

Overview

Things you need to know:

- Heat exposure can cause a range of effects on your body, from irritating rashes to heat stroke, which is often fatal.
- Heat exposure can cause confusion and poor judgment—use the buddy system to monitor coworkers for heat illness.
- Drinking enough water is critical to preventing heat illness. Stay hydrated.
- Cooling is the treatment for all heat illness.

Understanding heat stress can help you to stay safe while working in hot environments.

Factors that Increase Heat Illness Risk

- High humidity
- Lack of wind or breeze to cool the body¹
- Dehydration
- Lack of acclimatization
- Age over 60 years
- Protective gear, including non-breathable or minimally breathable clothing, respirators, and chemical-resistant apparel
- History of heat illness
- History of recent illness unrelated to heat (especially involving vomiting or diarrhea)
- Certain health conditions²
- Certain medications²
- Physically demanding work
- Recent alcohol use (within previous 24 hours)

¹When ambient conditions are higher than body temperature, warm airflow can actually increase heat gain.

²Refer to the Heat Stress: Risk Factors fact sheet [(DHHS) NIOSH No. 2017-125] or consult a healthcare provider.

Workers need to look out for each other! Use a buddy system!

Often it is a coworker who first notices signs of heat stress in another employee.



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Types of Heat Illness

Heat rash/"prickly heat"

- Red cluster of pimples or small blisters, usually on neck, upper chest, groin, under breasts, and in elbow creases

Heat cramps

- Muscle cramps, pain, or spasms in the abdomen, arms, or legs

Heat syncope (fainting)

- Fainting, dizziness, or light-headedness, after prolonged standing or suddenly rising from a sitting or lying position

Heat exhaustion

- Headache
- Nausea
- Dizziness, weakness
- Irritability
- Thirst
- Heavy sweating
- Elevated body temperature, decreased urine output

Heat stroke

- Confusion, altered mental status, slurred speech, loss of consciousness
- Hot, dry skin or profuse sweating
- Seizures
- Very high body temperature
- Fatal if treatment is delayed

Less Severe

Severe

OFTEN FATAL

Points to Remember

Hot environments can be hazardous!

- Heat exhaustion is treatable, but can turn into heat stroke quickly if not recognized and treated.
- Heat stress can affect alertness and judgment, which can lead to accidents and injuries.
- Heat illness does not always happen on the hottest days. It can happen in moderate conditions, or even in cool conditions when performing heavy physical work.
- Get emergency medical aid immediately if heat stroke is suspected. The risk of death is higher without rapid treatment.

Acclimatization is critical, and may need to be repeated!

- Heat acclimatization is the improvement in heat tolerance that comes from gradually increasing the duration or intensity of work performed in a hot setting.
- Acclimatization is most effective if it takes place gradually over a period of 7 to 14 days.
- You begin to lose your acclimatization after about one week away from work in the heat.
- After 1 month away from work in the heat, most people will have lost nearly all heat acclimatization.

Stay hydrated!

- Drinking enough fluids is one of the most important ways to avoid heat illness.
- Don't rely on thirst to tell you when you are dehydrated—thirst lags behind dehydration by several hours.
- Drink 1 cup (8 ounces) of water every 15–20 minutes while working in the heat.
- Electrolytes can be replaced by eating regular meals.
- Sports drinks can also replace electrolytes, but are not usually necessary unless heavy sweating continues for more than 2 hours and eating meals or snacks is not an option.

Give your body time to cool off.

Pay attention to work/rest schedules!

- You must take rest breaks periodically to allow your body to cool down.
- Work/rest schedules can increase productivity and reduce risk of heat illness by guiding workers on how often to take cooling breaks.
- Know your personal limits and options for cooling at your worksite. Let a buddy know if you need to take a break to cool down.

Case Study: Heat Illness and Heavy Machinery*

A 48-year-old employee was running a loader at an open pit mine in Arizona in mid-August when another employee noticed he was just sitting in the cab and not moving. A supervisor called the employee on the radio three times with no response. The supervisor went to the employee and discovered him to be confused and unresponsive.

More than just a health issue!

What might have happened if the employee had been driving or operating the loader when he became unresponsive?

**MSHA Accident and Injury Report*



Photo by ©Fotolia



HEAT STRESS

Risk Factors

Workers should be aware of the many factors that can impact the risk of heat illness.

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Environment

- High temperatures, especially with high humidity, which makes sweating less effective
- Direct sun exposure
- Lack of wind or breeze to cool the body; however, when ambient conditions are higher than body temperature, warm airflow can actually *increase* heat gain
- Proximity to engines or other hot equipment



Activities

- High exertion
- Not enough rest breaks
- Repeated strenuous days in the heat
- High motivation to push through discomfort from heat strain



Photo by NIOSH

No Acclimatization

- New employees
- Experienced employees returning from time away from the heat
- Acclimatized workers who experience a sudden change in worksite temperature, such as heat waves or mining in a new area



Medications

- Heat tolerance can be affected by medications taken for
- cold, allergies, and congestion
 - muscle spasms
 - blood pressure
 - urine production (diuretics)
 - high blood pressure
 - diarrhea
 - dizziness/vertigo
 - psychosis
 - depression



Dehydration

- One of the most important risk factors



Prior Heat Illness

- Increases the risk of heat illness in the future



Other Factors

- Age over 60
- Non-breathable clothing or personal protective equipment
- Alcohol use in the past 24 hours

Health Conditions

- Short-term illnesses, such as diarrhea, vomiting, or respiratory infections
- Chronic conditions, such as diabetes and heart disease
- Being overweight or obese
- Poor physical fitness



A worker may be affected by many risk factors at the same time. Talk to a healthcare provider about your personal risk factors.

Points to Remember

- **Acclimatization is critical**

Lack of acclimatization is a major factor in heat-related deaths on the job

- **Hydration is critical**

Dehydration greatly increases the risk of heat illness

- **A recent illness can temporarily lower your heat tolerance**

- **Be aware of other personal risk factors for heat illness**

Prior heat illness

Certain medications

Certain health conditions

Alcohol use within 24 hours of working in heat

Case showing hazards of heat illness even in acclimatized workers

A 27-year-old employee with two years' mining experience was coming to the end of a 12-hour shift at a mill in Arizona when he experienced muscle cramps and vomiting from dehydration. Although he did not lose consciousness, he missed two days of work due to the incident. The employee had been taking medication for high blood pressure.

Lessons Learned

Young, healthy, and experienced—anyone can get heat illness! This incident may have been related to the employee's high blood pressure medication. Multiple factors together, such as certain medications, a recent illness, or repeated strenuous days in the heat, can increase the risk for heat illness.



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HEAT STRESS Acclimatization

Things you need to know:

- Heat acclimatization is the improvement in heat tolerance that comes from gradually increasing the intensity or duration of work performed in a hot setting.
- The best way to acclimatize yourself to the heat is to increase the workload performed in a hot setting gradually over a period of 1–2 weeks.
- You begin to lose your acclimatization after about 1 week away from working in the heat.

New employees are at the highest risk for heat illness. Acclimatization is crucial to working in hot conditions.

What are the benefits of heat acclimatization?

- Heat exposure causes less strain to the heart and other vital organs.
- Sweating improves (higher volume, earlier onset), which cools the body more quickly. Acclimatized workers need more water—not less—due to increased sweating.
- Workers increase their ability to comfortably perform physical tasks in the heat.



Photo by NIOSH

Tips for acclimatization

- Best results will come from gradually increasing work time in hot conditions over a period of 7 to 14 days, and cooling off and fully rehydrating between shifts.
- **Pushing to the point of heat exhaustion will hurt, not help, your heat tolerance.**
- Typically, acclimatization requires at least two hours of heat exposure per day (which can be broken into two, 1-hour periods).
- The body will acclimatize to the level of work demanded of it. Simply being in a hot place is not sufficient. Doing light or brief physical work in the heat will acclimatize you **ONLY** to light, brief work. More strenuous or longer tasks require more acclimatization.
- Stay hydrated! Dehydration reduces the benefits of heat acclimatization.
- Eating regular meals aids acclimatization. Food replaces electrolytes lost in sweat, especially during the first few days of acclimatization, when you lose the most salt in sweat.
- Physical fitness aids acclimatization.

How quickly does the body LOSE heat tolerance after acclimatization?

- Acclimatization will be maintained for a few days after heat exposure stops, but will begin to be lost after about 1 week away from working in the heat.
- After 1 month away from work in the heat, most people's heat tolerance will have returned to baseline.
- Working for 1–2 days in cooler conditions or taking breaks in air conditioning will not hurt acclimatization.

HEAT STRESS **Acclimatization**

Sample Acclimatization Schedule

NIOSH Acclimatization Recommendations for *New Workers*

1st day	20% usual work duration
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2nd day	40% usual work duration
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3rd day	60% usual work duration
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4th day	80% usual work duration
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5th day	100% usual work duration
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NIOSH Acclimatization Recommendations for *Workers with Previous Experience** with the Same Job

1st day	50% usual work duration
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2nd day	60% usual work duration
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3rd day	80% usual work duration
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4th day	100% usual work duration
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*Workers returning from an absence

- Managers should have a formal acclimatization plan for employees working in the heat. Starting new employees at full intensity is not safe.
- Adjustments to the acclimatization schedule may be needed depending on the worksite's situation and on individual factors.
- **Most workers should be able to safely handle a full workload after 4 days of gradual increase, even though they will usually not be fully acclimatized yet. Most people will continue to see beneficial improvements in heat tolerance for up to 2 weeks after exposure starts.**
- Sudden shifts in work intensity or sudden increases in environmental temperature can increase the risk for heat illness even for acclimatized workers.

Case Study: Hazards of Not Acclimatizing Workers

A 41-year-old construction worker was sawing boards in 93 °F heat. At 5 p.m., the worker collapsed in the parking lot. He was found by another employee. His body temperature was recorded at 108 °F when he was admitted to the hospital. He died the next day. At the time of the incident, the employee had been working for the company for one day. The company had no formal heat stress policy or acclimatization plan.

Lessons Learned

- Heat casualties often occur with new or less experienced employees.
- Deaths from heat stress often occur during the first few days on the job.
- Employers should have heat stress policies, and should implement acclimatization plans.



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HEAT STRESS Hydration

Drinking enough fluids is one of the most important things you can do to prevent heat illness. Water is generally sufficient for hydration.

Urine Color Test

WELL
HYDRATED

HYDRATED

DEHYDRATED
Drink water!

SEVERELY DEHYDRATED
Drink water immediately!

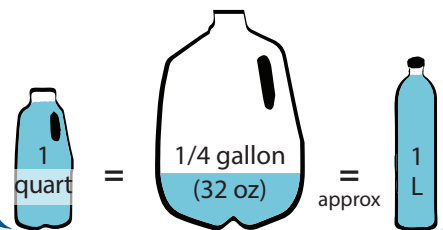
Hydrate *Before* Work

- Being hydrated when you start work makes it easier to stay hydrated through the day.
- If you are dehydrated when you start work, you may not be able to drink enough to catch up with your body's need for water.

Hydrate *During* Work

- Drink before feeling thirsty. **By the time you feel thirsty, you are already behind in fluid replacement.** Dehydration is a primary contributor to heat exhaustion.
- Your work performance may suffer when you are dehydrated, even if you don't notice.
- When working in the heat, drink 1 cup (8 ounces) of water every 15–20 minutes.
 - This translates to $\frac{3}{4}$ –1 quart (24–32 ounces) per hour.
 - Drinking at shorter intervals is more effective than drinking large amounts infrequently.
- Do not drink more than 48 oz (1½ quarts) per hour! Drinking too much water or other fluids (sports drinks, energy drinks, etc.) can cause a medical emergency because the concentration of salt in the blood becomes too low.

How much water is that?



Hydrate *After* Work

- Most people need several hours to drink enough fluids to replace what they have lost through sweat. The sooner you get started, the less strain you place on your body from dehydration.
- Hydrating after work is even more important if you work in the heat on a regular basis. Chronic dehydration increases the risk for a number of medical conditions, such as kidney stones.

What to Drink

Water

Water will almost always maintain hydration during work in the heat, as long as you eat regular meals to replace salt lost in sweat.

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What to Avoid

Energy Drinks

- Some energy drinks contain much more caffeine than standard servings of coffee, tea, or soft drinks.
- Drinking several energy drinks per day can raise your caffeine levels enough to affect your heart. High caffeine levels can be risky when added to the strain placed on your body by heat.
- Many energy drinks contain as much or more sugar as soft drinks, which adds hundreds of extra calories to your diet.

Alcohol

- Alcohol can cause dehydration.
- Drinking alcohol within 24 hours of working in the heat can increase the risk of heat illness.

What about salt tablets?

NIOSH does not recommend taking salt tablets. In most cases, salt can be replaced by eating normal meals and snacks throughout the day. Do not skip meals.

What about caffeine?

The amount of caffeine in tea, coffee, and soft drinks probably will not have an effect on overall hydration.

Do I need sports drinks?

In general, eating regular meals with adequate water intake is sufficient to maintain water and electrolyte balance.

For prolonged sweating lasting several hours, sports drinks with balanced electrolytes are another option to replace salt lost in sweat.

Heavy consumption of sports drinks will add unnecessary calories to your diet due to the added sugar.

Work/Rest Schedules

Using work/rest schedules can decrease the risk of heat illness

Sample Work/Rest Schedule for Workers Wearing Normal Clothing*

The NIOSH work/rest schedule is based on air temperature, with adjustments for direct sunlight and humidity. It may not be applicable to all worksites. Other work/rest schedules are available, some of which are based on Wet Bulb Globe Temperature.

See reverse for temperature adjustments for the NIOSH work/rest schedule and examples of light, moderate, and heavy work.

Temperature (°F)	Light Work Minutes Work/Rest	Moderate Work Minutes Work/Rest	Heavy Work Minutes Work/Rest
90	Normal	Normal	Normal
91	Normal	Normal	Normal
92	Normal	Normal	Normal
93	Normal	Normal	Normal
94	Normal	Normal	Normal
95	Normal	Normal	45/15
96	Normal	Normal	45/15
97	Normal	Normal	40/20
98	Normal	Normal	35/25
99	Normal	Normal	35/25
100	Normal	45/15	30/30
101	Normal	40/20	30/30
102	Normal	35/25	25/35
103	Normal	30/30	20/40
104	Normal	30/30	20/40
105	Normal	25/35	15/45
106	45/15	20/40	Caution
107	40/20	15/45	Caution
108	35/25	Caution	Caution
109	30/30	Caution	Caution
110	15/45	Caution	Caution
111	Caution	Caution	Caution
112	Caution	Caution	Caution

Things you need to know:

- Continuous work in the heat is not advisable—you must take rest breaks periodically to allow your body to cool down.
- A variety of work/rest schedules are available that can be adapted to your worksite. Relying on self-pacing alone may not be sufficient.

Example

A worker performing heavy work in 104 °F temperatures should work for 20 minutes and rest for 40 minutes.

Example


A worker performing moderate work at 108 °F should use extreme caution! The risk for heat injury is high in this situation.

* From NIOSH Criteria for a Recommended Standard, Occupational Exposure to Heat and Hot Environments, <https://www.cdc.gov/niosh/docs/2016-106/pdfs/2016-106.pdf>. **Assumptions:** workers are physically fit, well-rested, fully hydrated, under age 40, and environment has 30% humidity and perceptible air movement.

HEAT STRESS Work/Rest Schedules

Temperature Adjustments for this Work/Rest Schedule

Adjust the temperature in the table based on:

Environmental conditions	AND	Humidity
<ul style="list-style-type: none">• Full sun (no clouds): Add 13 °F• Partly cloudy/overcast: Add 7 °F• No shadows visible, in the shade, or at night: No adjustment		<ul style="list-style-type: none">• 40% humidity: Add 3 °F• 50% humidity: Add 6 °F• 60% humidity or more: Add 9 °F
Example Adjustment <p>Conditions at a mine are 90 °F, with partly cloudy skies and 50% humidity. Adjust the table as follows: Add 7 °F for partly cloudy skies and 6 °F for 50% humidity, to arrive at 103 °F.</p>		

Examples of Work at Different Intensity Levels

Light work

- Operating equipment
- Inspection work
- Walking on flat, level ground
- Using light hand tools (wrench, pliers, etc.). However, this may be moderate work depending on the task
- Travel by conveyance

Moderate work

- Jack-leg drilling
- Installing ground support
- Loading explosives
- Carrying equipment/supplies weighing 20–40 pounds
- Using hand tools (shovel, fin-hoe, scaling bar) for short periods

Heavy work

- Climbing
- Carrying equipment/supplies weighing 40 pounds or more
- Installing utilities
- Using hand tools (shovel, fin-hoe, scaling bar) for extended periods

Case Study: Use of Work/Rest Schedule

A crew was shoveling ore out from under the primary conveyor at a surface mine in Arizona in August. The high temperature that day was 113 °F. The crew was rotating in 10-minute shifts and hydrating between shifts. Coworkers noticed signs of heat illness in two employees, and they were transferred to the medical station for evaluation. From there they were sent to the hospital, where they were given IV saline and released home. Both employees recovered after rehydration at the hospital.

Lessons Learned

In extreme heat, even a work/rest schedule may not eliminate the risk of heat illness. In this case, use of work/rest schedules, frequent hydration, and team monitoring helped keep this situation from becoming even more serious. Without those safety precautions the workers could have potentially suffered more severe heat illness, possibly including heat stroke, which is life threatening.

Things you need to know:

- Heat illness can strike quickly. Stop working, get cool, and drink fluids.
- When treating severe heat illness, cooling is the first priority.
- Altered mental state can be a sign of heat stroke and requires immediate attention.
- Muscle cramps, pain, or spasms in the abdomen, arms, or legs—alone or with any symptom—should not be ignored.
- Never leave a worker with heat illness alone.

HEAT STRESS

First Aid for Heat Illness

Cooling is key. Know the symptoms and treatment of heat illness.*

Symptoms can occur in any order. You don't need to have all of the symptoms in a category to have heat illness.

Signs and Symptoms

What to Do

Heat Rash/ Prickly Heat

- Red cluster of pimples or small blisters, usually on neck, upper chest, groin, under breasts, and in elbow creases
- Extensive areas of skin that do not sweat on heat exposure, but present a gooseflesh appearance that subsides with cool environments

- When possible, a cooler, less humid work environment is the best treatment
- Keep rash area dry
- Do not use ointments or creams, as they may impair cooling—warm, moist skin can make the rash worse

Heat Cramps

- Muscle cramps, pain, or spasms in the abdomen, arms, or legs

- Drink fluids every 15 to 20 minutes and eat a snack or sports drink
- Avoid salt tablets, but drinks containing electrolytes are OK
- Get medical help if the worker has heart problems, is on a low sodium diet, or if cramps do not subside within 1 hour

Heat Syncope (Fainting)

- Fainting, dizziness, or light-headedness after standing or suddenly rising from a sitting/lying position

- Sit or lie down in a cool place when beginning to feel faint or dizzy
- Slowly drink water or clear juice

Heat Exhaustion

- Headache
- Nausea
- Dizziness, weakness
- Irritability
- Thirst, heavy sweating
- Elevated body temperature
- Decreased urine output

- Call for medical help or take worker to a health facility for evaluation and treatment
- Stay with worker until help arrives
- Remove worker from hot area and give liquids to drink
- Remove unnecessary clothing, including shoes and socks
- Cool worker with water, cold compresses, an ice bath, or fans
- Encourage frequent sips of cool water

Exertional Heat Stroke

- Confusion, altered mental state, slurred speech, loss of consciousness
- Hot, dry skin or profuse sweating
- Seizures
- Very high body temperatures
- Fatal if treatment delayed

- This is an emergency! Call for emergency care immediately!
- Move worker to a cool area and remove clothing
- Immerse worker in a tub of ice water
- If a tub is not available, place worker in a tarp with ice and water (e.g., tarp-assisted cooling with oscillation[†])
- If cold-water immersion is not possible,
 - Soak worker with cold water from a hose or shower
 - Apply cold, wet towels to as much of the skin as possible, and replace towels frequently



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Case Study: Heat Stroke

A 44-year-old male worker died of heat stroke while working on a North Carolina farm. The man had been working in the fields for about a week. On August 1st, the heat index was between 100°F and 110°F. The heat index reports how hot it feels to people outside based on the air temperature and humidity.

Around 3 p.m., the worker complained to the crew leader that he was feeling ill. He drank some water and was driven to the employee housing and left alone. He was found unconscious 45 minutes later. Emergency personnel took the worker to the hospital, where he was pronounced dead. His core body temperature was 108°F.



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Lessons Learned

- Feeling ill while working in the heat is a serious warning sign. Any employee who reports feeling unwell during work in hot conditions could have heat exhaustion, which can quickly progress to heat stroke if not treated.
- Proper first aid for someone with suspected heat exhaustion or heat stroke involves **COOLING** the body as quickly as possible—not simply drinking water.
- People with severe heat illness do not always recognize the risks they face. If a worker shows signs of heat exhaustion or heat stroke, do not leave him or her alone until he or she receives medical attention.

[†]For more information about heat exposure at work, see NIOSH [2016]. Criteria for a recommended standard: occupational exposure to heat and hot environments. By Jacklitsch B, Williams J, Musolin K, Coca A, Kim J, Turner N. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2016-106, <https://www.cdc.gov/niosh/docs/2016-106/>.

[†]For more information on tarp-assisted cooling with oscillation, see Luhning KE, Butts CL, Smith CR, Bonacci JA, Ylanan RC, Ganio MS, McDermott BP [2016]. Cooling effectiveness of a modified cold-water immersion method after exercise-induced hyperthermia. *J Athl Train* 51(11):946–951

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