

ELEVATION MEASUREMENTS

ALTITUDE	FEET	EFFECTS OF ALTITUDE
Low	Sea Level - 5,000	None
Moderate	5,000 - 8,000	Mild, temporary altitude illness may occur
High	8,000-14,000	Altitude illness and decreased performance is increasingly common
Very High	14,000-18,000	Altitude illness and decreased performance is the rule
Extreme	18,000-higher	With acclimatization, humans can function for short periods of time

Medical Terms

AMS	Acute mountain sickness
Apnea	Temporary pause of breathing
Edema	A local or general condition in which the body tissues contain an excessive amount of tissue fluid
HACE	High altitude cerebral edema (brain edema)
HAPE	High altitude pulmonary edema (lung edema)
Hypobaric hypoxia	Decreased availability of oxygen in ambient (surrounding) air
Hypoxia	Low oxygen content; decreased concentration of oxygen in inhaled air

THE HUMAN BODY'S RESPONSE TO HIGH ALTITUDE

Hypobaric hypoxia lowers the oxygen supply to the body, which in turn causes altitude illnesses and reduced physical and mental performance. Hypobaric hypoxia may also increase the likelihood of other environmental injuries (e.g., cold) or worsen preexisting medical conditions.

Altitude acclimatization allows soldiers to achieve the maximum physical work performance possible for the altitude to which they are acclimatized. Once acquired, acclimatization is maintained as long as the soldier remains at altitude, but is lost upon return to lower elevations. Exposure to higher altitudes requires further acclimatization.

For most soldiers at high to very high altitudes, 70-80% of respiratory component of acclimatization occurs in 7-10 days; 80-90% of overall acclimatization is generally accomplished by 21-30 days. Maximum acclimatization may take months to years. Note: There does not seem to be any way to speed acclimatization; some soldiers acclimatize more rapidly than others, and few soldiers may not acclimatize at all. There is no reliable way to identify soldiers who cannot acclimatize except by their experience during previous altitude exposures.

ACCLIMATIZATION

Staged Ascent: Requires soldiers to ascend (rise) to a moderate altitude and remain there for 3 days or more to acclimatize before ascending higher. When possible, soldiers should make several stops for staging during the ascent to allow a greater degree of acclimatization.

Graded Ascent: Limits the daily altitude gain to allow partial acclimatization. The altitude at which soldiers sleep is the critical element in this regard. Having soldiers spend two nights at 9,000 ft and limit the sleeping altitude to no more than 1,000 ft per day above

the previous night's sleeping altitude will significantly reduce the incidence of altitude illness.

A combination of graded ascent and staging is the safest and most effective method for prevention of high altitude illnesses.

HIGH ALTITUDE ILLNESSES

* IMPORTANT NOTE! The preferred step in treating any high altitude illness is to evacuate the soldier to a lower altitude.

Acute Mountain Sickness (AMS) is caused by rapid ascent (altitude gain in 24 hours or less) to high altitudes. Symptoms include headache, nausea, vomiting, fatigue, irritability, and dizziness, and appear 3 to 24 hours after ascent. Everyone is susceptible.

Staging, graded ascent, or movement to a lower altitude can prevent AMS. Consuming carbohydrates can reduce AMS symptoms (whole grains, vegetables, peas and beans, potatoes, fruits, honey, and refined sugar).

In situations where there is insufficient time for staged or graded ascent, soldiers may have to use medications to prevent AMS. Acetazolamide, the preferred medication for preventing AMS, will prevent symptoms in nearly all soldiers and reduce symptoms in most others. Use of any medication, including acetazolamide, should be discussed with physicians trained in high-altitude/wilderness medicine.

AMS symptoms will normally subside in 3-7 days if soldiers do not continue to ascend. Once symptoms are resolved, soldiers can resume gradual ascent. Soldiers who continue to show signs of AMS must be observed for development of HAPE or HACE, both of which are potentially fatal.

High Altitude Pulmonary Edema (HAPE) occurs when unacclimatized individuals rapidly ascend to high altitudes or when acclimatized soldiers ascend rapidly from a high to a higher altitude. Untreated, HAPE can be rapidly fatal and is the most common cause of death among the altitude illnesses. Soldiers experiencing AMS who are not treated and continue to ascend to higher altitudes are at significant risk for HAPE.

HAPE usually begins within the first two to four days after rapid ascent to altitudes greater than 8,000 ft and generally appears during the second night of sleep at high altitude. Symptoms include coughing, noisy breathing, wheezing, gurgling in the airway, difficulty breathing, and deteriorated mental status (confusion, vivid hallucinations). Ultimately coma and death will occur without treatment.

Countermeasures for HAPE include: proper acclimatization; sleeping at the lowest altitude possible; avoiding cold exposures; and avoiding strenuous exertion until acclimatized. Immediate descent is recommended as the best treatment for HAPE. Soldiers with AMS should be monitored carefully since AMS can rapidly evolve to HAPE.

High Altitude Cerebral Edema (HACE) is the most severe illness associated with high altitudes. Individuals with HACE are frequently found to also have HAPE. As with other high altitude illnesses, HACE is caused by rapid ascent to high elevations without proper acclimatization. Soldiers with AMS who continue ascent are considered to be at high risk for development of HACE.

HACE generally occurs later than AMS or HAPE. Untreated, HACE can progress to death over 1 to 3 days and, in some instances, in less than 12 hours. Symptoms often resemble AMS (severe headache, nausea, vomiting); however, a more dramatic signal that HACE may be developing is a swaying upper body, especially when walking. Early mental changes may include confusion, disorientation, and drowsiness.

Soldiers may appear to be withdrawn or demonstrate behavior generally associated with fatigue or anxiety.

Countermeasures for HACE include: following countermeasures for AMS and HAPE (acclimatization, etc.) and immediate evacuation (descent) for soldiers with HACE symptoms. Again, soldiers with AMS or HAPE should be monitored carefully for signs of HACE.

Under no circumstances should soldiers with severe AMS symptoms or suspected HAPE or HACE be allowed to continue ascent.

Subacute Mountain Sickness occurs in some soldiers during prolonged deployments (weeks/months) to elevations above 12,000 ft. Symptoms include sleep disturbance, loss of appetite, weight loss, and fatigue. This condition reflects a failure to acclimatize adequately.

Poor wound healing may occur at higher elevations resulting from lowered immune functions. Injuries resulting from burns, cuts, or other injuries may require descent for effective treatment and healing.

ENVIRONMENTAL THREATS

Conditions that are not unique to high mountain environments but commonly occur at high elevations include:

Cold Injuries. Once a soldier has acclimatized to altitude, cold injuries are generally the greatest threat. Frequent winds in mountain areas cause extremely low wind-chill. Because hypoxia-induced psychological effects can result in poor judgment and decision-making, a higher incidence of cold injuries should be anticipated.

Countermeasures for cold injuries include command emphasis in: maintaining nutrition; drinking plenty of fluids; and dressing in layers.

Injuries Caused by Sunlight. The potential for solar radiation injuries, caused by sunlight, is significant at high altitudes due to increased ultraviolet (UV) radiation (resulting from thinner atmosphere), and reflection of light from snow and rock surfaces. Solar radiation injuries can be severe and occur with much shorter exposure at high altitude. Injuries include sunburn and snow blindness.

Sunburn may be more likely to occur on partly cloudy or overcast days when soldiers may not be aware of the threat and do not take appropriate precautions. Some medications can also increase the threat of injury, including Acetazolamide. Application of sun block (at least 15 SPF) to exposed skin, face, and neck will help prevent instances of sunburn.

Snow blindness results from UV light absorption by the external parts of the eyes, such as the eyelids and cornea. There is no sensation, other than brightness, as a warning that eye damage is occurring with resulting sunburn-like damage occurring in a few hours. Sunglasses or goggles with UV protection will prevent snow blindness. Sunglasses with side protectors are recommended.

Terrain Injuries. Soldiers should be aware of the dangers of high altitude including avalanches and falls. Poor judgment at high altitude increases the risk of injury. The potential for being struck by lightning is also increased at higher altitudes, especially at areas above tree lines. Protective measures include taking shelter in solid-roofed structures or vehicles, staying low, and avoiding tall structures or large metal objects.

Carbon Monoxide (CO) Poisoning is a frequent hazard and is caused by the inefficient fuel combustion resulting from the low oxygen content of air and higher usage of stoves, combustion heaters, and engines in enclosed, poorly ventilated spaces. Cigarette smoking is another source of CO. Countermeasures to prevent CO poisoning include

ensuring soldiers do not: sleep in vehicles with engines running, or cook inside tents or sleep inside tents with working combustion heaters or stoves without adequate ventilation.

Non-Battle Injuries. Hypoxia and cold can impair judgment and physical performance resulting in a greater risk of injury while maneuvering in rugged terrain. Heavy clothing worn for protection against the cold and specialized equipment can also restrict movement. Non-battle injuries can be prevented by carefully observing safety procedures.

Infectious Diseases. Although there is generally a reduced threat of disease at higher elevations, soldiers should still take precautions to avoid diseases caused by insects, plants, and animals, and diseases transmitted person to person.

At moderate to high altitudes, insect-borne disease (from mosquitoes, ticks and flies) is common in most regions. In some areas, malaria-bearing mosquitoes range as high as 6,000 ft. The threat of diseases transmitted from person to person is increased at higher, cold climates since soldiers are more likely to gather together to keep warm.

HIGH MOUNTAIN OPERATIONS

Reduced Physical Performance. Hypobaric hypoxia causes a reduction in physical performance of soldiers deployed to high altitudes. Soldiers cannot maintain the same physical performance at high altitude that they can at low altitude, regardless of their fitness level.

Countermeasures to prevent disease and injury include ensuring acclimatization; adjusting work rates and load carriage; planning frequent rests during work and exercise; and planning and performing physical training programs to altitude.

Psychological Effects. Altitude exposure may result in changes in senses (vision, taste, etc.), mood, and personality. These effects are directly related to altitude and are common at over 10,000 ft. Some effects occur early and are temporary while others may persist after acclimatization or even for a period of time after descent.

Vision is generally the sense most affected by altitude exposure. Dark adaptation is significantly reduced, affecting soldiers as low as 8,000 ft. and can potentially affect military operations at high altitude.

Mental effects most noticeable at very high and extreme altitudes include decreased perception, memory, judgment, and attention. To compensate for loss of functional ability, soldiers should devise a strategy of a tradeoff between speed and accuracy -- allow for extra time to accomplish a task to minimize errors (and injuries).

Alterations in mood and personality traits are common during high-altitude exposures.

* Within hours of ascent, many soldiers may experience euphoria (joy, excitement) that is likely to be accompanied by errors in judgment leading to mistakes and accidents. Use of the buddy system during this early exposure time helps to identify soldiers who may be more severely affected.

* After a period of about 6-12 hours, euphoria decreases, often changing to varying degrees of depression. Soldiers may become irritable, or may appear listless.

Instilling a high morale and esprit de corps before deployment and reinforcing these frequently during deployment will help minimize the impact of negative mood changes.

Sleep Disturbances. High altitude has significant harmful effects on sleep. The most prominent effects are frequent periods of apnea and fragmented sleep. Sleep disturbances may last for weeks at elevations less than 18,000 ft and may never stop at higher elevations.

Reports of "not being able to sleep" and "awake half the night" are common and may also contribute to mood changes and daytime drowsiness. These effects have been reported at elevations as low as 5,000 feet and are very common at higher altitudes.

Acetazolamide has been found to improve sleep quality at high altitudes and reduce AMS and other altitude illnesses, an added benefit. Sleeping pills and other medications that promote sleep or drowsiness should be taken only with medical supervision.

Dehydration is a very common condition in soldiers at high altitude. Causes include perspiration/sweating, vomiting, and hypoxia-induced diminishing of thirst sensation. Routine activities and chores performed at high altitudes require increased exertion. Even common activities, like walking, cause increased exertion, resulting in increased perspiration and contributing to hot or cold weather injuries.

Dehydration increases the likelihood of operationally significant problems including cold injuries and decreased physical abilities. Note: Many symptoms of dehydration and HACE are similar.

Soldiers can prevent dehydration by consuming 3 to 4 quarts of water or other non-caffeinated fluids (or more) per day. Thirst is not an adequate warning of dehydration. Commanders must monitor soldiers to ensure they drink enough fluids and do not become dehydrated as a result of diminished judgment or the desire to avoid latrines.

Nutrition. Poor nutrition contributes to illness or injury, decreased performance, poor morale, and susceptibility to cold injuries and can severely impact military operations. Influences at high elevations that impact nutrition include a dulled taste sensation (making food undesirable), nausea, or lack of energy or motivation to prepare or eat meals. Poor eating habits may also lead to constipation or aggravation of hemorrhoids.

Soldiers can reduce the effects of poor nutrition at high elevations by increasing the quantity of and eating all components of meals. Rations should be supplemented and frequent snacking encouraged. High carbohydrate snacks are recommended since they are easily carried by soldiers and require no preparation.

Other products that can seriously impact military operations include tobacco, alcoholic beverages, and caffeine.

Tobacco smoke interferes with oxygen delivery by reducing blood oxygen-carrying capacity; tobacco smoke in close, confined spaces increases the amounts of CO, and the irritant effect of tobacco smoke may produce a narrowing of airways interfering with optimal air movement. Smoking can effectively raise the "physiological altitude" as much as several thousand feet.

Alcohol impairs judgment and perception, depresses respiration, causes dehydration, and increases susceptibility to cold injury.

Caffeine from coffee and other sources may improve physical and mental performance; however, it also causes increased urination (leading to dehydration) and therefore should be consumed in moderation.

A SOLDIER'S GUIDE TO STAYING HEALTHY AT HIGH ELEVATIONS

This health threat and countermeasure information is from the most current data available from U.S. Department of Defense medical agencies at the time of production. Please note that:

- Health threats may change as a result of weather conditions, natural disaster, war, or disease outbreak.
- Health threats can become widespread with movement of displaced people and animals.
- Soldiers may be exposed to diseases common to other countries and regions when working with multinational forces.

OVERVIEW

High mountain environments are inherently dangerous. They can be unforgiving for those without adequate knowledge, training, and equipment. Commanders, medical support personnel, and soldiers must understand that the interaction of environmental conditions with mission responsibilities and individual and unit characteristics can significantly impact on the outcome of the mission. Adequate planning and preparedness can reduce or prevent adverse impacts.

The ideal condition for soldiers operating in high mountain terrain is to be in a high degree of acclimatization, since this achieves maximum physical and mental performance and minimizes the incidence of altitude illness. However, operational scenarios often limit the time needed to achieve acclimatization. All soldiers should be aware of the threats associated with operations in high altitudes and use personal protective measures in order to minimize disease and non-battle injuries, which in turn results in accomplishment of the operational mission.

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Prepared By:
**U.S. Army Center for Health Promotion &
 Preventive Medicine
 Aberdeen Proving Ground, Maryland**



In Coordination With:
**U.S. Army Research Institute of Environmental
 Medicine
 Natick, Massachusetts**

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