Training and Racing at Altitude

Racing 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.

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.

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.
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.
3. Going to altitude then returning to sea level, then returning to altitude after a month break is best for optimising adaptation to altitude.
4. People who live at altitude are much better prepared than sea level dwellers owing to chronic exposure.
5. There are aspects pertaining to pre-race taper that will best prepare you for exercise.
6. There are some dietary aspects outlined below that will assist in best preparing you for exercise.

When tapering prerace at altitude: Performance in shorter events (*1 to 2 min) is relatively unaffected at moderate altitude (Peronnet et al., 1991), and this fact can be utilized when training elite athletes at altitude. To avoid a reduction in race-specific fitness, athletes should undertake a series of shorter race-pace efforts where velocity is not compromised (or possibly enhanced due to the reduced air density; Peronnet et al., 1991) and for which they have longer recoveries than at sea-level to maintain speed during the entire training session. See the Table below.

Eat well at altitude: When at altitude your metabolism is increased as your body begins using resources through adaptation. Thus 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.

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. 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.

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. 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.

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Table of best tapering practice is shown below:

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 ~2000 m	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 3500 m	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.