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## EXERCISE AT ALTITUDE

Although the human body tolerates small fluctuations in air pressure, large variations pose special problems. This is evident when mountain climbers ascend to higher altitudes where reduced pressure can substantially impair physical performance. This article looks at the special characteristics of high altitude, hypobaric (low pressure) environments and how these conditions effect the human body.

At sea level, the 'barometric pressure' averages about 760mmHg. At the summit of Mount Everest, the highest point on Earth (38.6km), the pressure exerted by the air is only about 250mmHg. Although barometric pressure varies, the percentage of gases in the air that we breathe remain unchanged from sea level to high altitude. At any elevation, the air contains 20.93% oxygen, .03% carbon dioxide and 79.04% nitrogen. However, as barometric pressure drops so does the pressure of oxygen that reaches the lungs, as well as the gradient between the lungs and blood and the blood and the muscles. Translation: you feel the unpleasant effects of oxygen deprivation, also known as 'hypoxia'.

The human body responds instantly when exposed to high altitude. Within seconds of exposure, receptors in the cardiovascular system stimulate the brain to increase breathing. The increased depth and rate of breathing helps to offset the decrease in oxygen pressure in the body and the negative effects that go along with it.

Within the first few hours of arrival at altitude, a person's plasma volume begins to progressively decrease and it pateauas by the end of the first few weeks. This decrease in plasma volume is the result of respiratory water loss (water in the air we exhale) and increased urine production. Essentially, dehydration of the body occurs resulting in a reduced total plasma volume of up to 25%. This is the body's way of increasing the concentration of red blood cells (which carry oxygen), allowing more oxygen to be delivered to the muscles.

Long term exposure to altitude results in additional changes including increased red blood cell production. However, these changes are slow, taking weeks to months to fully restore red cell mass.

Acute altitude sickness is characterized by symptoms such as headaches, nausea, vomiting, dyspnea (difficulty breathing), and insomnia. These symptoms can begin anywhere from 6-48 hours after arrival at high altitude and more most severe on days 2 and 3. Although not life threatening, altitude sickness can be incapacitating for several days or longer. In some cases the condition can worsen. In some cases, if steps are not taken to control altitude sickness, more lethal illness including pulmonary edema or cerebral edema can develop.

The incidence of altitude sickness varies with the altitude, rate of ascent and the individual's susceptibility. Studies have determined that at elevations of 2, 500-3,500m the incidence of altitude sickness is about 7% for men and 22% for women, but the reason for this difference is unclear.



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Headache is the most common symptom associated with ascent to high altitude. The headache at altitude, which many sufferers describe as continuous and throbbing, is typically worse in the morning and after exercise. Alcohol consumption worsens the symptoms.

How can you avoid acute altitude sickness? No evidence indicates that superior physical conditioning prevents the symptoms and some data suggests that young, fit individuals may be more prone to experiencing symptoms.

A gradual ascent of no more than 300m per day at elevations above 3000m has been suggested to minimize the risks of altitude sickness. Speak to your doctor about drugs that have been used to reduce the symptoms. Currently acetazolamide started the day before the ascent is the established preventative measure. The definitive treatment for severe altitude sickness conditions such as pulmonary and cerebral edema is a retreat to lower altitude.

People can usually prevent acute altitude sickness and enjoy the mountains without enduring severe symptoms by gradually ascending to altitude and spending periods of a few days at lower elevations.

Happy Trails!

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