High-Altitude Nutrition

What's the best food to eat on high altitude treks, climbs or expeditions? The short answer is: whatever tastes the best and will be something you will want to eat regularly. If you've ever climbed above ١٠,٠٠٠ feet, you may be somewhat familiar with the nausea, headache and general malaise associated with high altitude travel. Hopefully if you plan to spend any extended amount of time at altitude, you will have enough time to acclimatize so that you will be able to resume fairly normal eating habits. Eating to match exertion levels, and then some, is crucial in order to maintain lean muscle mass, keep sharp, and stay at a healthy body weight (or at least minimize loss so as not to be a problem when climbing). During the Himalayan Scientific and Mountaineering Expedition of ١٩٦٠-١٩٦١, most subjects working at an altitude of ١٩,١٤٠ feet lost between ١-٣ pounds per week; during the first week alone at altitude, some males can lose up to ٦.٦ pounds of bodyweight (Armstrong, p. ١٧٢; ١٨٨). If enough of that is insulating bodyfat, subjects may actually experience decreased tolerance to cold environments and be more susceptible to illness (NAMOHAE).

Acclimatization

Gaining altitude at an appropriate rate is also extremely important – above ١٠,٠٠٠ feet, it's recommended that you gain no more than ٢,٠٠٠ feet a day, and "climb high, sleep low" on those days involving carries, such as on Denali. When we traveled to Kilimanjaro (١٩,٣٤٠ feet) it took us ٤ days to go from ٦,٠٠٠ feet to base camp at ١٦,٢٠٠ feet, a rate that is admittedly faster than ideal, but which is fairly common for that particular mountain. On our Kilimanjaro summit day, we started the morning with hot cocoa and cookies near midnight (about all I could stomach), and didn't stop for a bite of food (nor did we even want to) until nearly ٨ hours later, when we were on our way down the other side of the mountain and running on fumes. On a climb of Mt. Rainier, people commonly go from sea level (Seattle) to ١٤,٤١١ feet in ١-٤ days. People opt for gummi bears, lemon drops, gu, licorice, or carb drinks on summit day, because anything else just doesn't sound appealing. Rescue workers dropped high on the mountain and expected to jump right in to do physical labor can expect signs of mountain sickness without appropriate acclimatization; key for them is to take frequent rest breaks and pressure breathe immediately.

Hydration

The key to success at altitude is to hydrate regularly, above all else. Dehydration exacerbates symptoms of altitude sickness and diminishes appetite further, so if you feel the start of a headache, try warding it off with a carb-loaded beverage (shoot for ٣-٤ liters a day, containing ١٠٠-٢٥٠g carbs in addition to your food calories; Askew, p. ١). While water is usually the beverage of choice, I find I need the regular, ongoing dose of carbs to help keep me going. Experiment to find what works for you. The other key is to eat plenty of food (or suck on hard candies or gu), as much as your body will tolerate. In fact, you'll notice in the recommendations below that cider, juice mixes, cocoa, tea, lemonade, Gatorade, soups, and the like all involve plenty of water and carbs; the more per meal, the better.

Macronutrient ratio and calories

What about the mixture of carbs to protein to fat? Carbohydrates are certainly important for any endurance activities such as marathons, triathlons, and backpacking. Do they behave the same at altitude, and in the cold? According to Armstrong's research, most mountain climbers prefer the taste of a high-carbohydrate, low-fat diet at altitude, and many find fatty foods to be unpleasant or distasteful. Carbs are helpful in replacing depleted muscle glycogen stores, preventing protein from being catabolized or burned as energy, and they require less oxygen for metabolism. According to Askew, "Fat, while tolerated relatively well in the cold at sea level, may not be as well tolerated in diets at high altitude… Although high-fat foods are energy dense and reduce the weight/calorie aspect of food carried on climbs, fat requires more oxygen for metabolism than carbohydrate and will place a small, but added burden upon the already overtaxed oxygen economy of the climber." (Askew, p. ٣) Climbers who reach for high fat foods usually are not going to be consuming as many carbs, which can result in low blood sugar that, in turn, can lead to confusion, lack of simple coordination, and disorientation.
Some people end up craving fats and dig into peanut butter (that hasn't frozen!) or add butter to whatever they can. In terms of the best recommendations for ongoing treks and sustained energy, Carolyn Gunn, the author of the Expedition Cookbook (Hanson, p. ١٧), suggests planning for ٤,٠٠٠ calories per person per day for a trip such as Denali, in the ratio of ٦٠-٦٥% carbs, ٢٠-٢٥% fat and ١٠-١٥% protein (what amounts to about ٢ pounds of food per person, per day, not counting packaging.) Expenditure can be as high as ٦٠٠٠ calories/day, depending on altitude, extreme temperatures, and performance requirements for any given day (NAMOHAE). The raw energy requirements increase ١٥-٥٠% over that needed at sea-level for comparable exertion, and will obviously depend on the size and gender of the individual; a ١١٥ pound woman, for example, won't need as much food as a ١٧٥ pound man, assuming they're doing comparable work. At the same time, food intakes typically fall ١٠-٥٠% during altitude exposure, depending on the rapidity of ascent and the individual's susceptibility to altitude illness such as AMS (acute mountain sickness). (Askew, p. ١)

Gender

Interestingly enough, one summary reported: "Women may have a biological advantage at altitude. In general, they suffer less severe symptoms of AMS and do not experience as great a depression in appetite and food intake as do their male counterparts" (NAMOHAE). Women may be challenged by other issues at altitude (such as toting comparable loads at a lower bodyweight) but being at altitude per se doesn't seem to be one!

What works for you…

In my own experience on Kilimanjaro and Rainier, cheddar mashed potatoes with freeze-dried turkey added to it seems to be the one freeze-dried meal that stays down nicely and fuels me for summit day; chicken noodle soups, hot cocoa, packets of gu, and carbohydrate-containing drinks definitely "feel" better in my mouth and stomach, and go down much more easily than jerky, nuts, or the tastiest candy bars, which simply take too much energy to chew, swallow, absorb into the bloodstream, and then digest. The more quickly a carbohydrate is absorbed into the bloodstream (i.e. in the form of fluids) the faster it can be used as energy. Each individual needs to find out what works best for his or her body and stick with it.

Recommendations

To determine what might work best for you, test out a variety of foods at elevations above ١٠,٠٠٠ feet and scrap what doesn't appeal there, as it probably won't get any more palatable higher up. Take the tastiest foods you can find, and plenty of different options, as you'll likely only get increasingly finicky higher up. Try to ward off monotony; I can't imagine anything worse than having the same food ٤-٥ days in a row if you didn't like it the first time you tried it. Try cooking or preparing the food as you will have to do in the field, and test out no-cook food when it's frozen to see if it's still edible. My husband once cut a gash in his cheek when he tried to bite into a too-cold Powerbar and swore he'd never buy one again! Test out additives to see if your system can run well on curry or other spices; you may find that the chicken gumbo that was fine at base camp on Mt. Baker just doesn't appeal to you in the least at high camp on Denali. Some recommendations from Hanson and Hanson (who have been to Denali ٣-٤ times) include:

- Breakfasts: granola or energy bars, Pop tarts, oatmeal, bagels, hot sweet rice, couscous, grapenuts, hot cocoa, tea and cider
- Lunches: crackers (wheat thins, Ritz, Cheezits), cookies, bagels or rolls, jerky, sausages, cheese sticks, nuts, candy bars, dried fruits, flavored juice drink mixes, fruit leather, fig bars, hard candy, trail mix
- Dinners: cocoa, cider, soups, hot jello, and teas as the first course; freeze dried meals with rice, noodles, vegetables; instant rice, stuffing, or mashed potatoes; pudding or mousse for desserts

Final fragments: frequent food foibles

So what do you tell someone who tells you to eat string cheese to plug you up? Constipation is actually a quite common complaint at altitude, where decreased oxygen slows down the function of the intestines and excessive fluid losses rob water from the colon (NAMOHAE p. ٣) The opposite can also occur due to food preparation with less-than-adequate hygiene; diarrhea is quite common among climbers in Africa, and several ways to prevent suffering from diarrhea are ١) clean hands thoroughly before eating; ٢) do not eat any exterior surfaces of tomatoes or fruit; ٣) avoid any vegetables that haven't been boiled; and ٤) after day ٢ of a trek, avoid eating meat of any kind that has not been freshly killed or somehow refrigerated, unless it's been dried and preserved (such as jerky sticks.) And lastly, if you suffer from intestinal gas, limit the amount of dehydrated food high in carbohydrates that you eat, as they tend to cause gas production. Happy eating up high!

Resources

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Kundrat, Susan, MS, RD, LD: "High Altitude Nutrition" at www.nutrifit.org/nutr_info/altitude.html

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Nutrition at High Altitude

E. Wayne Askew, PhD

Inappropriate thirst and appetite responses, together with increased insensible water loss, transient diuresis and increased energy expenditures can lead to rapid dehydration and glycogen depletion and weight loss at altitude if adequate food and fluid are neglected. Dehydration may intensify the symptoms of altitude sickness and result in even lower food intakes. One of the most effective and practical performance-sustaining measures that can be adopted upon arrival at high altitude is to consume a minimum of ٣ to ٤ liters of fluid per day containing ٢٠٠ to ٣٠٠ g of carbohydrate in addition to that contained in the diet. This should prevent dehydration, improve energy balance, improve the oxygen delivery capability of the circulatory system, replenish muscle glycogen, and conserve body protein levels.

Altitude Sickness

Abrupt exposure to elevations greater than ١٠،٠٠٠ ft (٣،٠٥٠ m) is frequently associated with symptoms of altitude illness. Altitude illness is a combination of symptoms, including headaches, anorexia, nausea, vomiting, and malaise. The combined effect of these symptoms is usually a profound depression of appetite and reduction of food intake, just at the time when the climber needs energy the most. Climbers that anticipate the consequences of altitude-impaired appetite may at least minimize the secondary consequences of the cachexia of altitude: reduced energy intake, depleted muscle glycogen stores, negative nitrogen balances, and loss of critical lean body mass.

Gradual acclimatization to progressively higher altitude exposure is the best preventive medicine for high-altitude sickness. Unfortunately, it is not always practical or possible to delay ascent to altitude. Rescue workers frequently must travel abruptly to high altitudes to perform critical tasks. Prior acclimatization is not always possible. Abrupt transportation from sea level to high altitude may be accompanied by debilitating altitude sickness symptoms, including altered mood, appetite, and performance. These uncomfortable symptoms usually increase in intensity for periods of up to ٤٨ hours after altitude exposure and then gradually lessen. Unfortunately, it is usually during the first ٤٨ hours at altitude that critical work must be accomplished. The strenuous activities associated with work or recreation at altitude, plus an initial increase in resting metabolic rate and the lack of adequate food intakes almost invariably result in an initially negative energy balance. Altitude illness can limit volitional activity, but energy expenditures of experienced and motivated climbers who are acclimatized can be quite high, depending upon the activity level achievable under hypoxic conditions.

Effect of altitude on energy balance

Food intakes are typically reduced ١٠ to ٥٠٪ during acute altitude exposure depending upon the individual and rapidity of ascent. Rose et al. (١٩٨٨) observed depressed food intakes and weight loss at altitude even under the controlled hypobaric chamber conditions of Operation Everest II. In this study, work requirements were relatively low, and a thermoneutral hypobaric environment with an adequate quantity and variety of palatable food were provided. Decreased food intake under these conditions indicated that hypoxia by itself was a major factor reducing appetite and food intake. Adequate food intake can be achieved at altitude but it requires a concerted, conscious effort of dietary management and forced eating (Butterfield ١٩٩٦). The combination of anorexia and reduced food intake can potentially exert a negative effect on work performance at even moderate altitude (Askew ١٩٩٦).

Numerous pharmacological attempts to reduce acute mountain sickness have been investigated, with limited success. Caffeine has been reported to enhance relatively short-term, high-intensity work at simulated high altitude, perhaps via an influence upon blood glucose availability. High carbohydrate diets have been recommended by some as a "non-pharmacological" method to reduce the symptoms associated with acute mountain sickness. As an adjunct for lessening or preventing altitude illness, high carbohydrate diets should be fed prior to and during the initial ٣ to ٤-day critical period of acute altitude exposure. It should be noted that only a limited number of investigators have studied high-carbohydrate diets or carbohydrate supplements for the relief of acute mountain sickness and performance enhancement. Some (Consolazio et al. ١٩٦٩; Askew ١٩٩٧), but not all (Swenson et al. ١٩٩٧), have reported some beneficial effects upon symptoms, mood, and performance. Most investigators agree that, at the very least, energy balances can be improved by aggressive carbohydrate supplementation at altitude, particularly via the fluid component of the diet. In addition to improving energy balance, carbohydrate supplementation also improves nitrogen balance in the initial phase of acute altitude exposure. Butterfield et al. (١٩٩٢) have confirmed that the negative nitrogen balance encountered at altitude is not due to any hypoxia-related decrease in protein digestibility or absorption, but primarily due to a negative energy balance.

The mechanism by which carbohydrate exerts a beneficial effect on relieving symptoms of altitude sickness and prolongs endurance at altitude may be related to improving blood oxygenation. Hansen et al. (١٩٧٢) showed that blood oxygen tension is increased by a high-carbohydrate diet and Dramise et al. (١٩٧٥) reported that carbohydrate can increase lung pulmonary diffusion capacity at altitude. Recently, Lawless et al. (١٩٩٩) have demonstrated that carbohydrate consumption significantly increased oxygen tension and oxyhemoglobin saturation in arterial blood of subjects during simulated altitude (reduced oxygen in inspired air). In addition to improving blood oxygenation, carbohydrate is a more "efficient" energy source at altitude than fat or protein. The energy production per liter of oxygen uptake is greater when carbohydrate is the energy source compared to fat (carbohydrate, ٥,٠٥ kcal/l $O_٢$; fat, ٤,٦٩ kcal/l $O_٢$) regardless of the oxygen tension in the inspired air. Taken together, these different lines of evidence suggest that carbohydrate is a more efficient energy source for work at reduced oxygen tension.

Influence of altitude upon substrate utilization and nutrient requirements

Roberts et al. (١٩٩٦) suggested that work at altitude in acclimatized individuals may be less reliant upon fat metabolism and hence more strongly influenced by carbohydrate availability. Although McClelland et al. (١٩٩٨) contend that the relative contribution of carbohydrate does not increase after altitude acclimatization and, like at sea level, the relative intensity of exercise is the major determinant of metabolic fuel utilization at high altitude.

There is little evidence that chronic or acute altitude exposure increases the requirement for any specific nutrient other than possibly vitamin E and iron (Marriott and Carison, ١٩٩٦). Studies of the effects of cold, energy expenditure, UV light exposure, and the reductive atmosphere at altitude indicates that supplementation of vitamins having an antioxidant function may be desirable at high altitude (Simon-Schnass ١٩٩٦; Pfeiffer et al. ١٩٩٩; Chao et al. ١٩٩٩; Bailey and Davies ٢٠٠١). Supplemental antioxidant vitamins taken during a prolonged stay at high altitude may prevent a "deterioration" of blood flow and subsequent decrease in physical performance associated with free radical damage to cellular antioxidant defense systems (Askew ١٩٩٥, Simon-Schnass ١٩٩٦). Manipulations that improve oxygen delivery to tissues under the conditions of hypoxia are generally beneficial to work performance.

In general, dietary treatments that preserve or enhance the fluidity or deformability of red blood cell (RBC) membranes at altitude are beneficial to oxygen delivery to tissues.

Exposure to hypoxia and resultant lipid peroxidation of the unsaturated fatty acids in the red blood cell membrane reduces red cell deformity (ability of RBC to bend or flex as they pass through a capillary bed). The improvement of RBC membrane fluidity (increased ability to deform) can be achieved by ٢ dietary mechanisms: supplementing the diet with polyunsaturated fatty acids or by protecting existing membrane polyunsaturated fatty acids from free radical peroxidation by supplementing the diet with antioxidant(s) such as vitamin E.
The suggestion that supplementary dietary iron may be beneficial at altitude stems from the observation that there is an increased erythropoietic response to altitude exposure as the oxygen delivery system of the body attempts to support increased hemoglobin synthesis at high altitude. Normal dietary iron intakes are adequate to support increased hemoglobin synthesis for males at high altitude, but females exposed to high altitude may benefit from a dietary iron supplement. All iron deficient individuals regardless of gender, may benefit from iron supplementation prior to going to altitude. Stray-Gundersen et al.(١٩٩٢) have demonstrated that iron deficient runners regardless of sex fail to exhibit a normal hematopoietic response upon exposure to altitude. Although Berglund (١٩٩٢) recommended oral supplement iron (ferrous sulfate, ٢٠٠-٣٠٠ mg/d) for ٢-٣ weeks before ascent and continuation of iron supplementation for ٢-٤ weeks while at altitude, he cautioned that a simultaneous free radical production might be enhanced by excess free iron.

Fluid requirements at altitude
Water requirements at altitude may be greater than those at sea level, due to the low humidity of the atmosphere at altitude and hyperventilation associated with altitude exposure (Hoyt and Honig ١٩٩٦, Askew ١٩٩٦). The risk of dehydration is high at altitude due to diuresis and water loss in breath and sweat, coupled with the difficulty of obtaining adequate water. An inappropriate thirst response coupled with an increase in insensible water loss and a transient diuresis during the initial hours of altitude exposure, can result in rapid dehydration if adequate fluid is either unavailable or neglected. The rate of respiratory water loss at altitude is about twice the rate of respiratory water loss for an equivalent activity at sea level (Milledge ١٩٩٢).

Hypoxia vs. cold
High altitude and cold environments are often similar with respect to the thermal challenge, tempting one to categorize work in the cold at sea level with work under similar cold conditions at altitude. There are some distinct differences, however, which should be considered when planning nutritional support at high altitude. Fat, while tolerated relatively well in the cold at sea level, may not be as well tolerated in diets at high altitude. The symptoms of acute altitude exposure may be exacerbated if fat displaces carbohydrate from the diet. Although high-fat foods are energy dense and reduce the weight/calorie aspect of food carried on climbs, fat requires more oxygen for metabolism than carbohydrate and will place a small, but added, burden upon the already overtaxed oxygen economy of the climber. Fat absorption may also be reduced at extremely high elevations. However, elevations commonly reached by recreational skiers, snowshoers, and backpackers are usually not associated with impaired fat or protein or carbohydrate absorption (Butterfield ١٩٩٢).
Another difference between cold exposure at sea level and high altitude is the calorigenic response to cold (Giesbrecht et al. ١٩٩٤). Cold exposure during hypoxia results in an increased reliance upon shivering for thermogenesis due to a reduction in non-shivering thermogenesis at altitude. Perhaps this is due to a reduction in aerobic catabolism of free fatty acids during hypoxia or to an alteration in the neural-hormonal axis thermogenic response.

NUTRITIONAL ADVICE FOR MILITARY OPERATIONS IN A HIGH-ALTITUDE ENVIRONMENT

At altitude, a soldier must be able to perform skilled movements with speed, coordination, and repetition. These movements must be done without excessive fatigue, often in severe cold and dangerous conditions, and with deficient oxygen. Training, skill, and equipment, in addition to health and fitness, are necessary for successful mountain operations; but diet is of paramount importance in helping maintain body weight, nutritional status, and mental and physical alertness. This chapter provides information on the nutritional requirements altered by exposure to altitude, the effect that diet may have on tolerance to altitude, and the problems in meeting nutritional requirements at altitude.

KEY ISSUES

Weight Loss

١. Eating enough food is the most important nutritional factor at altitude. Almost all persons going to altitude lose weight. This weight loss is a combination of body fat and lean tissue, and at very high altitudes the weight loss is incapacitating. The loss of insulating fat decreases tolerance to cold temperatures. Accompanying the weight loss are fatigue, loss of strength, and psychological changes such as decreased mental alertness and morale. All of these can contribute to accidents and failure to accomplish the mission.

٢. Energy requirements for high-altitude operations increase ١٥ to ٥٠% above sea-level requirements. The altitude, cold temperatures, and performance of physical activities over rugged terrain combine to increase energy expenditures to as much as ٦٠٠٠ calories per day.

٣. Although energy expenditures increase, food intake usually decreases due to lack of appetite, limited availability of food, and difficulty in food preparation. During the first ٣ to ٤ days at high altitude, the headache, nausea, vomiting and pronounced anorexia of acute mountain sickness (AMS) interfere with food and fluid intake. Even after the symptoms of AMS subside, appetite remains depressed and it takes less food to reach a feeling of fullness - the higher the altitude, the greater the appetite depression.

٤. Altitude reduces sense of taste and alters food preferences. These taste changes decrease tolerance to monotonous foods. Individuals often go hungry at high altitude rather than eat food which they do not crave. Many mountaineers report an aversion to fat and a preference for carbohydrates.

٥. Women may have a biological advantage at altitude. Women, in general, suffer less severe symptoms of AMS and do not experience as great a depression in appetite and food intake as do their male counterparts.

٦. Military personnel commonly report lack of time to prepare and consume food and beverages as the reason for limited consumption. Altitude compounds this problem because **cooking times double for each ٥٠٠٠-foot gain in elevation** (since altitude lowers the boiling point of water). Cold ambient temperatures and thin air mean that food starts out colder and heat dissipates faster at altitude. Providing adequate amounts of hot rations is a major challenge for leaders during high altitude operations.

Inadequate Carbohydrate Intake

١. Carbohydrate is the preferred energy source at altitude. Carbohydrates replace depleted muscle glycogen stores, prevent protein from being used as energy, and require less oxygen for metabolism. A high-carbohydrate diet can reduce the onset and severity of AMS and improve physical performance and mental efficiency. A low-carbohydrate diet can result in low blood sugar. Low blood sugar causes confusion, disorientation, and lack of coordination; these conditions can be extremely dangerous when combined with oxygen deficiency.

٢. The optimal diet at altitude contains at least ٤٠٠ grams of carbohydrate, accounting for ٦٠-٧٠% of dietary energy. Such a high carbohydrate intake is very difficult to achieve unless a concerted effort is made to consume high-carbohydrate foods. Female soldiers are at particular risk of inadequate carbohydrate intakes because of their relatively low calorie consumption.

٣. The supposed taste preference for high-carbohydrate foods cannot be counted on to ensure an adequate carbohydrate intake. Not everyone exhibits this food preference, especially at lower altitudes. Many of the common snacks or pogey bait items that soldiers bring to the field are high in fat and, therefore, displace preferred carbohydrate from the diet. Typical high-fat foods that soldiers bring to the field are cheeses, summer sausage, and jerky.

Dehydration

١. It is easy to become dehydrated in high-altitude environments. Dehydration increases the risk of cold injury and exacerbates the fatigue, impaired judgement and apathy of hypoxia. **The body's requirement for fluids is very high at altitude; often exceeding ٤ liters of water per day.** This is mainly caused by increased water losses from the lungs due to the increased ventilation of cold, dry air. There is also increased urinary loss of water due to the diuretic effects of altitude and cold. Sweating due to physical exertion adds to the water loss. Especially in the first few days at altitude, there may be significant body water losses due to the vomiting associated with AMS. Diarrheal fluid losses may also be a factor. Giardia, an intestinal parasite that causes diarrhea, is common in high altitude regions. Also, the high magnesium content of glacier water, consumed as drinking water, can have a laxative effect.

٢. Complicating the excessive water losses at altitude is the difficulty consuming adequate fluids. The sensation of thirst does not keep pace with water loss. Individuals do not feel like drinking, even when they are already dehydrated. AMS further exacerbates the dulling of the thirst sensation. Other symptoms of AMS include headache, nausea, vomiting, and the loss of appetite.

٣. Potable water is difficult to obtain in high-altitude environments. Because of the large water requirement at altitude, a day's supply cannot be carried by an individual soldier. When temperatures are very low, water in canteens and bulk water containers may freeze, restricting water availability. **It takes an exorbitant amount of time and fuel to melt snow in sufficient quantities (it takes ٤٠ minutes to melt ٤ cups of snow to make ١ cup of water).**

٤. All melted snow and ice, as well as water from streams, should be considered contaminated. **Because at altitude water boils before it reaches ٢١٢°F (١٠٠°C), the boiling temperature of water at sea level, it needs to be boiled longer than the ١٠ minutes necessary for sterilization at sea**

level. This amounts to an additional minute for every ١٠٠٠-foot gain in altitude. For example, at ١٤,٠٠٠ feet, water needs to be boiled for ٢٤ minutes to be purified.

Gastrointestinal Complaints

١. Constipation is a common complaint during any field exercise. It is especially prevalent at altitude where decreased oxygen slows down the function of the intestines and excessive fluid losses rob water from the colon. Emphasis on adequate fluid intake is the best preventative.

٢. Many soldiers complain of intestinal gas at high altitudes. Responses to particular foods are highly individual and, therefore, difficult to predict. Dehydrated foods high in carbohydrate tend to cause gas production and should be tried in small quantities until tolerance is established.

MANAGING THE KEY ISSUES

Prevent Weight Loss

١. Provide adequate calories.

a. The suggested energy allowance for high-altitude operations is ٤٥٠٠ calories per day, the amount provided by four Meals, Ready-to-Eat. One Ration, Cold Weather (RCW) or three Food Packets, Long Range Patrol (LRP) also meet the daily calorie allowance. The RCW requires about ٣ quarts to rehydrate all food components. Three LRPs require about ٣ quarts to rehydrate all components. The Ration, Lightweight (RLW-٣٠) is a high-fat ration that is not appropriate for high-altitude operations.

b. Items from the Cold Weather T Ration Supplemental Module (excluding the Nut Raisin Mix) can provide high-carbohydrate foods to enhance energy, carbohydrate, and fluid intakes of soldiers subsisting on A, B, or T Rations. Carbohydrate containing beverage supplements can increase both calorie and fluid intake at high altitude.

٢. Serve at least one hot meal daily if at all possible. Individuals voluntarily consume more food and beverages when they are served hot meals in a group setting.

٣. Use a variety of foods and food items. Monotony is the biggest problem to develop over time. Any food becomes tiring with repeated consumption. Almost anything different helps to maintain food intake.

٤. Encourage small meals plus frequent snacks. Large meals are poorly tolerated at altitude. Soldiers often cannot consume enough food to meet their nutrient requirements in two or three meals a day. It is a good idea to save food items such as granola bars, candies, cookies, crackers, cheese, and peanut butter spreads to eat as between-meal snacks that require minimal preparation.

٥. Respect individual food preferences and tolerances. Do not force food when soldiers are nauseous or vomiting. Do, however, force fluids. Food aversions are quick to develop and hard to get rid of. Even favorite foods are repulsive at altitude if they are associated with the nausea and vomiting of AMS.

Maintain a High-Carbohydrate Intake

١. Emphasize high-carbohydrate foods (starches and sugars). Aim for an intake of at least ٤٠٠ grams of carbohydrate per day. High-carbohydrate items include hot and cold breakfast cereals, juices and sugar-sweetened beverage base, fruits (dried, canned, or fresh), instant mashed potatoes, rice, couscous, noodles, MRE and T ration cakes (except pound cake), crackers, Fig Newtons, and pouch bread. High-carbohydrate beverages may be better tolerated than solids and also serve to provide needed fluid.

٢. Discourage high-fat, pogey bait snack items. Although high-fat foods are energy dense, fat is not tolerated well at altitude and can worsen the symptoms of AMS. Fat requires more oxygen for metabolism than carbohydrate. Also, even a very lean soldier has adequate fat reserves to meet an energy deficit on a short-term basis; but the body has limited carbohydrate stores which must be replaced on a daily basis if the soldier is to maintain a high-work capacity. High-fat snack foods such as nuts, cheese, jerky, and sausage can displace preferred carbohydrates. If high-fat foods are tolerated and desired, they should be eaten with carbohydrate foods.

٣. Have available easy-to-digest, high-carbohydrate foods for periods of AMS. Bland, easy-to tolerate foods that might appeal to soldiers suffering from AMS include Cream of Wheat or oatmeal, instant mashed potatoes, instant rice, Ramen noodles, crackers, bread, and vanilla pudding. A liquid high-carbohydrate, glucose-polymer "sport drink" can help to ensure adequate calories and carbohydrate intake if solid foods become unpalatable. Intolerance to solid foods is most likely to happen during the first ٢ to ٣ days at altitude when the symptoms of AMS are most severe or at extremely high altitudes.

Prevent Dehydration

١. Establish a program of regularly scheduled, enforced drinking. Remind soldiers to drink even when they are not thirsty. Encourage soldiers to drink one canteen of water every ٣ hours so that they consume a minimum intake of **٥ quarts of water** each day. If the training schedule prevents frequent stops to drink, at least two canteens drunk morning and evening can help compensate for limited fluid intake during the day. During periods of nausea, small, frequent sips of liquid are tolerated better.

٢. Provide a variety of noncaffeinated beverages. Warm fluids are well received in cold temperatures. However, tea and coffee have a diuretic effect and promote fluid loss. In addition, excess caffeine can interfere with sleep that is already disrupted at altitude. Cocoa is a good warming beverage since it is low in caffeine and contains needed carbohydrate. Other beverage suggestions are hot cider or apple juice, hot Jell-O, or instant soups. An exception to the limitation of caffeine is when treating the incapacitating high-altitude headache. Many climbers successfully use a double strength mug of coffee to relieve the headache.

٣. Monitor the color and volume of soldiers' urine to check for dehydration. If urine is dark yellow or brown or less than normal, the soldier is probably dehydrated. Soldiers should drink until their urine turn\s pale yellow in color.

POINTS TO REMEMBER

- Energy requirements are greater at altitude, therefore there is an increased requirement for the vitamins needed for energy metabolism. Military rations however, already provide more than enough vitamins and minerals so supplementation isn't necessary.
- Red blood cell count increases at altitude so the blood can carry more oxygen; however, unless there is a preexisting iron deficiency, there are sufficient body iron stores to meet this sudden but short-term need.
- Most of the weight loss commonly seen at altitude is not inevitable but is due to the reduced calorie intake. Weight loss can be prevented or slowed down by keeping calorie intake up.
- Adequate protein is needed to protect against muscle loss, but protein requirements are not increased at altitude.

- The best snacks for high altitude environments are high-carbohydrate, easy-to-prepare, easy-to-digest, taste good, and are worth their weight and space to carry. Suggested snacks are raisins and other dried fruits, yogurt-covered raisins, banana chips, fruit chews, jelly beans, Chuckles, Gummier Bears, Necco wafers, red and black licorice, granola bars, bagels, toaster pastries, and fig bars.
- It's important to military operations at altitude to replenish glycogen stores on a daily basis. **Four to ٦ hundred grams of carbohydrates daily** are adequate to continuously replace muscle glycogen stores.
- Soldiers generally need at least **٤ to ٦ quarts** of fluid per day when at altitude because of the extremely dry air. At least ١ quart of fluid must be consumed every ٣ hours to meet the requirement.
- The edema often seen at high altitudes is not caused by sodium retention, so limiting salt/sodium intake is of no benefit.
- For soldiers suffering from AMS, bland, low-fat foods (such as crackers, bread, cookie bars, mashed potatoes, rice, cereals, and puddings) are generally better tolerated. Small amounts of food should be eaten frequently - every ٢ hours. Encourage drinking as much fluid as can be tolerated.
- Alcohol is particularly dangerous at altitude where one needs to deal with cold temperatures and hazardous terrains. Alcohol increases body heat loss and decreases the blood supply to the exercising muscle. In addition, the body requires more oxygen to metabolize alcohol.

DOs AND DON'Ts for HIGH ALTITUDE NUTRITION	
DO monitor weight loss if possible. **DO** eat a high, complex-carbohydrate diet & eat portions of all ration components. **DO** serve at least one hot meal per day. **DO** provide food variety and plan snacks. **DO** drink ٤ to ٦ quarts of noncaffeinated beverages per day & monitor color/volume of urine for dehydration. **DO** discourage high-fat, pogey bait snack items and alcohol consumption.	**DON'T** use mountain exercises as an opportunity to lose weight. **DON'T** skip meals. **DON'T** fill up on high-fat foods. **DON'T** force food when nauseous or vomiting. **DON'T** drink unpurified water or melted snow. **DON'T** restrict water intake in order to "save it for later" or avoid having to urinate.

http://www.usariem.army.mil/nutri/nuadalti.htm