improved performance, this period can be from 4-6weeks post altitude

10. There are aspects pertaining to pre-race taper that will best prepare you for exercise

11. There are some dietary aspects outlined below that will assist in best preparing you for exercise

Supplementation at altitude: Iron stores are important for altitude adaptation. Perhaps an iron test prior departure is appropriate, or taking a small dose iron supplement could be indicated (50-100mg of elemental Iron). Anti-oxidant nutrients are important to maintaining balance at altitude owing to increased oxidative stress at altitude. Eating antioxidant rich food, or having access to a supplement is indicated. Fish Oil supplementation can also be useful owing to blood hyper-viscosity at altitude, taken daily. Water loss is increased due to dry inhaled air at altitude and direct and indirect solar radiation is high. Drinking more fluid is indicated here. I would suggest implementing the above weeks before the event in order to be familiar with these aspects and not experiencing any gastric upset associated with each supplement.

Eat well at altitude: When at altitude your metabolism is increased as your body begins using resources through adaptation: diet is critical. Protein input should remain the same, but carbohydrate and even fat can be used to increase calorie content. Carbohydrates will need to be consumed to a larger degree than at sea-level. DO NOT RESTRICTIVE ENERGY INTAKE AT ALTITUDE THIS WILL ALMOST DEFINATELY LEAD TO PERFORMANCE DECREMENTS.

On returning to altitude: If completing events separated by a return to altitude individuals that have done so should adapt better the second time around, providing they follow the guidelines listed above. Non-responders of altitude adaptation will have a marked decrease in performance when at altitude and not experience much adaptation across the period spent at altitude. Analysis of the data via a power meter and HR correlates will best enable identification of responders and non-responders. Bear in mind these aspects could be pertaining to genetic factors, or the 'health (homeostasis) of the individual when going to altitude. Importantly being well tapered for the event is critical.

Image 1: Yearly periodisation of altitude training (Saunders et.al 2018)

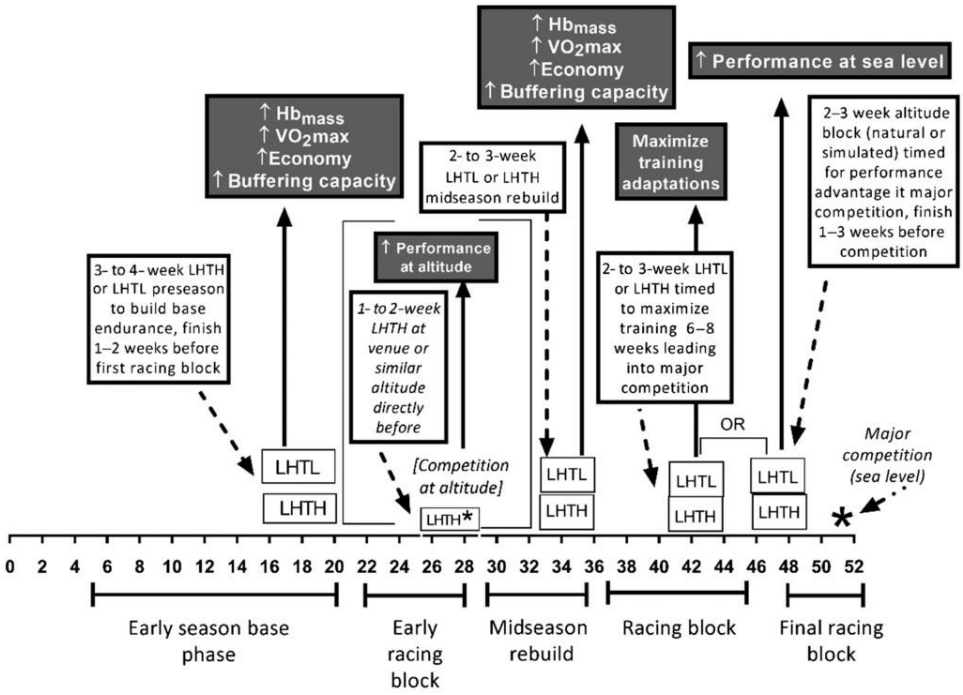

Image 2. Training recommendations based on altitude level (Saunders et.al, 2009)

TABLE 2. TRAINING RECOMMENDATIONS BASED ON ALITUDE LEVEL

Altitude (m)	*<1800*	*1800 to 2200*	*2200 to 3000*	*3000 to 3500*	*>3500*
Duration (weeks)	4 to 8	3 to 6	2 to 4	2 weeks	Not recommended
Typical training loads	Near normal to sea level	Lower intensity early; longer recoveries required for intense interval sessions	Higher volume, lower intensity throughout; intervals more around 5- to 10-km race pace	Low to moderate intensity training with emphasis on volume	Very minimal intensity during training and long build-in period required
Positives	Minimal training intensity disruption and shorter build-in period required for intense training	High enough to increase red blood cell production, especially over ~2000m	Relative intensity increased by 14% to 21%; means same metabolic load even though velocity is slower than at sea level	High training velocities during sprint training; almost certain increase in red blood cell production	Extremely high training velocities during sprint training
Negatives	Too low to induce increase in red blood cell production	Training intensity compromised (~3% to 6%) during 1500-m to 10-km race-pace interval sessions, especially early in camp	1500-m to 10-km race-pace training compromised (~6% to 12%) at 3000 m	Can cause overtraining and the inability to respond to hypoxia and training stimuli; 10,000 m race-speed training compromised by ~15% at 3500m	Too high and can lead to significant muscle atrophy;1500-m to 10-km race-pace training severely compromised
Ancillary factors prior to altitude training	Ideally conducted after a period of altitude training at higher altitude earlier in the preparation year	Iron supplement in few days preceding camp; efficacy of altitude camp is moderated by preceding "form;" being fresh and illness free; beneficial to have prior altitude training in previous years	Iron supplement in few days preceding; ideally, athletes should be fresh and illness free	Iron supplement for week or two beforehand; ideally, athletes should be fresh and illness free; only attempt altitude training this high if athletes have had several beneficial experiences at lower altitudes	Iron supplement in weeks preceding; essential to be fresh and illness free
Ancillary factors while at altitude	Useful as a top-up prior to competitions so that high-quality training can be undertaken at this lower altitude; these recommendations are for distance runners, but general guidelines are applicable for other endurance athletes	Daily iron supplements; allow for adequate recovery between training; no intense longer- duration work in first few days; compared with sea level, 2 to 3 times longer recoveries advisable during interval sessions (1500-m to 5-km race pace)	Daily iron supplements; start off easy with no intense training, especially in first week to avoid overtraining; 5- 10-km race-pace intervals done with 1.5 to 2 times longer recoveries than at sea level	Daily iron supplements; concentrate on low intensity, higher volume training; short efforts (≤200 m) to retain neuromuscular patterning; longer recoveries (3 to 4 times sea-level equivalent) for interval sessions (focus on 10-km race pace).	Daily iron supplements; only low-intensity training possible; some short-duration (≤200 m) speed work to retain neuromuscular patterning; very long recoveries (4 to 5 times sea-level equivalent) in longer-interval sessions (focus on 10- to 21.1-km race pace)

These recommendations are for distance runners but general guidelines are applicable for other endurance athletes.