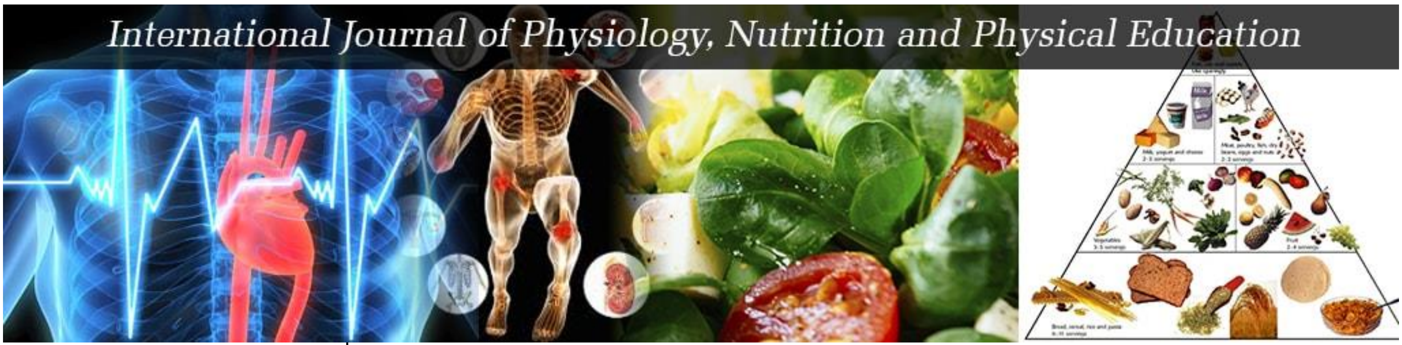

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High altitude illness and recovery: An insight

Bijender Singh and Dr. Sandeep Bhalla

Abstract
Risk factors for developing high altitude (2500-3500 metres) illness include previous history of high-altitude illness, a faster rate of ascent, higher elevation, poor hydration, increased intensity of physical activity, and individual variability. Slow ascent to altitude is the hallmark of prevention for all acute high-altitude illnesses. Three main syndromes of altitude illness may affect travellers: acute mountain sickness, high altitude cerebral oedema, and high-altitude pulmonary oedema. Allowing for the physiologic adaptations of acclimatization to occur through graded and gradual ascent to high altitude is the best strategy for safe participation at altitude. The adaptive process of acclimatization provides for improved aerobic capacity at altitude, which is critical for optimal athletic performance.

Keywords: High altitude; high altitude illness; high altitude recovery

Introduction

Altitude illness is common in people ascending to more than 2500 metres, especially if the ascent is rapid. In most cases it will manifest as a mild, self-limiting illness but in a few cases, it will progress to more severe, life threatening forms [1]. As more people travel to high altitudes for economic or recreational purposes, altitude medicine has become increasingly important. Doctors may be asked to give advice to people planning an excursion to high altitudes or to help with patients while they themselves are travelling. Altitude illness should be anticipated in travellers to altitudes higher than 2500 metres, although for most it will be mild, and self-limiting, and will not require the intervention of a doctor. Rarely altitude illness may progress to more severe forms, which can be life threatening. The best method of preventing altitude illness is to ascend slowly, allowing time for acclimatisation. The mainstay of treatment is descent, and drugs and other treatments should be used mainly to aid this.

Expanding athlete participation in high-altitude environments highlights the importance for a sports physician to have a good understanding of the high-altitude illness (HAI) syndromes: acute mountain sickness (AMS), high-altitude cerebral oedema (HACE), and high-altitude pulmonary oedema (HAPE). All may occur in the setting of acute altitude exposure higher than 2500 m; incidence and severity increase as altitudes or ascent rates increase. Once HAI is recognized, proven therapies should be instituted to alleviate symptoms and avert the possibility of critical illness. Allowing for acclimatization is the best strategy for preventing HAI. Acetazolamide and dexamethasone are additional preventive measures for AMS/HACE; nifedipine, salmeterol, and phosphodiesterase inhibitors are useful in preventing HAPE. Along with the immediate hazards of HAI with altitude exposure, the sport physician also should be familiar with altitude/hypoxic training practices used by athletes to enhance fitness and performance.

Children, pregnant women, and elderly people at altitude: impact assessment

Children are not at greater risk of altitude illness than adults and may be at lower risk. In addition, children do not experience altitude illness of greater severity than adults. Male children and children with a greater body mass index may be at greater risk for altitude illness compared with other children, though there is no correlation between altitude illness and physical fitness. However, children who develop severe altitude illness including HAPE should be evaluated for underlying cardiopulmonary abnormality. Treatment of altitude-related illness in children consists primarily of descent to lower altitude.

Medications for treatment and prevention of altitude-related illnesses in children are the same as used for adults. It is important to remember that use of these medications is based on clinical experience not on primary studies in children.
Aging is not a risk factor for altitude illness, and in fact, may be protective against severe altitude illness. The reason for this is not well understood, but it may be due to the known decrease in brain size with aging, which results in an increase in cranial compliance.

Children

- Altitude illness seems to have the same incidence in children as in adults, but the diagnosis may be delayed in children too young to describe their symptoms
- Any child who becomes unwell at altitude should be assumed to be having altitude illness unless a clear alternative diagnosis is obvious
- The principles of treatment are the same as in adults
- Lowland infants taken to altitude are at risk of developing pulmonary hypertension and subacute mountain sickness (also called high altitude heart disease)
- It remains unclear whether ascent to altitude increases the risk of sudden infant death syndrome

Pregnant women

- There are very few data on the risks of travelling to altitude when pregnant
- Studies from altitude residents indicate few differences in foetal oxygenation at altitudes below 3000 metres
- Data from small studies and the experience of the airline industry indicate that exposure to normal aircraft cabin pressure or altitudes <2500 metres in later pregnancy (up to 37 weeks) is safe, provided that no other complications of pregnancy have occurred
- There are very few data about pregnant lowlanders travelling to altitudes above 2500 metres
- Conditions that reduce maternal oxygenation, such as altitude illness, carboxyhemoglobin (exposure to cigarettes and fires), or other conditions impairing oxygen carriage, should be avoided or treated aggressively

Elderly People

- The risk of altitude illness does not seem to increase with increasing age
- Provided a traveller is fit, age is not a barrier to travel
- Exercise capacity and performance may be reduced and may also be affected by other medical conditions
- Elderly patients should limit their activity during the first few days at altitude to allow acclimatisation to take place

Definitions of altitude and associated physiological changes

1. Intermediate altitude (1500-2500 metres): Physiological changes detectable. Arterial oxygen saturation >90%. Altitude illness possible but rare
2. High altitude (2500-3500 metres): Altitude illness common with rapid ascent
3. Extremely high altitude (3500-5800 metres): Altitude illness common. Arterial oxygen saturation <90%. Marked hypoxaemia during exercise
4. Extreme altitude (>5800 metres): Marked hypoxaemia at rest. Progressive deterioration, despite maximal acclimatisation. Permanent survival cannot be maintained

Causation

Three main syndromes of altitude illness may affect travellers: acute mountain sickness, high altitude cerebral oedema, and high-altitude pulmonary oedema. The risk of dying from altitude related illnesses is low, at least for tourists. For trekkers to Nepal the death rate from all causes was 0.014% and from altitude illness 0.0036% [3]. Soldiers posted to altitude had an altitude related death rate of 0.16% [2]. In British climbers attempting peaks over 7000 metres, altitude related illnesses contributed to death in 17% [4]. Risk factors for developing altitude illness include the rate of ascent, the actual altitude reached, the altitude at which the traveller sleeps, and individual susceptibility. Physical fitness is not protective, and exertion at altitude increases a traveller's risk of becoming unwell. Genetic make-up may also influence performance at altitude. Most pre-existing illnesses, such as chronic obstructive airways disease or diabetes, are not in themselves risk factors for developing altitude illness.
There have been cases during events such as mountain races, athletes may experience very rapid ascent to high altitudes, which places them at high risk for developing altitude illness. At any point 1-5 days following ascent to altitudes 2500 m, individuals are at risk of developing one of three forms of acute altitude illness. Acute mountain sickness (AMS), a syndrome of nonspecific symptoms including headache, lassitude, dizziness and nausea; high-altitude cerebral oedema (HACE), a potentially fatal illness characterized by ataxia, decreased consciousness; and high-altitude pulmonary oedema (HAPE), a non-cardiogenic form of pulmonary oedema resulting from excessive hypoxic pulmonary vasoconstriction which also can be fatal. Risk factors for developing high altitude illness include previous history of high-altitude illness, a faster rate of ascent, higher elevation, poor hydration, increased intensity of physical activity, and individual variability. Slow ascent to altitude is the hallmark of prevention for all acute high-altitude illnesses. Guidelines recommend that once above 2500 m, altitude should be increased at a rate of 400 m to 500 m per day. Duration of an effective acclimatization also depends on the athlete’s residing altitude and the altitude to which the athlete plans to ascend. The athletes may be at lower risk for these illnesses at lower elevation less than 2000 m. Still appropriate measures should be in place as some individuals who are highly susceptible to acute altitude illness may become symptomatic at altitudes <2500 m. Acute mountain sickness (AMS) can be more common in the lower elevations. The athletes of poor subjective sleep quality is should be cautious as insomnia can become a risk factor for AMS.

Acclimatisation and rates of ascent

- Above 3000 metres increase your sleeping altitude by only 300-600 metres per day
- Above 3000 metres take a rest day for every 1000 metres of elevation gained
- Different people will acclimatise at different rates
- If possible, do not fly or drive directly to high altitude
- If you do go directly to high altitude by car or plane, do not overexert yourself or move higher for the first 24 hours
- “Climb high and sleep low”
- If symptoms are not improving, delay further ascent
- If symptoms deteriorate, descend as soon as possible

Risk Factors and Associated Sickness

During certain athletic events such as mountain races, athletes may experience very rapid ascent, which places them at high risk for developing altitude illness. Risk factors for developing high altitude illness include previous episodes of high-altitude illness, a faster rate of ascent, higher elevation, poor hydration, increased intensity of physical activity, and individual variability. Slow ascent to altitude is the hallmark of prevention for all acute high-altitude illnesses (AHAIs). Guidelines recommend that once above 2500 m, altitude should be increased at a rate of 600 to 1200 m per 24-hour period. Duration of an effective acclimatization also depends on the athlete's residing altitude and the altitude to which the athlete plans to ascend. Methods using hypobaric hypoxic chambers or true high altitude may be more effective for acclimatization than those using normobaric hypoxic conditions. Pharmacologic prevention should be considered as an adjunct to slow ascent and proper acclimatization, or when this is not feasible (e.g., during mountain bike and foot races). There are limited data on the effectiveness of agents other than acetazolamide for prevention and treatment of acute mountain illness. The adverse effects of acetazolamide are uncommon and include paraesthesia, urinary frequency, and dysgeusia.

Athletes with Acute Mountain Sickness (AMS) should not continue ascent until symptoms resolve and should consider descent if medical management does not resolve symptoms. Medical providers should advise athletes with High Altitude Cerebral Oedema (HACE) or High-Altitude Pulmonary Oedema (HAPE) to immediately descend to a lower altitude and be followed for medical management. The preferred rate of Acclimatization has not been well studied. Chronic Mountain Sickness (CMS) is an uncommon condition among highlanders. Its prevalence has direct correlation with altitude of residence. CMS is characterized by extreme polycythaemia, pulmonary hypertension, severe right ventricular hypertrophy, low systemic blood pressure, hypoventilation, and chronic arterial oxygen desaturation.

Treatment of altitude illness

Mild acute mountain sickness

- Rest days, relaxation; consider descent
- Aspirin, paracetamol, ibuprofen
- Antiemetics may be useful
- Acetazolamide may be considered

Severe acute mountain sickness and high-altitude cerebral oedema

- Descent, evacuation, oxygen
- Dexamethasone
- Pressure bag to facilitate descent

High altitude pulmonary oedema

- Descent, evacuation, oxygen
- Nifedipine
- Pressure bag to facilitate descent

Altitude illness, type unknown

- Descent, evacuation, oxygen
- Dexamethasone
- Nifedipine
- Pressure bag to facilitate descent

Pre-existing medical conditions and altitude illness

Cardiac disease

- The risk of ischaemic heart disease in previously well trekkers is not increased
- Angina of effort at sea level is likely to worsen at altitude, and ascent to moderate altitude may precipitate angina in patients with previously stable coronary artery disease
- Well controlled hypertension is not a contraindication to travel to altitude
- Tests such as an electrocardiogram have no benefit in predicting potential problems at altitude
- Echocardiography while the patient is breathing a hypoxic gas mixture will identify someone whose hypoxic pulmonary vascular response is brisk, but this test is not discriminatory for the development of altitude illness

Asthma

- Asthma is generally unaffected by travel to altitude
- There is no evidence that people with asthma are at greater risk of altitude illness than people without asthma
- Some peak flow meters may be inaccurate at altitude

Chronic obstructive airways disease

- Symptoms at sea level will be worse at altitude, and performance will deteriorate. Infectious exacerbations are a greater risk, so appropriate antibiotics should be carried, and treatment started early
- Patients with interstitial lung disease, such as cystic fibrosis, are at high risk of deterioration on travelling to altitude

Diabetes mellitus

- Exposure to altitude does not worsen diabetes
- Symptoms of hypoglycaemia may be confused with high altitude cerebral oedema
- Diabetic patients should have ready access to glucose supplements, and their companions should be aware of the symptoms and management of hypoglycaemia
- Some blood glucose monitors may be inaccurate at altitude

Epilepsy

- Altitude does not increase the risks of seizures in patients with well controlled epilepsy
- The consequences of an epileptic seizure may be more severe in a remote mountain area

Conclusion

Because of the potentially dangerous nature of high-altitude illnesses, conservative management, including prompt descent to lower altitude, is essential to prevent life-threatening conditions. Altitude training is a popular training method particularly among elite athletes. Effects of altitude training on athletic performance seem to be at best minimum and temporary. Most studies were conducted on individual endurance athletes; hence, the effects on team-sport athletic performance is unknown. Because of the potentially dangerous nature of high-altitude illnesses, conservative management, including prompt descent to lower altitude, is essential to prevent life-threatening conditions. Altitude training is a popular training method particularly among elite athletes. Effects of altitude training on athletic performance seem to be at best minimum and temporary. Most studies were conducted on individual endurance athletes; hence, the effects on team-sport athletic performance is unknown [5].

- Altitude related illness is rare at altitudes below 2500 metres but is common in travellers to 3500 metres or more
- The occurrence is increased by a rapid gain in altitude and reduced by a slow ascent, allowing time for acclimatisation
- For most travellers, altitude related illness is an unpleasant but self-limiting and benign syndrome, consisting chiefly of headache, anorexia, and nausea

- More severe forms of illness including cerebral or pulmonary oedema may occur and may be fatal, particularly if not recognised
- The treatment of altitude related illness is to stop further ascent and, if symptoms are severe or getting worse, to descend
- Oxygen, drugs, and other treatments for altitude illness should be viewed as adjuncts to aid descent

In sum, the acclimatized athlete will be physiologically disadvantaged when competing against the acclimatized athlete at a given high-altitude venue. The adaptive process of acclimatization provides for improved aerobic capacity at altitude, which is critical for optimal athletic performance. As athletic and recreational events taking place in high-altitude environments increase in both number and participation, increasing attention should be given to the potential hazards posed to athletes within this environment. AMS, HACE, and HAPE comprise the key HAI syndromes of importance because of both their common occurrence (in the case of AMS) and their potential for serious harm (in the cases of HACE and HAPE). Physicians managing the care of athletes in high-altitude venues need to be aware of and use the effective treatment and preventive strategies for the HAI syndromes described in this article. Allowing for the physiologic adaptations of acclimatization to occur through graded and gradual ascent to high altitude is the best strategy for safe participation at altitude. The cornerstone of treatment for all HAI is improvement in oxygenation, through rest and acclimatization in mild AMS, and through rapid descent and oxygen administration in more severe circumstances of HACE and HAPE. Several athletic training models incorporating altitude or artificially induced hypoxic environments are being used by contemporary athletes to improve performance because of the presumed advantageous physiologic changes that occur with acclimatization. Evidence supporting performance benefit from any of these models (LH+TH, LH+TL, or LL+TH) is limited and inconclusive at this time. Prudent training advice for the athlete competing at altitude is to plan and allow for full acclimatization before the event through both exposure and practice within the altitude setting.

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