

**Environmental Threats**

Many environmental threats commonly occur at altitude.

**Cold Injuries:** Cold injuries are a threat at high altitude. Frequent winds in mountain areas cause extremely low windchill. Because altitude exposures can result in poor judgment and decision-making, more cold injuries should be anticipated. Countermeasures for cold injuries include command emphasis on maintaining nutrition, drinking plenty of fluids, and dressing in multiple, loose layers.

**WINDCHILL CHART**

Wind Speed (mph)	Temperature (°F)																	
	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Calm	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
5	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
10	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
15	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
20	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
25	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
30	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
35	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
40	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
45	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
50	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
55	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98
60																		

Frostbite Times:  30 minutes  10 minutes  5 minutes

Adequate planning and preparedness can reduce or prevent adverse impacts.

**Injuries Caused by Sunlight:** Solar radiation injuries caused by sunlight are likely at altitude due to increased ultraviolet (UV) radiation and reflection of light from snow and rock surfaces. Solar radiation injuries can be severe and occur with much shorter exposure at higher altitudes. Injuries caused by sunlight include:

**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. Use sun block (at least 30 SPF) to help prevent instances of sunburn.

**Snow blindness** occurs when UV light is absorbed by the external parts of the eyes, such as the eyelids and cornea. There is no warning, aside from brightness, that sunburn-like eye damage is occurring. Damage can occur in just 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 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 in areas above tree lines. Take shelter in solid-roofed structures or vehicles, stay low, and avoid tall structures or large metal objects.

**Carbon Monoxide (CO) Poisoning** is a frequent hazard and is caused by using stoves, combustion heaters, and engines in enclosed, poorly ventilated spaces. Cigarette smoking is another source of CO. To prevent CO poisoning, do not sleep in vehicles with engines running, do not cook inside tents, and do not sleep in tents without adequate ventilation while using combustion heaters or stoves. Seek fresh air immediately if CO poisoning is suspected.

**Non-Battle Injuries:** Altitude and cold can impair judgment and physical performance 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 high elevations, Soldiers should still take precautions to avoid diseases caused by insects, plants, and animals, as well as diseases transmitted from 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 1800m. 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.

**References:**

Refer to USACHPPM Technical Guide 273: Diagnosis and Treatment of Diseases of Tactical Importance to U.S. Central Command (2005) for more detailed information regarding altitude illnesses and treatments.

USACHPPM Technical Guide 273 is available at <https://usaphcapps.amedd.army.mil/HIOShoppingCart/>.

Technical Bulletin Medicine (TB MED) 505, Altitude Acclimation and Illness Management

Technical Bulletin Medicine (TB MED) 508, Prevention and Management of Cold-Weather Injuries

DISTRIBUTION UNLIMITED

Prepared By:  
U.S. Army Public Health Command  
Aberdeen Proving Ground, Maryland



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

JANUARY 2011  
SHG-028-0111

**Deployment Health Guide:  
A Soldier's Guide to Staying  
Healthy at High Elevations**

USAPHC

This deployment health guide provides information that can reduce your risk of injury and disease when deployed. Army G-1 Personnel Policy Guidance (<http://www.armyg1.army.mil/militarypersonnel/ppg.asp>) requires that you receive a preventive medicine briefing prior to your deployment.

**Overview**

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 mission outcome. In order to accomplish the operational mission, all Soldiers should be aware of the threats associated with operations at altitude and use personal protective measures in order to minimize disease and non-battle injuries.

**ELEVATION MEASUREMENTS**

ALTITUDE	METERS (m) / FEET (ft)	EFFECTS OF ACUTE ALTITUDE EXPOSURE
Low	Sea Level – 1200m / 4000 ft	None
Moderate	1200 – 2400m / 4000 – 7870 ft	Mild altitude illness and decreased performance may occur
High	2400 – 4000m / 7870 – 13,125 ft	Altitude illness and performance decrements are more common and greater
Very High	4000 – 5500m / 13,125 – 18,000 ft	Altitude illness and decreased performance is the rule
Extreme	5500m / 18,000 ft – and higher	With acclimatization, humans can function for short periods of time

## The Human Body's Response to Altitude

At altitude, there is decreased availability of oxygen in ambient (surrounding) air. This lowers the oxygen supply to the body, which can lead to altitude illnesses and reduced physical and mental performance. Altitude exposure may also increase the likelihood of other environmental injuries (e.g., cold injuries) or worsen pre-existing medical conditions. Some of the most common effects of altitude exposure on the human body include:

**Reduced physical performance:** Soldiers cannot maintain the same physical performance at altitude as they can at sea level, regardless of their fitness level.

Countermeasures include ensuring acclimatization, adjusting work rates and load carriage, planning frequent rests during work and exercise, and planning and performing physical training programs at altitude.

**Psychological Effects:** Altitude exposure may result in changes in senses (e.g., vision, taste), mood, and personality. These effects are directly related to altitude and are common at over 3,048m. 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 2,438m and can potentially affect military operations at altitude.
- Mental effects most noticeable at very high and extreme altitudes include decreased perception, memory, judgment, and attention.
- Alterations in mood and personality traits are common during altitude exposures.

Soldiers should allow for extra time to accomplish tasks. Using the buddy system during the early exposure period helps to identify Soldiers who may be more severely affected. A high morale and esprit de corps before and during deployment will help minimize the impact of negative mood changes.

**Sleep Disturbances:** Altitude exposure may have significant effects on sleep. The most prominent effects are frequent periods of apnea (a temporary pause in breathing) and fragmented sleep. Reports of "not being able to sleep" and "being 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 1,524m and are very common at higher altitudes.

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

**Dehydration:** Dehydration is a very common condition in Soldiers at altitude. Causes include perspiration/sweating, vomiting, increased breathing, and diminished thirst sensation. Dehydration decreases physical performance, increases symptoms of altitude illness, and may increase risk of developing cold injuries.

Soldiers can prevent dehydration by consuming 3 to 4 quarts or more of water or other non-caffeinated fluids per day. Thirst is not an adequate warning of dehydration. Commanders must make sure that Soldiers drink enough fluids and do not become dehydrated as a result of diminished judgment or the desire to not urinate. Urine color should be no darker than light yellow.

**Nutrition:** Poor nutrition can severely impact military operations and contribute to illness or injury, decreased performance and poor morale. At high elevations dulled taste sensations (making food undesirable), nausea, or lack of energy can decrease the motivation to prepare or eat meals. Poor eating habits may also lead to constipation, aggravation of hemorrhoids, and undesired weight loss.

Soldiers should eat more and eat all components of meals. Rations should be supplemented and frequent snacking encouraged. Snacks high in carbohydrates are recommended since they improve physical performance, are better tolerated, are easily carried by Soldiers, and require no preparation.

## Products to Avoid at Altitudes

**Tobacco** smoke interferes with oxygen delivery in the body and increases the amounts of carbon monoxide (CO) in close spaces. The irritant effect of tobacco smoke can narrow the airways and interfere with breathing.

**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. But it should be consumed in moderation.

## Acclimatization

Altitude acclimatization eliminates altitude illness and allows Soldiers to achieve the maximum physical work performance possible. Once acquired, acclimatization is maintained as long as the Soldier remains at altitude, but is lost over several days upon return to lower elevations. Exposure to higher altitudes requires further acclimatization.

For most Soldiers at high to very high altitudes, 70-80 percent of the **respiratory** component of acclimatization occurs in 7-10 days; 80-90 percent of overall acclimatization generally occurs in 14-30 days; and maximum acclimatization may take months or years.

## Two Ways to Achieve Acclimatization

**Staged Ascent:** Soldiers ascend to a moderate altitude and remain there for 4 days or more to acclimatize before ascending higher. When possible, Soldiers should stop at several altitudes to allow a greater degree of acclimatization.

**Graded Ascent:** Slow ascents allow partial acclimatization. To reduce the risk of altitude illness:

- have Soldiers spend one or two nights at moderate altitude (1200 - 2400m).
- at altitudes above 2400m, sleep no more than 300m above the previous night's sleeping altitude.

A combination of staged and graded ascent is the safest and most effective way to prevent altitude illnesses.

## Altitude Illnesses

The best way to treat any altitude illness is to evacuate the Soldier to a lower altitude.

There are a number of illnesses of varying severity associated with altitude exposure. Symptoms to look for when working at altitude include:

- headache
- nausea and vomiting
- fatigue
- difficulty sleeping
- dizziness
- coughing
- difficulty breathing, noisy breathing or wheezing, gurgling in the airway
- impaired mental status such as confusion, vivid hallucinations or disorientation
- a swaying upper body, especially when walking
- poor wound healing
- edema (a condition in which body tissues contain an excessive amount of tissue fluid)
- apnea (a temporary pause in breathing during sleep)

Medications such as acetazolamide and low dose dexamethasone may be used to prevent and treat altitude illness. Use of any medication should be discussed with physicians. Evacuation to a lower elevation and close monitoring by a medical provider may be recommended.

Under no circumstances should Soldiers with altitude illness be allowed to continue ascent. High altitude pulmonary edema (HAPE) and high altitude cerebral edema (HACE), if untreated, WILL be fatal. Evacuate to a lower altitude as soon as possible.