

Altitude and the Body

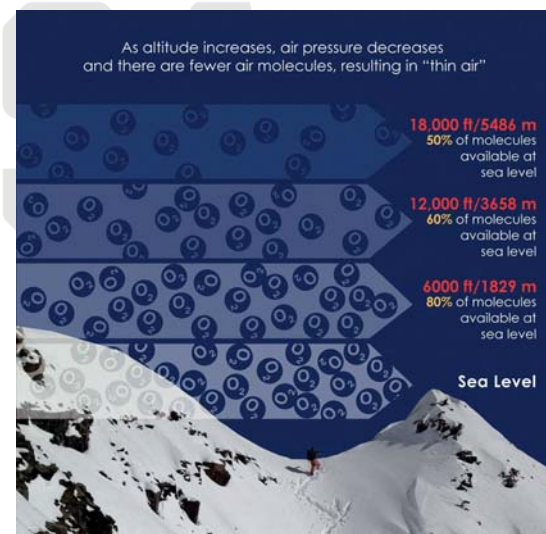
At higher elevations, oxygen molecules are more spread out than they are at sea level. As a result, inhalation and breathing delivers less oxygen to working tissues per breath of air.

"Altitude training" generally takes place at moderate altitudes that range anywhere from 4,920-9,840 feet above sea level. The increase in elevation causes a cascade of physiological adaptations to occur for the body to maintain the same balance of gas exchange and delivery, both at rest and during exercise. Although performance may be significantly decreased at first, the body eventually adapts to lower levels of oxygen by using less oxygen for the same amount of work. This adaptation can be especially beneficial for endurance sports, high intensity team sports, and anaerobic sports like track sprinting or mogul skiing. Athletes may use altitude training to improve performance at both sea level and altitude.

Key Points

Be prepared for the additional stress altitude can place on the body before traveling to or competing at altitude. Make sure to:

1. Be well rested and healthy (no cold or flu)
2. Know iron status and treat if iron deficient
3. Eat enough calories and carbohydrates to support the additional stress of altitude
4. Effectively manage training load by minimizing high intensity training in the first few days at altitude



Effects of Altitude Exposure

Initial Effects (within the first 72 hours)

- ↑ Iron needs
- ↓ Restful sleep (breathing pattern changes)
- ↑ Risk of dehydration (frequent urination)
- ↑ Headaches
- ↑ Reliance on stored carbohydrate (glycogen)
- ↑ Resting metabolism and ↓ appetite (weight loss)
- ↑ Adaptive pro- and anti-inflammatory responses

Effects of Acclimatization

Following 2-3 weeks training at altitude

- ↑ Oxygen-carrying capacity of blood
- ↑ Efficiency of oxygen utilization in muscles
- ↑ Formation of new blood vessels
- ↑ pH regulation = ↑ exercise tolerance
- ↓ Heart rate
- ↑ Red blood cell volume for 10-14 days after leaving altitude

"Sleep High, Train Low"

This method of altitude training can be done by:

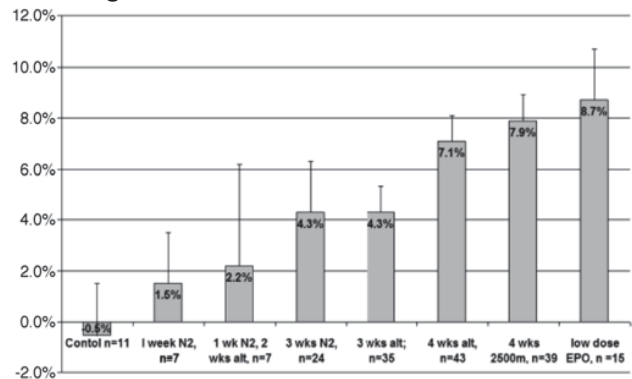
1. Living at lower elevations and sleeping in an altitude-simulating chamber or tent
2. Living at a high elevation, but traveling to sea level to train
3. Living at a high elevation, but using supplemental oxygen when training

Training at altitude limits the ability to perform high-intensity exercise, even when acclimated, which is why athletes tend to "sleep high" (to adapt to lower oxygen concentration) but "train low" (to perform at a higher intensity).

How Long Should it Take to Adapt?

A minimum of 3 weeks of altitude exposure is recommended for athletes **if they are healthy, well-rested, and have sufficient iron stores before arriving**. Evidence suggests additional benefits after 4 weeks of exposure due to increases in red blood cells.

Changes in Percent Red Blood Cell Mass



Nutritional Strategies for Travel to Altitude - Before and During Training Blocks

1. Hydration

- Drink regularly throughout the day, in training, and in competition. Don't wait until thirsty.
- Check morning urine color and body weight as well as bathroom frequency to monitor status.

2. Iron Status

- Increase intake of lean beef, eggs, oysters, lean pork, tuna, lentils, beans, tofu, and fortified cereal.
- Get a blood test **at least 6 weeks before** leaving for altitude training to allow time to correct any existing deficiency. Particularly important for vegetarians and those with a history of iron deficiency.
- Consult with a sport dietitian or medical provider to determine if an iron supplement should be used during altitude training.

3. Immune Health

- Eat a variety of colorful fruits and vegetables (red, orange, yellow, green, purple, blue, white) to combat increased oxidative stress associated with moderate to high altitude exposure.
- Ensure adequate rest and recovery as it may be disturbed in the first few nights at altitude.

4. Metabolism

- Focus on eating 3 balanced meals and 2-3 protein-containing snacks per day.
- Consider adding a few extra servings of carbohydrate to your usual dietary intake.
- Attempt to maintain body weight during intense altitude training.

5. Sleep

- Have a plan in place to prevent sleepless nights. For ideas, see a sport psychologist.
- Foods that may enhance sleep: tart cherry juice, herbal teas, lean meats, whole grains, nuts.
- Foods that negatively affect sleep: caffeine, alcohol, fried food, high-calorie meals close to bedtime.