POWER PERFORMANCE
THE NUTRITION CONNECTION

Module 4: Fluids: Your Key To Performance

This module of Performance Nutrition emphasizes the need to increase fluid and electrolyte intake during physical activities and when in extreme environmental conditions, such as heat, cold and altitude.

Introduction

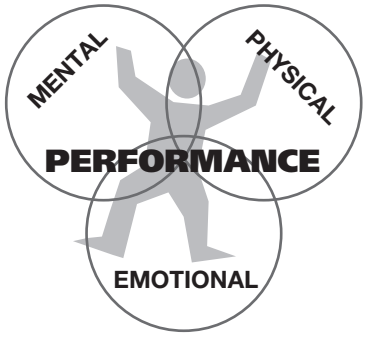
Water is the most important nutrient for performance. Not drinking enough water during physical activity can hurt your performance and your health. In severe cases, lack of water can lead to serious physical problems, even death. This material will explain how critical water is to your performance in training and how other fluids can help or harm performance.

KEY CONCEPT
Fluid and electrolyte requirements are increased by physical activities and environmental conditions, such as heat, cold and altitude.

OBJECTIVES
After reading this material you will be familiar with:

- ▲ The functions of water.
- ▲ The consequences of dehydration in relation to health and performance.
- ▲ Training situations in which sport drinks can help performance.
- ▲ The amount of fluid recommended before, during and after physical activity.
- ▲ How environmental conditions affect fluid requirements.

The Elements of Military Performance



What and when and how much you eat affect all of these elements.

Water: Your Body's Most Important Ingredient

If you were to squeeze all of the water out of your body, you wouldn't have much left — a small heap of bone and tissue. That's because about 60% of your body is made of water. 75% of your muscle and brain is water.

Look at some things water does in your body:

- ▲ Maintains the right body temperature - it keeps you cool when you heat up.
- ▲ Maintains blood pressure.
- ▲ Carries nutrients such as carbohydrates and protein to working muscles.
- ▲ Carries away waste products from the muscles that prevent them from contracting.
- ▲ Rids the body of waste products through the urine.
- ▲ Lubricates joints and internal organs.

Your body needs enough water to keep working well. It needs to have its water replaced constantly.

When you are working your body as hard as you do in training, you need more water, more often, than you do when you're sitting at a desk. That's because your active muscles are heating up, and your body is rushing water to them to keep them cool — the same way a car's radiator flushes water through a hot engine to keep it from overheating.

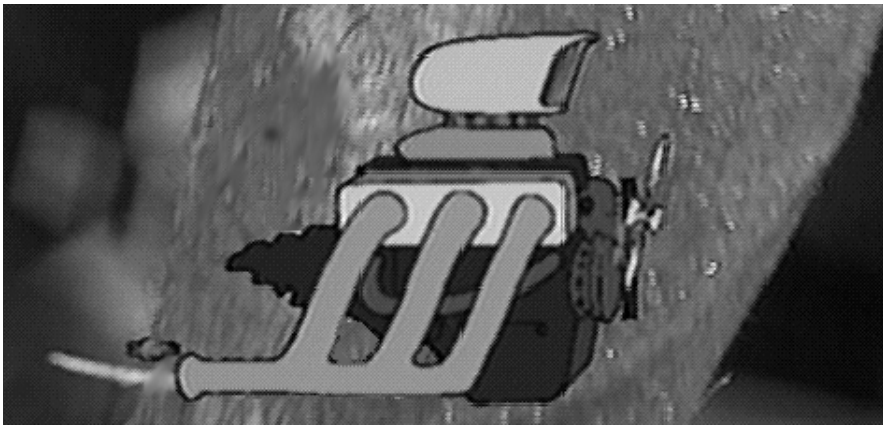
What Is Your Water Status?

How much water do you drink during the course of a typical day? Check the answer below that best approximates your average daily fluid intake:

Types of Fluids	none	1-2 cups	3-5 cups	6-8 cups	more than 8 cups
Water	❒	❒	❒	❒	❒
Non-caffeinated (tea, coffee, soda)	❒	❒	❒	❒	❒
Fruit juices	❒	❒	❒	❒	❒
Other _____	❒	❒	❒	❒	❒

Sorry, you can't count alcoholic or caffeinated beverages.

Muscles: High Performance Engines



When you are physically active, your muscles contract and relax, similar to the way pistons move in a car engine.

Active muscles can create heat up to 100 times more than that of inactive muscles.

If you didn't have a way to cool your body, your internal temperature would go up more than a degree every 5 to 8 minutes of moderate exercise, such as walking.

That's where water saves us from literally frying. Water flows to hot muscles, cools them down, then works its way out of the body as sweat. The evaporating sweat cools your body.

But when you sweat, you lose water from your body. To keep cooling your muscles, you need to replace that water frequently.

DEHYDRATION

It Can Happen To You

It doesn't matter how fit you are, what your body composition is, or how old you are, you can easily become dehydrated. It can happen quickly when you are physically active, especially in extreme climates.

Dehydration hits top athletes often. In almost every New York and Boston Marathon, top place runners are treated for dehydration. A well-known NFL quarterback was given intravenous fluids on a plane trip home from a game because he was so dehydrated.

During the 1984 Olympics in Los Angeles, a shocked world watched a severely dehydrated marathon runner stagger across the finish line, dangerously ill from loss of water.

It's just as easy to become dehydrated in military training. Even mild dehydration can slow your performance. You become fatigued and your concentration is reduced. Severe dehydration can lead to heat exhaustion and death.

WEIGHT LOSS = WATER LOSS

Weight loss is used to measure water loss. The weight you lose over a period of several hours of physical activity is the body water you have lost in the form of sweat.

A marathoner running at a world record pace can lose about 12 pounds of water in a marathon, depending on environmental conditions. That's equivalent to about 6-8% of body weight, a level of dehydration that can cause, among other things, weakness, dizziness, and shortness of breath.

SGT, USA, Airborne Instructor, Veteran, Operation Desert Storm

"You can pretty much tell when a soldier is dehydrated, needing some water. He starts looking lackadaisical or holds his head down, stops sweating. You know he's in trouble, so you tell him to drink water, pretty much every 30 minutes."

Dehydration

You are in a state of dehydration when you lose water from your body without replacing it.

LOSS OF WATER = LOSS OF PERFORMANCE

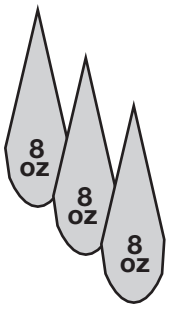
It doesn't take much water loss for your performance to suffer. With only 5% weight loss, your speed and concentration are reduced. In intense military training and in combat, that reduced performance could make a critical difference in whether the mission is accomplished.

And water loss happens quickly. A football player playing in full gear can lose 1.8% of his body weight in only 30 minutes. Compare this to a soldier or Marine training in full field gear.

This chart shows you how fluid loss can affect you. Even small percentages of weight loss can reduce your performance.

WARNING SIGNALS OF DEHYDRATION

% Body Weight Loss	Symptoms
15 - 20%	Numb/cracked skin, inability to urinate, stiffened eyelids, deafness, death
12 - 15%	Shriveled tongue, sunken eyes, dim vision, inability to swallow, painful urination
8 - 12%	Swollen tongue, muscle spasms, delirium
6 - 8%	Cotton-mouth, headache, weakness, shortness of breath, indistinct speech
4 - 6%	Flushed skin, difficulty concentrating, loss of muscular endurance
2 - 4%	Thirst, verbal complaints, vague discomforts
0 - 2%	Increased body temperature



3 cups of sweat = 1% weight loss

In a 150 lb person, a pound and a half weight loss would be a loss of 1% of body weight. This is about three cups of sweat.

(Bad) Reasons We Have For Not Drinking

Man is the only animal that will choose not to drink Here are some reasons we don't drink …

- Want to "weigh in" at lowest possible weight.
- Don't want to stop what we're doing to drink.
- Don't want to stop what we're doing to urinate.
- Don't feel thirsty.

Whatever your reason for not drinking, the result will be risk of dehydration and reduced performance.

Preventing Dehydration

To avoid dehydration that can harm your performance and health, you might have to make yourself drink when you're not thirsty. Get into the habit of following these steps for preventing dehydration.

MAKE WATER YOUR FIRST CHOICE OF FLUIDS

Cool, plain water is the best performance fluid replacer for any physical activity that lasts less than 90 minutes. Water is always better than soda, coffee, beer or full-strength fruit juice, and equal to sports drinks for replacing the fluid you lose. Cool water is absorbed into your bloodstream quickly and has none of the drawbacks that other fluids can have.

DON'T WAIT UNTIL YOU'RE THIRSTY TO DRINK

By the time you feel thirsty you've already lost 2 quarts of water. You're already dehydrated.

DRINK BEYOND YOUR FEELINGS OF THIRST

If you stop drinking when your thirst is satisfied, you have replaced only about 2/3 of the water you've lost. Drink 1 or 2 glasses after your thirst is satisfied.

W. F., COL. (Ret.) USMC Former CO, OCS, Quantico, VA.

"Every candidate has to drink eight canteens a day. That's a lot of water. It's not a natural thing to do, to drink that much water, but your body really needs it if you're putting out hard physical work and losing moisture, especially in the heat."

MONITOR FLUID LOSS

- ▲ Monitor urine color — When you have enough water, urine is clear or pale yellow. When you need water, it is dark yellow or brown.
- ▲ Weigh yourself before and after activity to see how much water you've lost. Drink two cups of water for every pound you lose during activity.

DRINK REGULARLY & FREQUENTLY

Drink at least eight to ten cups of water a day, at regular intervals. Ten to 12 cups is even better. In extreme climates you'll need even more water to prevent dehydration.

DRINK BEFORE, DURING AND AFTER ACTIVITY

Get into the habit of drinking regularly and frequently all day. Use these guidelines for drinking before, during and after physical activity.

BEFORE

- ▲ Drink 2 to 2 1/2 cups water throughout the 2 hours before physical activity. Then drink up to 2 more cups of cool water 15 minutes before activity.

DURING

- ▲ 1/2 to 1 cup water every 15-20 minutes.
- ▲ About 1 1/4 quart canteens per hour is the most fluid your stomach can empty in one hour. This may not be enough to prevent dehydration in some hot-weather situations. Watch for signs of dehydration even if you are drinking the maximum amount.
- ▲ For exercise lasting 90 minutes or longer, sports drinks may help you to sustain your pace.

AFTER

- ▲ Drink 2 cups fluid for every pound lost during activity.
- ▲ Drink until urine is clear or light yellow.
- ▲ Avoid alcohol as a fluid replacement. If you do drink beer after activity, drink 1-2 cups water or juice at the same time to counter the dehydrating effects of alcohol.
- ▲ Optimize glycogen refueling by consuming 50 - 100 grams of carbohydrate in beverage or food within 30 minutes of exercise and every 2 - 4 hours thereafter. A complete balanced meal within 3-4 hours of activity will replace electrolytes.

No! To Salt Tablets

Sodium is a valuable electrolyte, but a small amount is all you need for performance. You can easily replace sodium lost in sweat with regular meals.

Do not take salt tablets to replace sodium lost in sweat. Salt tablets actually dehydrate you, because they soak up water that should be going to your muscles.

One salt tablet increases your water requirement by a pint. Salt tablets can cause muscles to cramp, because water is drawn from muscles to dilute your blood.

Excess salt can irritate your stomach lining and cause nausea and vomiting during physical activity. Excess salt also contributes to high blood pressure.

WHEN IT'S DIFFICULT TO SCHEDULE REGULAR DRINK BREAKS …

In some field situations and in extreme environments, it's not always easy to drink as often as you should. But it is always important.

Try to drink regularly. Take advantage of rest periods to drink. Try to drink at least 1 cup of water or fluid replacement beverage at every opportunity.

Don't "save your water for later." You may never get to "later."

Do You Need More Than Water?

During physical activity lasting less than 90 minutes, water is your best fluid replacement. But when you are working continuously for longer than 90 minutes, especially in the heat, your glycogen levels start to dwindle if you're drinking only water.

So, for continuous physical activity over 90 minutes, sports drinks, such as Gatorade and Exceed, can have added performance benefits. They provide carbohydrates that help refuel energy-giving glycogen stores and blood sugar levels. They also contain electrolytes, which help you retain body water.

Sports drinks:

- ▲ Help performance of continuous activity lasting longer than 90 minutes. They also help replenish fluids in activities lasting less than 90 minutes, but they are not necessary if water is available.
- ▲ Are absorbed by the body faster than water because of the added sugar and electrolytes.
- ▲ Have added sodium that increases thirst, stimulates drinking, and helps retain water.

COMPARE THESE FLUID SOURCES OF CARBOHYDRATE & ELECTROLYTES

drink 8 oz	carbohydrate grams	sodium mg	potassium mg
Apple juice	29	7	296
Coke	27	5	0
Cranapple juice	32	23	252
Cranberry juice cocktail	37	5	45
Diet Coke	0	5	12
Exceed	17	50	45
Gatorade	14	110	25
Grape juice	38	7	334
Milk	11	120	370
Orange juice	27	2	474
Pepsi	27	1	0
Recharge, orange	13	15	25
Sprite	24	46	0
Tomato Juice	10	877	533
Vitalade	23	0	93

Sweat & Electrolytes

When sweat goes through your pores, it takes some electrolytes with it.

Electrolytes are mineral salts, such as potassium and sodium. Electrolytes help your body hold on to water and are important for the function of muscles and nerves.

Sweat may taste salty, but, contrary to popular belief, you do not lose a lot of electrolytes in sweat. At the end of a 3-hour training session, you have lost much more water than electrolytes.

In most cases, you don't need to replace electrolytes during exercise or physical activity. You can easily replace these losses with the food and fluids you consume at regular meals and snacks. The one exception is during prolonged activity — greater than 4 hours — when you sweat heavily, especially in the heat.

During events that keep you active off and on all day, you also may need to replace electrolytes during activity. Prolonged endurance events, such as ultramarathons and Ironman- type triathlons, may cause electrolyte imbalance if proper replacement techniques are not used. In these cases, if you are not eating regular meals or snacks, sports drinks with electrolytes would be better than water.

You Can Make Your Own Performance Beverage

Some alternatives to sports drinks:

1. Dilute any fruit juice with an equal amount of water. Add 1/8 teaspoon salt per quart. This mix closely approximates the carbohydrate, sodium and potassium of commercially available sports drinks.

2. Mix 1/3 cup sugar and 1/8 teaspoon salt per quart of water. Flavor with unsweetened Kool-Aid or beverage base. Provides about 70 mg. sodium per cup in a 7% carbohydrate solution.

SSGT, USMC

"I drink a lot of water in the evening and constantly flush water before I go to bed. In the morning I start drinking water again. If I didn't drink, you could carry me off right now."

FOR QUICK REFERENCE

FLUID	DRAWBACKS	WHEN TO DRINK	OTHER TIPS
Water	None, except in ultra and extreme conditions when electrolytes may not be replaced by water alone.	Before, during, after physical activity. Minimum 8-10 cups a day, more in extreme climates.	Cool to cold water is absorbed into the bloodstream faster than warm water.
Soda	Carbonation can cause gas or cramps if drunk before and during activity. Sugar can cause stomach discomfort. Sugar holds water in the stomach, takes longer to reach muscles.	After physical activity for repleting glycogen.	
Coffee & soda with caffeine	Caffeine causes increased urination, which dehydrates, irritates stomach, causes jitters.	Maybe before exercise to provide stimulation and increase endurance,after physical activity OK.	Drink with water to counter dehydrating effects of caffeine.
Beer and other alcoholic beverages	Alcohol causes increased urination, which dehydrates you. Slows reaction time .	Not until after physical activity and after replacing body water losses with non- alcoholic fluid.	If you drink after exercise, drink with 1-2 cups water or juice to reverse dehydrating effects of alcohol.
Fruit juice	Sugar from fruit can cause stomach discomfort if taken right before or during activity.	After physical activity to replete glycogen.	Dilute juice with water if you drink before or during physical activity.
Sports drinks	Can cause stomach discomfort during activity if you're not used to them. Test yourself to determine your body's tolerance.	If less than 10% carbohydrate, before and during continuous physical activity lasting longer than 90 minutes. During first couple of hours after activity to replace glycogen. If 10% carbohydrate or greater: Avoid 15 - 30 minutes before and during exercise.	Have no performance advantage over water in most activities lasting less than 90 minutes. For activity greater than 90 minutes, contribute to glycogen stores, raise blood sugar and replace water losses.

BENEFITS OF SPORTS DRINKS

2.5 - 5% Carbohydrate Diluted Sports Drink	May encourage drinking because it tastes better than water. Sodium may help your body retain water. Supplies minimum carbohydrates for exercise longer than 90 minutes.
6 - 9% Carbohydrate (13 - 22 grams/cup) Most commercial sports drinks	Carbohydrate source for exercise longer than 90 minutes. Sodium may help your body retain water.
10 - 15% Carbohydrate Includes soda, full strength fruit juice. May be diluted with equal parts water for carbohydrate concentration of 5-10%.	Higher in carbohydrates; may be too concentrated for most people. Can cause cramps or diarrhea during heavy activity. If greater than 7% carbohydrate, avoid within 30 minutes of exercise.

Dehydration In Extreme Environments

Preventing dehydration is important to military performance in all climates, but extreme heat, humidity, cold, and high altitude increase your risks of becoming dehydrated more quickly than in a temperate climate.

In extreme environments, avoiding dehydration is a key issue in preserving the health, performance, effectiveness, and morale of individuals and units.

Heat

The risks of dehydration are greatest in hot and humid climates. Your body heats up faster in the heat. You sweat more to keep your body cool. It's not unusual to lose 1 1/2 quarts or more of sweat an hour when you are very active in the heat.

When the climate is also humid, or you are wearing clothing or protective chemical gear that traps sweat, your sweat rate — hence your water loss rate — is even higher. It is possible in some hot, humid climates to lose water faster than you are able to replace it.

In hot, arid climates, such as the desert, sweat cools your body too. But sweat evaporates as soon as it hits the dry air, which may keep you from feeling sweaty. Remember that you are losing water rapidly when you work in hot, dry environments.

Frequent drinking to replace body water is critical in the heat. In extreme heat, you are more susceptible to dehydration and heat stress that can lead to reduced performance, heat injury and irreparable kidney damage and death.

TO REDUCE RISKS OF DEHYDRATION IN THE HEAT:

1. Take the following steps to reduce body heat build up.

2. Drink enough water frequently.

REDUCE BODY HEAT BUILD-UP

You often have no control over when you do your activity or what you wear. But when you do, or when you can plan your own exercise schedule, follow these guidelines to reduce heat injury and dehydration.

- ▲ Observe work-rest cycles.
- ▲ Schedule heavy activity for the coolest time of the day. When possible, don't exercise outside during the middle of the day, when the temperature is highest.
- ▲ Gradually build up tolerance to the heat. Work outside for a short time, then increase the length of your workout each day.
- ▲ When possible, wear the lightest-weight clothing possible, such as mesh jerseys, lightweight shorts and low-cut socks. They allow more sweat to evaporate.
- ▲ Wear light-colored clothing. Cover as much of your body as possible to prevent sunburn. Sunburn decreases your ability to sweat and increases your risk of heat illness.

MAJOR, USMC

"Water is something I automatically do. In the field it's definitely a factor in performance. You quite often see people who have problems with the sun, especially in the desert. You tend to get headaches and basic stamina problems that you wouldn't have otherwise."

DRINK ENOUGH WATER FREQUENTLY

Whether you are in a training exercise, organized PT, or doing your own exercises, follow these guidelines for replacing body water in the heat:

FORCE YOURSELF TO DRINK EVEN IF YOU'RE NOT THIRSTY!

- ▲ Drink 4-6 quarts of water a day for light work in warm weather.
- ▲ Drink up to 10-12 quarts of water a day for heavy work in hot humid climates.
- ▲ In extreme heat, especially when wearing protective clothing, you may lose as much as 28 quarts of water a day. However, 22 quarts is about the most water your body can absorb in 18 waking hours.
- ▲ Drink smaller amounts frequently rather than large amounts only occasionally — ideally, 4-6 fluid ounces every 15 minutes.
- ▲ Drink these amounts:
  - 4 cups of water in the morning.
  - 4 cups of water at each meal.
  - 2 cups of water every half hour during activity.
- ▲ Take more rest breaks in the heat. Drink at every rest period.

Conversion Chart

4 cups = 1 quart canteen

16 cups = 1 gallon

4 quarts = 1 gallon

Cold

Even though you may not feel your body heat the same way you do in hot climates, you still face increased risks of dehydration when you train and exercise in extreme cold.

You have increased water loss through the lungs because of dry air. When you're working hard, it's easy to overheat and sweat under multi-layers of cold weather clothes.

When you are dehydrated in the cold, you feel the cold more. Dehydration can impair your shivering response, which is one way your body generates heat to stay warm. Because dehydration makes you tired, you may not move around enough to stay warm.

If dehydration reduces your appetite in the cold, you may not eat the calories you need to stay active, stay warm and perform well.

TO REDUCE RISKS OF DEHYDRATION IN THE COLD:

DRESS APPROPRIATELY

- ▲ Wear layers of loose clothing. Your body heat will be trapped to keep you warm, but sweat can be absorbed through the layers. As you warm up, remove layers of clothing to avoid getting overheated.

DRINK WATER FREQUENTLY

- ▲ Drink even if you're not thirsty or don't feel like drinking.
- ▲ Drink at least 4-5 quart canteens of water a day in cold weather.
- ▲ Don't eat ice or snow. Their cold temperatures can irritate your mouth and lower your body temperature. If you need to use ice or snow as a fluid replacement, **melt and purify** it to prevent diarrhea.
- ▲ Drink warm liquids for comfort and to conserve body heat.
- ▲ Watch caffeine intake. Caffeine increases urine production and the risk of dehydration.

Hot chocolate is lower in caffeine than coffee and high in carbohydrate. It helps warm you and restores glycogen. If you drink coffee or other caffeinated drinks, drink water along with them.

D.W., Captain USMC, member U.S. Military Pentathlon team

"I drink a gallon or two of water a day. I drink every time I think about it."

High Altitudes

High altitudes have unique conditions that increase water loss:

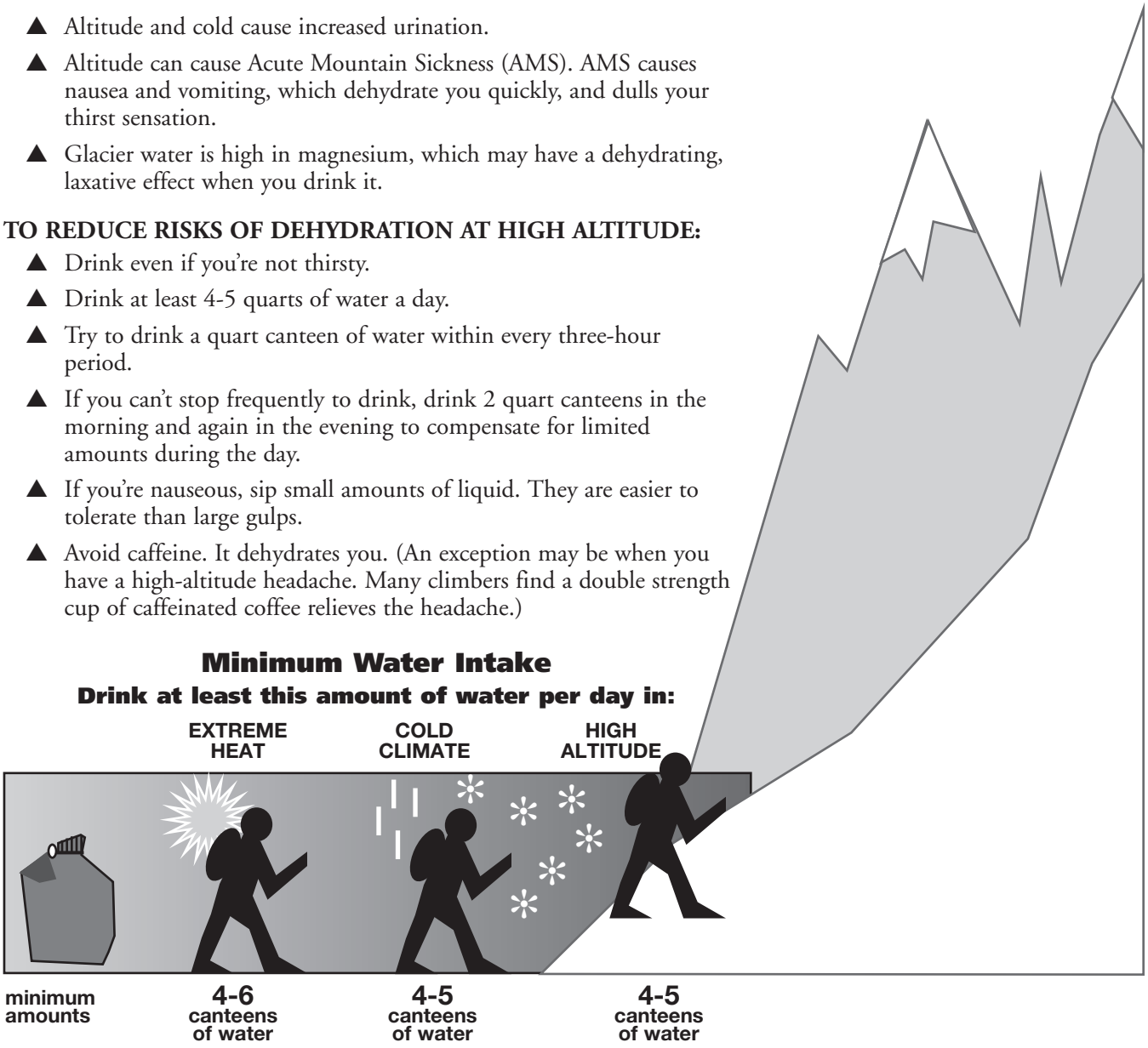
- ▲ Dry, cold air evaporates water from your lungs and mouth when you breathe.
- ▲ Altitude and cold cause increased urination.
- ▲ Altitude can cause Acute Mountain Sickness (AMS). AMS causes nausea and vomiting, which dehydrate you quickly, and dulls your thirst sensation.
- ▲ Glacier water is high in magnesium, which may have a dehydrating, laxative effect when you drink it.

TO REDUCE RISKS OF DEHYDRATION AT HIGH ALTITUDE:

- ▲ Drink even if you're not thirsty.
- ▲ Drink at least 4-5 quarts of water a day.
- ▲ Try to drink a quart canteen of water within every three-hour period.
- ▲ If you can't stop frequently to drink, drink 2 quart canteens in the morning and again in the evening to compensate for limited amounts during the day.
- ▲ If you're nauseous, sip small amounts of liquid. They are easier to tolerate than large gulps.
- ▲ Avoid caffeine. It dehydrates you. (An exception may be when you have a high-altitude headache. Many climbers find a double strength cup of caffeinated coffee relieves the headache.)

LT., USA, Airborne student

"I probably drink six to ten canteens a day. You go through it and don't even notice it."



A Dangerous Myth

THE MYTH: Your body can adapt to going without fluids if you restrict your fluid intake.

THE TRUTH: Restricting fluids, in any climate, is a dangerous practice. Your body will never adjust to being dehydrated. If you restrict fluids, your performance, and possibly your health, will suffer.

Survival experts know how important water is. In average conditions you can go only three days without water before you face death. In extreme weather conditions, you can face death even sooner if you go without water.

In training and exercise you will always perform better when you drink frequently to replace the water you lose in sweat.

Those marathoners who skip water stations will later be passed by the runners who did not!

Alcohol As A Performance Fluid Replacement?

MYTH: Alcohol helps increase endurance for heavy physical activity.

TRUTH: Alcohol can reduce endurance. It can decrease glucose output from the liver, leading to low blood glucose levels. This can lead to fatigue during and after endurance activities.

MYTH: Alcohol helps performance because it improves your psychological well-being.

TRUTH: Alcohol is a nervous system depressant. It impairs judgment and reaction time and reduces gross motor skills such as balance and coordination, essential elements of military training and athletics.

MYTH: Alcohol helps keep you warm in cold climates.

TRUTH: Alcohol leads to a lowering of body temperature. It speeds up body heat loss by bringing warm blood to the surface of the skin where the heat escapes. And alcohol impairs shivering, an important heat-making mechanism in the cold. Alcohol also increases urine production, which dehydrates you. When you are dehydrated you can be too tired to move around and exercise to make body heat. Furthermore, if you are under the influence of alcohol, you may take unnecessary risks which increase your chances of a cold injury.

MYTH: Beer is a good source of carbohydrate calories.

TRUTH: Beer does have carbohydrate calories, but only 1/4 to 1/3 of the total calories are from carbohydrate. The 1/2 ounce of alcohol in the beer is a potentially harmful chemical and is stored as fat.

Summary

KEY POINTS

- Water is critical to performance and health in military training and exercise.
- Water is the best fluid replacement.
- Water, in the form of sweat, cools you down during physical activity. You are able to sweat only if you drink.
- Replace water often during physical activity to prevent dehydration.
- Dehydration can affect performance and, in severe cases, can lead to kidney failure and death.
- For continuous activity lasting longer than 90 minutes, fluid replacement drinks may have added performance value.
- The small amount of electrolytes you lose in sweat can easily be replaced with food.
- Extreme climates increase body water loss.
- Drink even when you're not thirsty.

Making It To Your Goal

Below are listed fluid intake goals in various situations.

In garrison: 8-10 cups **Hot-weather training: 10-12 quart canteens**
Cold-weather training: 6-8 quart canteens **High-altitude training: 8-10 quart canteens**

Looking at your current fluid intake status (page 4-1) and applying what you've learned from Performance Nutrition, define your personal strategy to get to your goal.

Example:

Current Status: *I do not currently drink any water.*

Strategy: *I am going to increase my water intake by drinking one additional cup of water every three days until I reach my goal of 10 cups of water a day.*

Current Status: _____

Strategy: _____

_____

_____

_____

_____