

Environmental Factors in Sports Medicine Curriculum



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(1061330-01)

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About the Author



Krista Wenz has been a Licensed Paramedic for 34 years. She holds a bachelor's degree in Fire Safety Management and worked 23 years as a Firefighter-Paramedic for a large Metropolitan Fire Department in California. Krista has extensive knowledge in Emergency Medicine, including experience as an Adjunct Instructor at community and private colleges teaching EMT and Paramedic students. She has additional experience working as a Mental Health Technician in a psychiatric ward and emergency crises, Drill-Instructor and Field Training Officer for multiple agencies, CPR, First-Aid, PALS, BLS, and ALS instructor, sports medicine and nutrition expert, and EMS Captain for a rural fire department. Now retired from the fire service, Krista works as an EMS Educator, passing on her knowledge and experience for those interested in entering the healthcare field.

This curriculum will help participants learn to recognize atmospheric conditions that contribute to environmental injury and illness. Participants will describe what constitutes an environmental injury and will learn to define the six atmospheric conditions as well as how each of them can affect athletes. Participants will also learn how to determine the relative humidity using a sling psychrometer and wet bulb globe temperature (WBGT) heat stress meter, determine the WBGT, and use those findings to keep athletes safe from heat-related injuries and illnesses while practicing in different environmental conditions. Participants will measure light intensity at different locations in their environment and record their findings. Participants will learn about circadian rhythms and how light affects the sleep-wake cycle, affecting athletic performance, and recovery.

Curriculum Structure

The *Environmental Factors in Sports Medicine* curriculum is composed of the following lessons. Approximate lesson times are included.

Lesson	Title	Approximate Time
One	Atmospheric Conditions That Contribute to Environmental Injury	60 minutes
Two	Environmental Factors to be Considered When Caring for Athletes	70 minutes
Three	Circadian Dysrhythmia Impact on Athletes	70 minutes
Four	Developing an Emergency Action Plan (EAP) And Policy for Thunder and Lightning as It Relates to Athletics	70 minutes
Five	Sun Exposure and Risks to Athletes	80 minutes
	Total	6 hours

Lesson Structure

Each lesson begins with a Lesson Overview, Lesson Objectives, and a Lesson at a Glance table which lists the lesson activities, materials required, suggested preparation steps, and approximate class time.

Lesson Sections

The actual lesson follows the overview, which will contain some of the sections described below.

FOCUS

Every lesson begins with a FOCUS activity intended to capture participants' attention. This may be in the form of a small or large class discussion, a game, a review of previous lesson information, or a demonstration. During this activity, participants are introduced to the topic of the lesson.

LEARN

The LEARN activity in each lesson varies in its presentation mode. It may be a slide presentation, group activity, or demonstration.

REVIEW

The majority of lessons end with a REVIEW activity intended to briefly review the lesson's key messages or main points.

Lesson One – Atmospheric Conditions That Contribute to Environmental Injury

Lesson Overview

In this lesson, participants will learn to recognize atmospheric conditions that contribute to environmental injury, and what constitutes an environmental injury. Participants of this lesson will learn to define the six atmospheric conditions and how each can affect athletes.

Lesson Objectives

After completing this lesson, participants will be able to:

- Recognize atmospheric conditions that contribute to environmental injury.
- Describe what is considered an environmental injury.
- Define the six atmospheric conditions and how each can affect athletes.

Lesson at-a-Glance

Activity	Materials	Preparation	Approximate class time
FOCUS:	• <i>Atmospheric Conditions That Contribute to Environmental Injury Pre-Test</i> • <i>Atmospheric Conditions That Contribute to Environmental Injury Pre-Test – Answer Key</i>	1. Print/photocopy <i>Atmospheric Conditions That Contribute to Environmental Injury Pre-Test</i> (one per participant).	20 minutes
LEARN	• <i>Atmospheric Conditions That Contribute to Environmental Injury</i> slide presentation • <i>Atmospheric Conditions That Contribute to Environmental Injury Notes</i> • <i>Atmospheric Conditions That Contribute to Environmental Injury Notes – Answer Key</i>	1. Prepare <i>Atmospheric Conditions That Contribute to Environmental Injury</i> slide presentation for viewing. 2. Print/photocopy <i>Atmospheric Conditions That Contribute to Environmental Injury Notes</i> (one per participant).	30 minutes
REVIEW	• <i>Atmospheric Conditions That Contribute to Environmental Injury Post-Test</i> • <i>Atmospheric Conditions That Contribute to Environmental Injury Post-Test – Answer Key</i>	1. Print/photocopy <i>Atmospheric Conditions That Contribute to Environmental Injury Post-Test</i> (one per participant).	10 minutes

Lesson One – Atmospheric Conditions That Contribute to Environmental Injury

FOCUS: Developing Awareness of Atmospheric Conditions That Contribute to Environmental Injury

20 minutes

Purpose:

To help participants develop an awareness of atmospheric conditions that contribute to environmental injury.

Materials:

- *Atmospheric Conditions That Contribute to Environmental Injury Pre-Test*
- *Atmospheric Conditions That Contribute to Environmental Injury Pre-Test – Answer Key*

Facilitation Steps:

1. Distribute the *Atmospheric Conditions That Contribute to Environmental Injury Pre-Test*.
2. Have the *Atmospheric Conditions That Contribute to Environmental Injury Pre-Test – Answer Key* available. The answers will be given after the post-test is given since the tests are the same.
3. Have participants complete the pre-test.
4. Collect the pre-tests to grade.

Name: _____ Class: _____

Atmospheric Conditions That Contribute to Environmental Injury Pre-Test

Directions: Select the best answer to the following multiple-choice questions.

1. How many main components of weather are there?
 - a. Three
 - b. Six
 - c. Five
 - d. Ten
2. Which of the following is the **best** way for an athlete to dissipate heat from their body while exercising?
 - a. Evaporation
 - b. Conduction
 - c. Convection
 - d. Radiation
3. Which is the most severe type of heat-related injury or illness?
 - a. Heat cramps
 - b. Heat exhaustion
 - c. Heat stroke
 - d. Heat rash
4. What is the proper treatment for frostbite?
 - a. Place hot compresses on the affected area
 - b. Place the affected area in hot water
 - c. Rub the affected area vigorously
 - d. Remove wet clothing and cover the area with a blanket
5. What are the biggest concerns with humidity and how it affects athletic performance?
 - a. Muscle cramps and dehydration
 - b. Muscle cramps and heat stroke
 - c. Heat exhaustion and dehydration
 - d. Muscle cramps and heat exhaustion

Atmospheric Conditions That Contribute to Environmental Injury Pre-Test – Answer Key

1. How many main components of weather are there?
 - a. Three
 - b. Six**
 - c. Five
 - d. Ten
2. Which of the following is the **best** way for an athlete to dissipate heat from their body while exercising?
 - a. Evaporation**
 - b. Conduction
 - c. Convection
 - d. Radiation
3. Which is the most severe type of heat-related illness or injury?
 - a. Heat cramps
 - b. Heat exhaustion
 - c. Heat stroke**
 - d. Heat rash
4. What is the proper treatment for frostbite?
 - a. Place hot compresses on the affected area
 - b. Place the affected area in hot water
 - c. Rub the affected area vigorously
 - d. Remove wet clothing and cover the area with a blanket**
5. What are the biggest concerns with humidity and how it affects athletic performance?
 - a. Muscle cramps and dehydration**
 - b. Muscle cramps and heat stroke
 - c. Heat exhaustion and dehydration
 - d. Muscle cramps and heat exhaustion

Lesson One – Atmospheric Conditions That Contribute to Environmental Injury

LEARN: Atmospheric Conditions That Contribute to Environmental Injury Slide Presentation

30 minutes

Purpose:

Participants will receive a thorough introduction to atmospheric conditions that contribute to environmental injury and how athletes are affected by these conditions.

Materials:

- *Atmospheric Conditions That Contribute to Environmental Injury* slide presentation
- *Atmospheric Conditions That Contribute to Environmental Injury* Notes
- *Atmospheric Conditions That Contribute to Environmental Injury* Notes – Answer Key

Facilitation Steps:

Share the following information as you show the slide presentation. Some slides will have questions for you to ask to keep the participants engaged.

Slide 1: Introduction slides

Slide 2: The goals and objectives of this lesson are to:

- Recognize atmospheric conditions that contribute to environmental injury
- Describe what is considered an environmental injury
- Define the six atmospheric conditions and how each can affect athletes:
 1. Temperature
 2. Atmospheric pressure
 3. Wind
 4. Humidity
 5. Precipitation
 6. Cloudiness

Slide 3: Atmospheric conditions describe the weather. There are six main components of weather:

1. Temperature
2. Atmospheric pressure
3. Wind
4. Humidity
5. Precipitation
6. Cloudiness

Together, these components describe the weather at any given time.

Slide 4: Environmental injuries are injuries sustained that are directly attributed to the environment.

For example, an athlete could be overcome by heat cramps, heat stroke, or receive a sunburn on a hot day.

On a cold day, an athlete could receive frostbite or hypothermia.

On a humid day, an athlete can become dehydrated by sweating too much.

Environmental conditions can significantly impact player health and safety. Extreme temperatures and severe weather impact players' ability to practice and compete safely. By recognizing and understanding these environmental conditions, athletes and coaches can be better informed and help reduce environmental injuries.

*Ask the question, "Which type of atmospheric condition do you think affects athletes the most?"

**Answer: There is no right or wrong answer. Athletes are affected differently depending on the region and what type of sport they play.

Slide 5: Weather temperature is measured with a thermometer and refers to how cold or hot it is in the atmosphere.

Temperature can be measured two ways:

1. Fahrenheit (°F): used in the US
2. Celsius (°C): used in other parts of the world

Most scientists use Celsius when studying the temperature.

Slide 6: There are four primary methods how the body gains or loses heat:

1. **Conduction:** Direct contact with a hot or cold object. For example, if an athlete were sitting on a hot metal bench, the heat would transfer from the bench to their body through conduction.
2. **Convection:** Transfer of heat by circulation of a medium such as wind or water current. An example of convection is the wind or a fan blowing on a player's face, cooling them down.
3. **Radiation:** Heat transfer without direct contact with an object. The perfect example of radiation is the sun beating down on an athlete's body. The athlete will gain heat without ever touching the rays of the sun.
4. **Evaporation:** The evaporation of fluid, such as sweating, is typically the most effective way to dissipate heat from the body during physical activity. However, evaporation is most effective at cooling the body if the relative air temperature and humidity are low.

It is important for athletes and trainers to understand these four methods, which will help prevent environmental injuries from happening.

*Ask the question, "How are conduction and radiation different from each other?"

**Answer: Conduction requires direct contact with an object to gain or lose heat, and radiation is heat transfer without direct contact with the object.

Slide 7: There are numerous factors in how hot temperatures affect athletes. Heat and cold can negatively impact athletes' health and safety. It is critical for athletic trainers, coaches, and athletes to understand the potential for injury by noting the environment's characteristics, knowing how to stay hydrated, and the different warning signs of

heat- and cold-related illnesses and injuries. Most environmental illnesses and injuries can be prevented or lessened through education and good decision-making when preparing for an event. Proper hydration prevents many injuries and illnesses, from muscle cramps to heat stroke. Athletes should drink water before, during, and after practices and games. We will start with the heat-related illnesses and injuries and we will then cover cold-related injuries on the following slide, starting with the least severe heat-related illness:

- **Heat rash:** A stinging rash that turns your skin red.
- **Dehydration:** All heat-related illnesses are due to dehydration, except for heat rash. Dehydration occurs when the body loses more fluids than you take in. When the average water content of the body is reduced, it upsets the balance of salt and sugar in your body, affecting how you function. Signs and symptoms of dehydration include the cessation of sweating, dry mouth, muscle cramps, weakness, heart palpitations, and feeling lightheaded.
- **Heat cramps:** Painful spasms in the muscles, especially in the legs. Other signs and symptoms are flushed, moist skin, and a mild fever.
- **Heat exhaustion:** Caused by too few fluids and long hours in high temperatures. Heat exhaustion causes heavy sweating, a weak and rapid pulse, and rapid breathing. Heat exhaustion is a true medical emergency and can lead to heat stroke if not treated promptly.
- **Heat stroke:** A life-threatening illness when the body temperature rises above 106°F. A few characteristic signs and symptoms of heat stroke are the inability to sweat in hot temperatures, headache, dizziness, confusion, muscle cramps, dry skin, and unconsciousness.

Most heat-related illnesses can be treated by removing the athlete from the heat, resting, drinking water, a sports drink, or clear juice, and gently massaging muscle cramps. Avoid anything with caffeine when giving fluids as that can cause dehydration. For more severe illnesses such as heat exhaustion and heat stroke, it is critical to call 911 and have EMS respond. Emergency medical assistance is needed immediately. If the

player is confused, unconscious, or cannot follow commands, do not force fluids as they could choke.

*Ask the question, “Has anyone experienced any of these heat-related illnesses, and if so, how did you feel?” Pick one or two students to answer briefly.

Slide 8: Cold-related injuries and illnesses affecting athletes:

- **Hypothermia:** When exposed to cold temperatures, your body begins to lose heat faster than it can be produced. Signs and symptoms of hypothermia are shivering, exhaustion, confusion, fumbling hands, memory loss, slurred speech, and drowsiness. Hypothermia is treated by gently moving the athlete out of the cold, removing wet clothing, covering the player with blankets, providing warm decaffeinated beverages, and monitoring closely. If their condition does not improve, call 911.
- **Frostbite:** An injury to the body caused by the tissues freezing, typically on the toes, fingers, nose, and ears. The signs and symptoms of frostbite are decreased sensation in the affected body part, blistering, stinging sensation, redness, and cold waxy skin. To treat frostbite, remove the player from the cold environment and seek medical attention immediately. While waiting for medical care, you can remove any wet clothing, cover the athlete in a blanket, and keep them from walking if toes are affected. Do **not** rub the affected area, place a hot compresses on the site, or place the frostbitten body part in hot water. Rewarming needs to be accomplished at a medical facility.
- **Trench foot:** Also called immersion foot, this occurs when the feet are wet for long periods of time. The signs and symptoms of trench foot include a tingling or itching sensation in the foot, pain, swelling, cold and blotchy skin, and a heavy or prickly feeling in the affected foot or feet. Remove the player from the cold environment, gently clean and dry the affected foot or feet, and call for medical assistance.
- **Dehydration:** Sweat evaporates more rapidly in cool, dry air, which can cause dehydration. Cooler temperatures also reduce the body's

thirst response, so many people do not drink enough fluids in colder weather. Signs and symptoms of dehydration include the cessation of sweating, dry mouth, muscle cramps, weakness, heart palpitations, and lightheadedness.

Cold-related injuries can be treated by removing the athlete from the cold environment, resting, drinking liquids such as water or clear juice, and gently massaging muscle cramps. When giving fluids, avoid anything with caffeine as that can cause dehydration. If the player is confused, unconscious, or cannot follow commands, do not force fluids as they could choke.

- **Asthma:** Cold weather can trigger asthma attacks in players who have been diagnosed with asthma. If an asthma attack occurs, the patient will most likely have an inhaler to puff on to help their breathing. If not, 911 needs to be immediately called as asthma can be a life-threatening illness. If the patient has relief from an inhaler, it is recommended to move them into a warmer environment and discontinue anything exertional.

Slide 9: Atmospheric pressure, also known as barometric pressure, is the pressure within Earth's atmosphere. It is the force exerted on a surface by the air above it as gravity pulls it to Earth. Changes in atmospheric pressure signal to meteorologists that there are weather changes in the forecast.

Slide 10: Athletes can be affected by atmospheric pressure due to changing weather conditions. The changing conditions bring in weather patterns such as precipitation, thunder and lightning, and wind.

Studies show that an increased barometric (atmospheric) pressure leads to an increase in athletic performance, and a decreased barometric pressure leads to decreased athletic performance.

The higher atmospheric pressure increases the amount of oxygen in the air, so athletic performance increases. When the pressure is low, athletes report feeling sluggish, headaches, muscle and joint pain, and lack of motivation to exercise. Some say this is where the term “feeling under the weather” came from.

Slide 11: Wind is defined as the movement of air, which forms a difference in temperature and atmospheric pressure in nearby regions. Winds tend to blow from high-pressure areas, where it is colder, to low-pressure areas, where it is warmer.

Slide 12: Wind affects athletic performance due to the wind chill factor and an increase in cold weather injuries. The wind chill factor is the lowering of body temperature due to the passing flow of lower-temperature air.

Lower body temperatures can lead to hypothermia, pulled muscles, muscle cramping, and decreased performance. If a player is showing signs of hypothermia, you will treat them as you learned in the cold-related injuries section.

*Ask the question, “What are some signs and symptoms of hypothermia?”

**Answer: Signs and symptoms of hypothermia are shivering, exhaustion, confusion, fumbling hands, memory loss, slurred speech, and drowsiness.

Slide 13: Humidity refers to the amount of water vapor there is in the air. The water vapor is what is used to make rain, clouds, and snow. If there is a lot of water vapor in the air, the humidity will be high. The higher the humidity, the wetter it feels outside.

Slide 14: The biggest concerns with humidity and athletic performance are muscle cramps and dehydration.

Cold air with high relative humidity "feels" colder than dry air of the same temperature because high humidity in cold weather increases the conduction of heat from the body and can lead to lower core body temp and Hypothermia. Humidity with heat is an issue caused by the humidity slows evaporation of sweat causing increase core body temp and eventually hyperthermia.

You would treat a player who is experiencing signs of dehydration or muscle cramping the same

way as was taught in the heat-related injuries section.

Slide 15: Precipitation is “water that falls to the earth as hail, mist, rain, sleet, or snow.”

Slide 16: Precipitation affects athletes in the following ways:

- Increased risk of cold weather injuries due to cold weather and decreased traction on rainy and muddy surfaces or ice and snow
- Risk of hypothermia
- Increased risk of dehydration
- Decreased physical performance

Any athlete who presents with signs of cold weather injuries, hypothermia, dehydration, or decreased physical performance should be moved out of the elements and into a dry environment. Wet clothes should be removed, the athlete should be warmed and rehydrated, and their injuries should be attended to. If any of the player’s symptoms are unusual or severe, call 911.

Slide 17: Cloudiness refers to the clouds and cloud cover that are in the sky. It can also refer to foggy conditions. Cloudiness is an indicator of different high-and low-pressure systems that may bring a change of weather to the area. Clouds also contribute to regulating the temperature at Earth’s surface by providing a “blanket” layer.

Slide 18: Cloudiness can affect athletes in the following ways:

- Decreased visibility can lead to difficulty seeing some objects due to foggy conditions or shady conditions on the ground.
- Sunburn from the ultraviolet rays refracting off the clouds. Many people do not think they will get sunburned on a cloudy day, so forego protective measures such as sunscreen and proper attire.
- Lack of motivation like when the barometric pressure is low. Some athletes might be affected by seasonal affective disorder (SAD), which occurs in climates where there is less sunlight.

Atmospheric Conditions That Contribute to Environmental Injury Notes

What are the six atmospheric conditions that can affect athletes?

What are the four primary methods by which the body gains or loses heat?

How are conduction and radiation different from each other?

True or False: When giving fluids, avoid anything with caffeine as that can cause dehydration.

What are examples of cold-related injuries and illnesses affecting athletes?

Environmental Factors in Sports Medicine Curriculum

Studies show that an increased barometric (atmospheric) pressure leads to _____
_____ in athletic performance, and a decreased barometric pressure leads to
_____ athletic performance.

How does wind affect athletic performance?

What are some signs and symptoms of hypothermia?

What is the biggest concern with humidity and athletic performance?

How does cloudiness affect athletes?

Atmospheric Conditions That Contribute to Environmental Injury Notes – Answer Key

What are the six atmospheric conditions that can affect athletes?

1. Temperature
2. Atmospheric pressure
3. Wind
4. Humidity
5. Precipitation
6. Cloudiness

What are the four primary methods the body gains or loses heat?

1. Conduction
2. Convection
3. Radiation
4. Evaporation

How are conduction and radiation different from each other?

Conduction requires direct contact with an object to gain or lose heat, and radiation is heat transfer without direct contact with the object.

True or False: When giving fluids, avoid anything with caffeine as that can cause dehydration.

What are examples of cold-related injuries and illnesses affecting athletes?

- Hypothermia
- Frostbite
- Trench foot
- Dehydration
- Asthma

Studies show that an increased barometric (atmospheric) pressure leads to **an increase** in athletic performance, and a decreased barometric pressure leads to **decreased** athletic performance.

How does wind affect athletic performance?

Wind affects athletic performance due to the wind chill factor and an increase in cold weather injuries. The wind chill factor is the lowering of body temperature due to the passing flow of lower-temperature air.

What are some signs and symptoms of hypothermia?

Signs and symptoms of hypothermia are shivering, exhaustion, confusion, fumbling hands, memory loss, slurred speech, and drowsiness.

What is the biggest concern with humidity and athletic performance?

The biggest concern with humidity and athletic performance is muscle cramps and dehydration. You would treat a player experiencing signs of dehydration or muscle cramping the same way as was taught in the heat-related injuries section.

How does cloudiness affect athletes?

- **Decreased visibility can lead to difficulty seeing some objects due to foggy conditions or shady conditions on the ground.**
- **Sunburn from the ultraviolet rays refracting off the clouds. Many people do not think they will get sunburned on a cloudy day, so forego protective measures such as sunscreen and proper attire.**
- **Lack of motivation like when the barometric pressure is low. Some athletes might be affected by seasonal affective disorder (SAD), which occurs in climates where there is less sunlight.**

Lesson One – Atmospheric Conditions That Contribute to Environmental Injury

REVIEW: Post-Test

10 minutes

Purpose:

Participants will take a post-test on atmospheric conditions that contribute to environmental injury. The questions are based on the slide presentation and are a good review of the materials covered in the lesson.

Materials:

- *Atmospheric Conditions That Contribute to Environmental Injury Post-Test*
- *Atmospheric Conditions That Contribute to Environmental Injury Post-Test – Answer Key*

Facilitation Steps:

1. Distribute the *Atmospheric Conditions That Contribute to Environmental Injury Post-Test*.
2. Give participants 2-5 minutes to complete the questions.
3. After the post-test is completed, give the correct answers from the answer key, answer any questions participants may have, and collect the tests.

Name: _____ Class: _____

Atmospheric Conditions That Contribute to Environmental Injury Post-Test

Directions: Select the best answer to the following multiple-choice questions:

1. How many main components of weather are there?
 - a. Three
 - b. Six
 - c. Five
 - d. Ten
2. Which of the following is the **best** way for an athlete to dissipate heat from their body while exercising?
 - a. Evaporation
 - b. Conduction
 - c. Convection
 - d. Radiation
3. Which is the most severe type of heat-related injury or illness?
 - a. Heat cramps
 - b. Heat exhaustion
 - c. Heat stroke
 - d. Heat rash
4. What is the proper treatment for frostbite?
 - a. Place hot compresses on the affected area
 - b. Place the affected area in hot water
 - c. Rub the affected area vigorously
 - d. Remove wet clothing and cover the area with a blanket
5. What are the biggest concerns with humidity and how it affects athletic performance?
 - a. Muscle cramps and dehydration
 - b. Muscle cramps and heat stroke
 - c. Heat exhaustion and dehydration
 - d. Muscle cramps and heat exhaustion

Atmospheric Conditions That Contribute to Environmental Injury Post-Test – Answer Key

1. How many main components of weather are there?
 - a. Three
 - b. Six**
 - c. Five
 - d. Ten
2. Which of the following is the **best** way for an athlete to dissipate heat from their body while exercising?
 - a. Evaporation**
 - b. Conduction
 - c. Convection
 - d. Radiation
3. Which is the most severe type of heat-related illness or injury?
 - a. Heat cramps
 - b. Heat exhaustion
 - c. Heat stroke**
 - d. Heat rash
4. What is the proper treatment for frostbite?
 - a. Place hot compresses on the affected area
 - b. Place the affected area in hot water
 - c. Rub the affected area vigorously
 - d. Remove wet clothing and cover the area with a blanket**
5. What are the biggest concerns with humidity and how it affects athletic performance?
 - a. Muscle cramps and dehydration**
 - b. Muscle cramps and heat stroke
 - c. Heat exhaustion and dehydration
 - d. Muscle cramps and heat exhaustion

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Lesson Two – Environmental Factors to be Considered When Caring for Athletes

Lesson Overview

In this lesson, participants will learn how to determine the relative humidity using a sling psychrometer and WBGT heat stress meter, how to determine the wet bulb globe temperature (WBGT), and how to use those findings to keep athletes safe from heat-related injuries and illnesses while practicing in different environmental conditions.

Lesson Objectives

After completing this lesson, participants will be able to:

- Describe the wet bulb globe temperature (WBGT).
- Explain the function of a sling psychrometer and WBGT heat stress meter.
- Describe relative humidity.
- Learn how to use the above two instruments to measure relative humidity.
- Explain how to use a sling psychrometer.
- Formulate the WBGT using a sling psychrometer.
- Describe safe practices for athletes using the WBGT guidelines.

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS:	• <i>Environmental Factors to be Considered When Caring for Athletes Pre-Test</i> • <i>Environmental Factors to be Considered When Caring for Athletes Pre-Test – Answer Key</i>	1. Print/photocopy <i>Environmental Factors to be Considered When Caring for Athletes Pre-Test</i> (one per participant).	10 minutes
LEARN	• Sling psychrometer • WBGT heat stress meter • <i>Environmental Factors to be Considered When Caring for Athletes</i> slide presentation	1. Prepare <i>Environmental Factors to be Considered When Caring for Athletes</i> slide presentation for viewing.	30 minutes
REVIEW	• Sling psychrometer and WBGT heat stress meter • Room temperature water • <i>Environmental Factors to be Considered When Caring for Athletes</i> slide presentation • <i>Practice Lab Worksheet</i> • <i>Practice Lab Worksheet – Answer Key</i> • <i>Environmental Factors to be Considered When Caring for Athletes Post-Test</i> • <i>Environmental Factors to be Considered When Caring for Athletes Post-Test – Answer Key</i>	1. Print/photocopy the <i>Practice Lab Worksheet</i> (one per participant). 2. Gather sling psychrometers and WBGT heat stress meters and have available for lab. 3. Have a container of room temperature water available. 4. Print/photocopy <i>Environmental Factors to be Considered When Caring for Athletes Post-Test</i> (one per participant).	30 minutes

Lesson Two – Environmental Factors to be Considered When Caring for Athletes

FOCUS: Developing Awareness of Environmental Factors to be Considered When Caring for Athletes

10 minutes

Purpose:

To help participants develop an awareness of environmental factors to consider when caring for athletes.

Materials:

- *Environmental Factors to be Considered When Caring for Athletes Pre-Test*
- *Environmental Factors to be Considered When Caring for Athletes Pre-Test – Answer Key*

Facilitation Steps:

1. Distribute the *Environmental Factors to be Considered When Caring for Athletes Pre-Test*.
2. Have the *Environmental Factors to be Considered When Caring for Athletes Pre-Test* – Answer Key available. The answers will be given after the post-test is given since the tests are the same.
3. Have participants complete the pre-test.
4. Collect the pre-tests to grade.

Name: _____ Class: _____

Environmental Factors to be Considered When Caring for Athletes Pre-Test

Directions: Select the best answer to the following multiple-choice questions:

1. Why is the wet bulb globe temperature (WBGT) used for athletes?
 - a. It is a preventative measure for athletes against wind speed
 - b. It is a preventative measure for athletes against radiation
 - c. It is a preventative measure for athletes against heat
 - d. It is a preventative measure for athletes against the cloud cover
2. What does a sling psychrometer measure?
 - a. Relative humidity
 - b. Wind speed
 - c. Airflow
 - d. Evaporation
3. Which of the following does a WBGT heat stress meter **not** measure?
 - a. Wet bulb globe temperature
 - b. Relative humidity
 - c. Temperature
 - d. Barometric pressure
4. What type of water is used to moisten the cotton wick on a wet-bulb thermometer?
 - a. Cold water
 - b. Room temperature water
 - c. Warm water
 - d. Hot water
5. When determining a WBGT reading, what two components are needed?
 - a. The barometric pressure and the indoor temperature
 - b. Relative humidity and the indoor temperature
 - c. The dew point temperature and the outdoor temperature
 - d. Relative humidity and the outdoor temperature

Environmental Factors to be Considered When Caring for Athletes Pre-Test – Answer Key

1. Why is the wet bulb globe temperature (WBGT) used for athletes?
 - a. It is a preventative measure for athletes against wind speed
 - b. It is a preventative measure for athletes against radiation
 - c. It is a preventative measure for athletes against heat**
 - d. It is a preventative measure for athletes against the cloud cover
2. What does a sling psychrometer measure?
 - a. Relative humidity**
 - b. Wind speed
 - c. Airflow
 - d. Evaporation
3. Which of the following does a WBGT heat stress meter **not** measure?
 - a. Wet bulb globe temperature
 - b. Relative humidity
 - c. Temperature
 - d. Barometric pressure**
4. What type of water is used to moisten the cotton wick on a wet-bulb thermometer?
 - a. Cold water
 - b. Room temperature water**
 - c. Warm water
 - d. Hot water
5. When determining a WBGT reading, what two components are needed?
 - a. The barometric pressure and the indoor temperature
 - b. Relative humidity and the indoor temperature
 - c. The dew point temperature and the outdoor temperature
 - d. Relative humidity and the outdoor temperature**

Lesson Two – Environmental Factors to be Considered When Caring for Athletes

LEARN: Environmental Factors to be Considered When Caring for Athletes Slide Presentation

30 minutes

Purpose:

Participants will receive a thorough introduction on wet globe bulb temperature, relative humidity, use of a sling psychrometer and WBGT heat stress meter, and formulating the WBGT using a sling psychrometer. After formulating the WBGT reading, participants will use their findings to describe safe practices for athletes to avoid heat-related injuries.

Materials:

- *Environmental Factors to be Considered When Caring for Athletes* slide presentation
- Sling psychrometer
- WBGT heat stress meter

Facilitation Steps:

1. Share the following information as you show the slide presentation.

Slide 1: Introduction slides to Environmental Factors to be Considered When Caring for Athletes

Slide 2: The goals and objectives of this lesson are to:

- Describe the wet bulb globe temperature (WBGT) and its relevance to athletes
- Explain the function of a sling psychrometer and a WBGT heat stress meter
- Describe relative humidity
- Learn how to use the above two instruments to measure relative humidity
- Explain how to use a sling psychrometer
- Formulate the WBGT using a sling psychrometer
- Describe safe practices for athletes using the WBGT guidelines

Slide 3: Wet Bulb Globe Temperature (WBGT) is a measure of the heat stress on athletes in direct sunlight, which takes into account:

- Temperature
- Humidity
- Wind speed
- Sun angle
- Cloud cover (solar radiation)

This differs from the heat index, which considers temperature and humidity and is calculated for shady areas.

The WBGT is used for athletes as a preventative measure against heat.

As previously learned, heat can cause heat-related illnesses such as heat exhaustion and heat stroke. When extreme heat and high humidity are combined, evaporation is slowed down in the human body. In response, the body must work harder to maintain an average temperature, resulting in heat-related illnesses or injury. The most important aspect in protecting athletes from heat is using the WBGT, which is a heat measurement to keep athletes safe while performing strenuous outdoor activities at high temperatures. We will learn how to obtain a WBGT reading later in the lesson.

2. Hold up a WBGT heat stress meter, so participants see what it looks like.

Slide 4: A sling psychrometer is an instrument that measures the relative humidity in an area. The sling psychrometer consists of a wet bulb and a dry bulb.

The drier the air is, the more evaporation takes place off the wet bulb, dropping the temperature on the thermometer.

When a sling psychrometer is swung around in the air, moisture will evaporate from the wet-bulb thermometer, reducing its temperature depending on the humidity of the air. The higher the humidity, the higher the recorded temperature will be. That is why there are restrictions on the WBGT guidelines chart (slide 12) for athletes working out in higher WBGT readings because the athlete's evaporation rate is less. When the rate of evaporation is lowered, heat illnesses can develop. How to use the sling psychrometer is covered later in the lesson.

3. Hold up a sling psychrometer for students to view.

Slide 5: A WBGT heat stress meter quickly and accurately measures the following:

- Temperature
- Relative humidity
- Dew point temperature
- Wet bulb globe temperature

The WBGT heat stress meter has been shown to be slightly more accurate than the sling psychrometer. If both instruments are used to measure the WBGT, the WBGT heat stress meter reading should be used over the reading from the sling psychrometer, which at times can read 5-10% higher than the WBGT heat stress meter. Follow the manufacturer's instructions for use.

Slide 6: Relative humidity is the amount of water vapor in the air compared to how much it could hold at that temperature.

The relative humidity is shown as a percent. For example, relative humidity of 75% means the air is holding $\frac{3}{4}$ of the water vapor it can hold. The importance of relative humidity as it pertains to athletes is the higher the relative humidity is, the harder it is for athletes to cool down. When athletes cannot maintain an average body temperature, heat-related illnesses can happen.

The relative humidity is used with the outdoor temperature to calculate the WBGT reading, which we will cover in the following slides.

Slide 7: Relative humidity will be shown as a reading on the WBGT heat stress meter.

The sling psychrometer is also used to measure relative humidity.

The psychrometer has two thermometers: a wet bulb and a dry bulb. The wet bulb has a cotton wick over the bulb of the thermometer, which is moistened with room temperature water. The dry bulb is simply a thermometer. Both thermometers are attached to a dowel with a screw so they can be spun through the air.

The following slide shows the steps needed to obtain relative humidity using a sling psychrometer.

Slide 8: When using the sling psychrometer to measure relative humidity, take the following steps:

1. Wet the cotton wick with room temperature water. Distilled water works best.
2. Secure both thermometers on the dowel.
3. Go outside in the sun and swing the psychrometer around for three minutes.
4. Record the temperature of the wet bulb and the dry bulb. The wet temperature is never warmer than the dry bulb. If it is, the water used on the wick was too warm or the psychrometer is broken.
5. Find the difference between the wet bulb and the dry bulb. For example, if the dry bulb is 22°C and the wet bulb is 14°C, there is a difference of 8°C.
6. Go to the chart on the slide. Find the dry bulb temperature on the left side using the example of 22°C. Then, go over to the right of the chart and find the difference of 8°C. Where those two numbers meet is the percentage of relative humidity. So, for this example, the relative humidity is 40%. Record these numbers.

Slide 9: The relative humidity conversion table is used to determine the relative humidity using the readings from the sling psychrometer.

Slide 10: To formulate the WBGT reading using a sling psychrometer, which will determine safe practices for athletes, you will consult the graph on the next slide, following these steps:

1. After determining the relative humidity using a sling psychrometer or the WBGT heat stress meter, you will then see what the outdoor temperature is. Take an outdoor thermometer reading (if one is available at your facility) or look up the temperature on your smartphone or computer.

2. Using the graph, you will find the relative humidity on the left side, and you will then go across to the outdoor temperature. The corresponding number is the WBGT reading.
3. Take the WBGT reading and consult the chart on slide 12 for safe practices for athletes.

Slide 11: This graph will determine the wet bulb globe temperature using outdoor temperature and relative humidity.

Slide 12: The WBGT guidelines are in place for coaches, trainers, and athletes to follow depending on the WBGT reading, which will be taught in the following lessons. This chart will be used as a guideline for practice hours and activity, and breaks based on the WBGT reading.

Starting with the green level, a WBGT reading of under 82.0 recommends that you can follow normal practice hours as the reading is at a safe level. Every hour, the athletes should have been given three breaks of 3 minutes each, hydrating with water or electrolyte drinks.

If the WBGT reading is 82.0-86.9, you are in the yellow level. It is advised to use discretion for intense or prolonged exercise and to monitor at-risk players carefully. Athletes should hydrate with water or electrolyte drinks when taking their breaks. Each hour, the athletes should receive three breaks at 4 minutes each.

The orange level occurs when the WBGT reading is between 87.0-89.9, with a maximum practice time of 2 hours. Four separate breaks should be given every hour, lasting 4 minutes each, hydrating with water or electrolyte drinks. Football players should only wear a helmet, shoulder pads, and shorts during practice, and all protective gear should be removed for conditioning activities.

The red level is when the WBGT reading is 90.0-92.0, restricting the maximum practice time to 1 hour. The guidelines recommend there should be 20 minutes of breaks during the hour practice, and there should be no protective equipment worn and no conditioning activities. As with the other levels, water and electrolyte drinks should be used for hydration.

When the WBGT reading is over 92.1, it is in the black level. There shall be no outdoor workouts, and exercise should be canceled until a cooler WBGT reading occurs. Athletes will still hydrate with water and electrolyte drinks.

****Instructor Note**** Please keep the slide presentation open for reference during the activities.

Lesson Two – Environmental Factors to be Considered When Caring for Athletes

REVIEW: Practice Using the Sling Psychrometer and WBGT Heat Stress Meter

30 minutes

Purpose:

Participants will practice using the sling psychrometer and WBGT heat stress meter to obtain relative humidity and WBGT readings. Participants will be given scenarios based on these readings, and they will suggest safe practices for athletes to avoid heat-related illnesses. Once the practice and assessment are complete, a post-test will be given.

Materials:

- Sling psychrometer (one for each pair)
- WBGT heat stress meter (one for each small group)
- Room temperature water
- *Environmental Factors to be Considered When Caring for Athletes* slide presentation
- *Practice Lab Worksheet*
- *Practice Lab Worksheet – Answer Key*
- *Environmental Factors to be Considered When Caring for Athletes Post-Test*
- *Environmental Factors to be Considered When Caring for Athletes Post-Test – Answer Key*

Facilitation Steps:

1. Sling psychrometer practice: Pair up participants and give each pair of a sling psychrometer.
2. Starting with **Slide 8**, have participants practice using the sling psychrometer outdoors as outlined in the steps. After the wet bulb and dry bulb readings are recorded, have participants record the outside temperature. These readings will be used to determine the WBGT reading.
3. WBGT heat stress meter practice: Combine pairs of participants until you have five small groups. Give each small group a heat stress meter. Next, have the participants take readings using the WBGT heat stress meter and record those findings.
4. Take all results back to the classroom.
5. **Slide 9.** Have participants determine the relative humidity from the sling psychrometer numbers using the relative humidity conversion table. Compare the results to the WBGT heat stress meter numbers. If there is a considerable difference between the two, use the WBGT heat stress meter numbers for the next activity.
6. **Slide 10.** Have participants determine the WBGT reading using the relative humidity and outdoor temperature readings. Record the results.
7. **Slide 12.** Using the WBGT reading, have participants consult the wet bulb globe temperature guidelines for safe practices for athletes. Use the scenario that there is a two-hour football practice scheduled. Then, have participants describe what type of practice there should be and how many breaks are needed based on the guidelines.
8. **Slide 9.** Next, have participants repeat the process of determining the relative humidity using a dry bulb reading of 21°C and a wet bulb reading of 16°C. The difference is 5°C, so the relative humidity is 60%.
9. **Slide 10.** Have participants repeat the process to determine the WBGT reading using the relative humidity from the above scenario (60%) and an outdoor temperature reading of 91°F. Record the results.
10. **Slide 12.** Use the scenario that there is a one-and-a-half-hour soccer practice scheduled.

Using the WBGT reading from this scenario, have participants consult the wet bulb globe temperature guidelines for safe practices for athletes. Then, have participants describe what type of practice there should be and how many breaks are needed based on the guidelines.

11. Finally, ask participants what kind of heat-related injuries an athlete could incur if they practiced or played in these conditions.
****Answer:** An athlete could incur any type of heat injury, specifically dehydration, heat cramps, or heat stroke.

Ask participants what they would do if they noticed a teammate who appeared to be suffering from a heat-related illness or injury, which can be referenced back to Lesson One.

12. Distribute the *Environmental Factors to be Considered When Caring for Athletes Post-Test*.
13. Have the *Environmental Factors to be Considered When Caring for Athletes Post-Test* – Answer Key available. Instruct participants to take a few minutes to complete the post-test. Have participants self-check their answers as you share from the answer key.

Name: _____ Class: _____

Practice Lab Worksheet

- Using a sling psychrometer outdoors (see steps below), record the wet bulb and dry bulb readings as well as the outside temperature. These readings will be used to determine the WBGT reading.

When using the sling psychrometer to measure relative humidity, take the following steps:

- Wet the cotton wick with room temperature water.
- Secure both thermometers on the dowel.
- Go outside in the sun and swing the psychrometer around for three minutes.
- Record the temperature of the wet bulb and the dry bulb. The wet temperature is never warmer than the dry bulb. If it is, the water used on the wick was too warm or the psychrometer is broken.
- Find the difference between the wet bulb and the dry bulb.
- Go to the chart below. Find the dry bulb temperature on the left side. Then, go over to the right of the chart and find the difference. Where those two numbers meet is the percentage of relative humidity. Record these numbers

Dry-bulb temperature	Dry-bulb temperature minus wet-bulb temperature, °C									
	1	2	3	4	5	6	7	8	9	10
10°C	88	77	66	55	44	34	24	15	6	
11°C	89	78	67	56	46	36	27	18	9	
12°C	89	78	68	58	48	39	29	21	12	
13°C	89	79	69	59	50	41	32	22	15	7
14°C	90	79	70	60	51	42	34	26	18	10
15°C	90	80	71	61	53	44	36	27	20	13
16°C	90	81	71	63	54	46	48	30	23	15
17°C	90	81	72	64	55	47	40	32	25	18
18°C	91	82	73	65	57	49	41	34	27	20
19°C	91	82	74	65	58	50	43	36	29	22
20°C	91	83	74	66	59	51	44	37	31	24
21°C	91	83	75	67	60	53	46	39	32	26
22°C	92	83	76	68	61	54	47	40	34	28
23°C	92	84	76	69	62	55	48	42	36	30
24°C	92	84	77	69	62	56	49	43	37	31
25°C	92	84	77	70	63	57	50	44	39	33
26°C	92	85	78	71	64	58	51	46	40	34
27°C	92	85	78	71	65	58	52	47	41	36
28°C	93	85	78	72	65	59	53	48	42	37
29°C	93	86	79	72	66	60	54	49	43	38
30°C	93	86	79	73	67	61	55	50	44	39

Readings:

- Go outside in your small groups and take readings using the WBGT heat stress meter. Following the steps below and record the findings.

How to formulate the WBGT:

To formulate the WBGT reading using a sling psychrometer, which will determine safe practices for athletes, you will consult the graph below, following these steps:

- After determining the relative humidity using a sling psychrometer or the WBGT heat stress meter, you will then see what the outdoor temperature is. Take an outdoor thermometer reading (if one is available at your facility) or look up the temperature on your smartphone or computer.
- Using the graph, you will find the relative humidity on the left side, and you will then go across to the outdoor temperature. The corresponding number is the WBGT reading.
- Take the WBGT reading and consult the chart for safe practices for athletes.

Readings:

- Take all results back to the classroom. Determine the relative humidity from the sling psychrometer numbers using the relative humidity conversion table. Compare the results to the WBGT heat stress meter numbers. If there is a considerable difference between the two, use the WBGT heat stress meter numbers for the next activity.

STEP 1 FIND THE WET BULB GLOBE TEMPERATURE (WBGT)

Measure the temperature and humidity at your site. Find the estimated WBGT corresponding below.

		TEMPERATURE IN DEGREES FAHRENHEIT																											
		69.0	69.9	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	111.2									
RELATIVE HUMIDITY (%)	0	59.0	60.8	62.6	64.4	66.2	68.0	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2
	5	60.8	62.6	64.4	66.2	68.0	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0
	10	62.6	64.4	66.2	68.0	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8
	15	64.4	66.2	68.0	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6
	20	66.2	68.0	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4
	25	68.0	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2
	30	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0
	35	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0
	40	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0
	45	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0
	50	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0	126.0
	55	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0	126.0	128.0
	60	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0	126.0	128.0	130.0
	65	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0	126.0	128.0	130.0	132.0
	70	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0	126.0	128.0	130.0	132.0	134.0
	75	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0	126.0	128.0	130.0	132.0	134.0	136.0
	80	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0	126.0	128.0	130.0	132.0	134.0	136.0	138.0
	85	89.6	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0	126.0	128.0	130.0	132.0	134.0	136.0	138.0	140.0
	90	91.4	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0	126.0	128.0	130.0	132.0	134.0	136.0	138.0	140.0	142.0
	95	93.2	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0	126.0	128.0	130.0	132.0	134.0	136.0	138.0	140.0	142.0	144.0
	100	95.0	96.8	98.6	100.0	101.8	103.6	105.4	107.2	109.0	110.8	112.6	114.4	116.2	118.0	120.0	122.0	124.0	126.0	128.0	130.0	132.0	134.0	136.0	138.0	140.0	142.0	144.0	146.0

NOTE: This table is compiled from an approximate formula which only depends on temperature and humidity. The formula is valid for full sunshine and a light wind. Table adapted from Bureau of Meteorology

Environmental Factors in Sports Medicine Curriculum

4. Determine the WBGT reading using the relative humidity and outdoor temperature readings. Record the results.
5. Using the WBGT reading, consult the wet bulb globe temperature guidelines for safe practices for athletes (below).

Wet Bulb Globe Temperature Guidelines For Safe Practices

WBGT Reading	Level	Practice Hours	Activity and Break Guidelines	Fluids
Under 82.0	Green	Resume normal activities	3 separate rest breaks of 3 minutes each, every hour	Water or electrolyte drinks
82.0-86.9	Yellow	Use discretion for intense or prolonged exercise	3 separate rest breaks each hour for 4 minutes each	Water or electrolyte drinks
87.0-89.9	Orange	Maximum practice time is 2 hours	At least 4 separate rest breaks each hour for 4 minutes each Limited or no protective equipment for conditioning activities	Water or electrolyte drinks
90.0-92.0	Red	Maximum practice time is 1 hour	20 minutes of rest breaks during the hour No protective equipment worn and no conditioning activities	Water or electrolyte drinks
Over 92.1	Black	No outdoor workouts	Cancel exercise until a cooler WBGT reading occurs	Water or electrolyte drinks

Scenario: There is a two-hour football practice scheduled. Describe what type of practice there should be and how many breaks are needed based on the guidelines.

Environmental Factors in Sports Medicine Curriculum

6. Repeat the process of determining the relative humidity using a dry bulb reading of 21°C and a wet bulb reading of 16°C. The difference is _____°C, so the relative humidity is _____%.
7. Repeat the process to determine the WBGT reading using the relative humidity from the above scenario _____% and an outdoor temperature reading of 91°F. Record the results below.
8. Scenario: There is a one-and-a-half-hour soccer practice scheduled. Using the WBGT reading from number 7, consult the wet bulb globe temperature guidelines for safe practices for athletes. Describe what type of practice there should be and how many breaks are needed based on the guidelines.
9. What kind of heat-related injuries could an athlete incur if they practiced or played in these conditions?
10. What would you do if you noticed a teammate who appeared to be suffering from a heat-related illness or injury?

Practice Lab Worksheet – Answer Key

- Using a sling psychrometer outdoors (see steps below), record the wet bulb and dry bulb readings as well as the outside temperature. These readings will be used to determine the WBGT reading.

When using the sling psychrometer to measure relative humidity, take the following steps:

- Wet the cotton wick with room temperature water.
- Secure both thermometers on the dowel.
- Go outside in the sun and swing the psychrometer around for three minutes.
- Record the temperature of the wet bulb and the dry bulb. The wet temperature is never warmer than the dry bulb. If it is, the water used on the wick was too warm or the psychrometer is broken.
- Find the difference between the wet bulb and the dry bulb.
- Go to the chart below. Find the dry bulb temperature on the left side. Then, go over to the right of the chart and find the difference. Where those two numbers meet is the percentage of relative humidity. Record these numbers

Dry-bulb temperature	Dry-bulb temperature minus wet-bulb temperature, °C									
	1	2	3	4	5	6	7	8	9	10
10°C	88	77	66	55	44	34	24	15	6	
11°C	89	78	67	56	46	36	27	18	9	
12°C	89	78	68	58	48	39	29	21	12	
13°C	89	79	69	59	50	41	32	22	15	7
14°C	90	79	70	60	51	42	34	26	18	10
15°C	90	80	71	61	53	44	36	27	20	13
16°C	90	81	71	63	54	46	48	30	23	15
17°C	90	81	72	64	55	47	40	32	25	18
18°C	91	82	73	65	57	49	41	34	27	20
19°C	91	82	74	65	58	50	43	36	29	22
20°C	91	83	74	66	59	51	44	37	31	24
21°C	91	83	75	67	60	53	46	39	32	26
22°C	92	83	76	68	61	54	47	40	34	28
23°C	92	84	76	69	62	55	48	42	36	30
24°C	92	84	77	69	62	56	49	43	37	31
25°C	92	84	77	70	63	57	50	44	39	33
26°C	92	85	78	71	64	58	51	46	40	34
27°C	92	85	78	71	65	58	52	47	41	36
28°C	93	85	78	72	65	59	53	48	42	37
29°C	93	86	79	72	66	60	54	49	43	38
30°C	93	86	79	73	67	61	55	50	44	39

Readings:

****Answers Will Vary****

- Go outside in your small groups and take readings using the WBGT heat stress meter. Following the steps below and record the findings.

How to formulate the WBGT:

To formulate the WBGT reading using a sling psychrometer, which will determine safe practices for athletes, you will consult the graph below, following these steps:

- After determining the relative humidity using a sling psychrometer or the WBGT heat stress meter, you will then see what the outdoor temperature is. Take an outdoor thermometer reading (if one is available at your facility) or look up the temperature on your smartphone or computer.
- Using the graph, you will find the relative humidity on the left side, and you will then go across to the outdoor temperature. The corresponding number is the WBGT reading.
- Take the WBGT reading and consult the chart for safe practices for athletes.

Readings:

****Answers Will Vary****

- Take all results back to the classroom. Determine the relative humidity from the sling psychrometer numbers using the relative humidity conversion table. Compare the results to the WBGT heat stress meter numbers. If there is a considerable difference between the two, use the WBGT heat stress meter numbers for the next activity.

STEP 1 FIND THE WET BULB GLOBE TEMPERATURE (WBGT)

Measure the temperature and humidity at your site. Find the estimated WBGT corresponding below.

WET BULB GLOBE TEMPERATURE (WBGT) FROM TEMPERATURE AND RELATIVE HUMIDITY																																	
		TEMPERATURE IN DEGREES FAHRENHEIT																															
		68.0	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	111.2													
RELATIVE HUMIDITY (%)	0	59.0	60.9	60.8	62.6	64.4	64.4	66.2	66.2	68.0	69.0	69.0	71.6	71.6	73.4	73.4	75.2	75.2	77.0	77.0	78.8	80.6	80.6	82.4	82.4	84.2	84.2	86.0	87.8	87.8	89.6	89.6	
	5	60.8	60.8	62.6	64.4	64.4	66.2	66.2	68.0	69.8	69.8	71.6	71.6	73.4	75.2	75.2	77.0	78.8	78.8	80.6	80.6	82.4	84.2	84.2	86.0	87.8	87.8	89.6	91.4	91.4	93.2	95.0	
	10	60.8	62.6	62.6	64.4	66.2	66.2	68.0	69.8	69.8	71.6	73.4	73.4	75.2	77.0	77.0	78.8	80.6	80.6	82.4	84.2	86.0	86.0	87.8	89.6	89.6	91.4	93.2	95.0	96.8	96.8	98.6	
	15	62.6	62.6	64.4	66.2	66.2	68.0	69.8	69.8	71.6	73.4	73.4	75.2	77.0	78.8	78.8	80.6	82.4	84.2	84.2	86.0	87.8	89.6	91.4	91.4	93.2	95.0	96.8	96.8				
	20	62.6	64.4	64.4	66.2	68.0	69.8	69.8	71.6	73.4	75.2	75.2	77.0	78.8	80.6	80.6	82.4	84.2	86.0	87.8	89.6	89.6	91.4	93.2	95.0	96.8	96.8						
	25	64.4	64.4	66.2	68.0	68.0	69.8	71.6	73.4	75.2	75.2	77.0	78.8	80.6	82.4	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	96.8								
	30	64.4	66.2	68.0	68.0	69.8	71.6	73.4	73.4	75.2	77.0	78.8	80.6	82.4	84.2	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	96.8									
	35	64.4	66.2	68.0	69.8	71.6	73.4	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	96.8											
	40	66.2	68.0	69.8	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	93.2	95.0	96.8	96.8												
	45	66.2	68.0	69.8	71.6	73.4	75.2	77.0	78.8	80.6	80.6	82.4	84.2	86.0	89.6	91.4	93.2	95.0	96.8	96.8													
	50	68.0	69.8	71.6	73.4	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	91.4	93.2	95.0	96.8	96.8														
	55	68.0	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	93.2	95.0	96.8	96.8															
60	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	89.6	91.4	95.0	96.8	96.8																	
65	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	87.8	89.6	91.4	93.2	96.8	96.8																		
70	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	87.8	91.4	93.2	95.0	96.8																			
75	71.6	73.4	75.2	77.0	78.8	80.6	84.2	86.0	87.8	89.6	91.4	95.0	96.8	96.8																			
80	73.4	75.2	77.0	78.8	80.6	82.4	84.2	86.0	89.6	91.4	93.2	96.8	96.8																				
85	73.4	75.2	77.0	78.8	82.4	84.2	86.0	87.8	89.6	93.2	95.0	96.8																					
90	75.2	77.0	78.8	80.6	82.4	84.2	87.8	89.6	91.4	95.0	96.8	96.8																					
95	75.2	77.0	78.8	80.6	84.2	86.0	87.8	91.4	93.2	95.0	96.8																						
100	75.2	78.8	80.6	82.4	84.2	87.8	89.6	91.4	95.0	96.8																							

NOTE: This table is compiled from an approximate formula which only depends on temperature and humidity. The formula is valid for full sunshine and a light wind. Table adapted from Bureau of Meteorology

- Determine the WBGT reading using the relative humidity and outdoor temperature readings. Record the results.

****Answers Will Vary****

- Using the WBGT reading, consult the wet bulb globe temperature guidelines for safe practices for athletes.

Wet Bulb Globe Temperature Guidelines For Safe Practices

WGBT Reading	Level	Practice Hours	Activity and Break Guidelines	Fluids
Under 82.0	Green	Resume normal activities	3 separate rest breaks of 3 minutes each, every hour	Water or electrolyte drinks
82.0-86.9	Yellow	Use discretion for intense or prolonged exercise	3 separate rest breaks each hour for 4 minutes each	Water or electrolyte drinks
87.0-89.9	Orange	Maximum practice time is 2 hours	At least 4 separate rest breaks each hour for 4 minutes each Limited or no protective equipment for conditioning activities	Water or electrolyte drinks
90.0-92.0	Red	Maximum practice time is 1 hour	20 minutes of rest breaks during the hour No protective equipment worn and no conditioning activities	Water or electrolyte drinks
Over 92.1	Black	No outdoor workouts	Cancel exercise until a cooler WBGT reading occurs	Water or electrolyte drinks

Scenario: There is a two-hour football practice scheduled. Describe what type of practice there should be and how many breaks are needed based on the guidelines.

****Answers Will Vary****

- Repeat the process of determining the relative humidity using a dry bulb reading of 21°C and a wet bulb reading of 16°C. The difference is 5 °C, so the relative humidity is 60%.
- Repeat the process to determine the WBGT reading using the relative humidity from the above scenario 60% and an outdoor temperature reading of 91°F. Record the results below.

WBGT = 95

- Scenario: There is a one-and-a-half-hour soccer practice scheduled. Using the WBGT reading from number 7, consult the wet bulb globe temperature guidelines for safe practices for athletes. Describe what type of practice there should be and how many breaks are needed based on the guidelines.

No outdoor workouts and cancel exercise until cooler WBGT reading occurs

- What kind of heat-related injuries could an athlete incur if they practiced or played in these conditions?

Answers can include heat stroke, heat exhaustion, and dehydration, as well as components of heat stroke

- What would you do if you noticed a teammate who appeared to be suffering from a heat-related illness or injury?

Most heat-related illnesses can be treated by removing the teammate from the heat, resting, drinking water, a sports drink, or clear juice, and gently massaging muscle cramps. When giving fluids, avoid anything with caffeine as that can cause dehydration. For more severe illnesses such as heat exhaustion and heat stroke, it is critical to call 911 and have EMS respond. Emergency medical assistance is needed immediately

Name: _____ Class: _____

Environmental Factors to be Considered When Caring for Athletes Post-Test

Directions: Select the best answer to the following multiple-choice questions:

1. Why is the wet bulb globe temperature (WBGT) used for athletes?
 - a. It is a preventative measure for athletes against wind speed
 - b. It is a preventative measure for athletes against radiation
 - c. It is a preventative measure for athletes against heat
 - d. It is a preventative measure for athletes against the cloud cover
2. What does a sling psychrometer measure?
 - a. Relative humidity
 - b. Wind speed
 - c. Airflow
 - d. Evaporation
3. Which of the following does a WBGT heat stress meter **not** measure?
 - a. Wet bulb globe temperature
 - b. Relative humidity
 - c. Temperature
 - d. Barometric pressure
4. What type of water is used to moisten the cotton wick on a wet-bulb thermometer?
 - a. Cold water
 - b. Room temperature water
 - c. Warm water
 - d. Hot water
5. When determining a WBGT reading, what two components are needed?
 - a. The barometric pressure and the indoor temperature
 - b. Relative humidity and the indoor temperature
 - c. The dew point temperature and the outdoor temperature
 - d. Relative humidity and the outdoor temperature

Environmental Factors to be Considered When Caring for Athletes Post-Test – Answer Key

1. Why is the wet bulb globe temperature (WBGT) used for athletes?
 - a. It is a preventative measure for athletes against wind speed
 - b. It is a preventative measure for athletes against radiation
 - c. It is a preventative measure for athletes against heat**
 - d. It is a preventative measure for athletes against the cloud cover
2. What does a sling psychrometer measure?
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 - c. Airflow
 - d. Evaporation
3. Which of the following does a WBGT heat stress meter **not** measure?
 - a. Wet bulb globe temperature
 - b. Relative humidity
 - c. Temperature
 - d. Barometric pressure**
4. What type of water is used to moisten the cotton wick on a wet-bulb thermometer?
 - a. Cold water
 - b. Room temperature water**
 - c. Warm water
 - d. Hot water
5. When determining a WBGT reading, what two components are needed?
 - a. The barometric pressure and the indoor temperature
 - b. Relative humidity and the indoor temperature
 - c. The dew point temperature and the outdoor temperature
 - d. Relative humidity and the outdoor temperature**

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Lesson Three – Circadian Dysrhythmia Impact on Athletes

Lesson Overview

In this lesson, participants will learn about circadian rhythm, how teenagers' rhythms are affected differently, and optimal training and recovery times for athletes based on circadian rhythms. Participants will be educated on circadian dysrhythmias, the complications associated with it, and on how experiment using a light meter to measure light intensity in their environment.

Lesson Objectives

After completing this lesson, participants will be able to:

- Define circadian rhythms.
- Explore how circadian rhythms affect teenagers differently.
- Learn about optimal training and recovery times based on circadian rhythms.
- Describe what a circadian dysrhythmia is.
- Explain the complications circadian dysrhythmias could have for various levels of athletes.
- Experiment using a light meter to measure light intensity.

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS	• <i>Circadian Dysrhythmia Impact on Athletes Pre-Test</i> • <i>Circadian Dysrhythmia Impact on Athletes Pre-Test – Answer Key</i>	1. Print/photocopy <i>Circadian Dysrhythmia Impact on Athletes Pre-Test</i> (one per participant).	10 minutes
LEARN	• <i>Circadian Dysrhythmia Impact on Athletes</i> slide presentation	1. Prepare <i>Circadian Dysrhythmia Impact on Athletes</i> slide presentation for viewing.	30 minutes
REVIEW	• Light meter for participant practice and demonstration of skills • <i>Circadian Dysrhythmia Impact on Athletes Activity Sheet</i> • <i>Circadian Dysrhythmia Impact on Athletes Activity Sheet – Answer Key</i> • <i>Circadian Dysrhythmia Impact on Athletes Post-Test</i> • <i>Circadian Dysrhythmia Impact on Athletes Post-Test – Answer Key</i>	1. Print/photocopy the <i>Circadian Dysrhythmia Impact on Athletes Activity Sheet</i> (one per participant). 2. Print/photocopy <i>Circadian Dysrhythmia Impact on Athletes Post-Test</i> (one per participant).	30 minutes

Lesson Three – Circadian Dysrhythmia Impact on Athletes

FOCUS: Developing Awareness of Circadian Dysrhythmia Impact on Athletes

10 minutes

Purpose:

To help participants develop an awareness of circadian dysrhythmia's impact on athletes.

Materials:

- *Circadian Dysrhythmia Impact on Athletes Pre-Test*
- *Circadian Dysrhythmia Impact on Athletes Pre-Test – Answer Key*

Facilitation Steps:

1. Distribute the *Circadian Dysrhythmia Impact on Athletes Pre-Test*.
2. Have the *Circadian Dysrhythmia Impact on Athletes Pre-Test – Answer Key* available. The answers will be given after the post-test is given since the tests are the same.
3. Have the students complete the pre-test.
4. Collect the pre-tests to grade.

Name: _____ Class: _____

Circadian Dysrhythmia Impact on Athletes Pre-Test

Select the best answer to the following multiple-choice questions:

1. What timetable do circadian rhythms follow?
 - a. A 24-hour timetable
 - b. A 25-hour timetable
 - c. A 12-hour timetable
 - d. A 16-hour timetable
2. What are circadian rhythms directly tied to?
 - a. Dark exposure
 - b. Cold exposure
 - c. Heat exposure
 - d. Light exposure
3. What is the master clock sometimes called?
 - a. The circadian peacekeeper
 - b. The circadian alarm clock
 - c. The circadian pacemaker
 - d. The circadian defibrillator
4. What hormone is delayed in teenagers that alters their circadian rhythm?
 - a. Melatonin
 - b. Serotonin
 - c. Insulin
 - d. Testosterone
5. What are common light levels for classrooms?
 - a. 10,000-15,000 lux
 - b. 100-250 lux
 - c. 300-500 lux
 - d. 100,000-130,000 lux

Circadian Dysrhythmia Impact on Athletes Pre-Test – Answer Key

1. What timetable do circadian rhythms follow?
 - a. **A 24-hour timetable**
 - b. A 25-hour timetable
 - c. A 12-hour timetable
 - d. A 16-hour timetable
2. What are circadian rhythms directly tied to?
 - a. Dark exposure
 - b. Cold exposure
 - c. Heat exposure
 - d. **Light exposure**
3. What is the master clock sometimes called?
 - a. The circadian peacekeeper
 - b. The circadian alarm clock
 - c. **The circadian pacemaker**
 - d. The circadian defibrillator
4. What hormone is delayed in teenagers that alters their circadian rhythm?
 - a. **Melatonin**
 - b. Serotonin
 - c. Insulin
 - d. Testosterone
5. What are common light levels for classrooms?
 - a. 10,000-15,000 lux
 - b. 100-250 lux
 - c. **300-500 lux**
 - d. 100,000-130,000 lux

Lesson Three – Circadian Dysrhythmia Impact on Athletes

LEARN: Circadian Dysrhythmia Impact on Athletes Slide Presentation

30 minutes

Purpose:

Participants will receive a thorough introduction of circadian rhythms, how teenagers' rhythms are affected differently, circadian dysrhythmias, and how circadian rhythms and dysrhythmias affect athletic performance and recovery.

Materials:

- *Circadian Dysrhythmia Impact on Athletes* slide presentation

Facilitation Steps:

1. Share the following information as you show the slide presentation.

Slide 1: Introduction slides to Circadian Dysrhythmia Impact on Athletes

Slide 2: The goals and objectives of this lesson are to:

- Define circadian rhythms
- Explore how circadian rhythms affect teenagers differently
- Learn about optimal training and recovery times based on circadian rhythms
- Describe what a circadian dysrhythmia is
- Explain the complications circadian dysrhythmias could have for various levels of athletes
- Experiment using a light meter to measure light intensity

Slide 3: Circadian rhythms are the cycle of physiological and biological processes that work on a 24-hour timetable. Known as the body's internal clock, circadian rhythms control periods of activity and inactivity through the "sleep-wake" cycle. Circadian rhythms are directly tied to light exposure. During the day, light exposure causes the master clock to send signals to the brain to keep the body awake and alert. At night, the master clock starts producing melatonin, a

sleep-promoting hormone, which signals the brain to help the body sleep through the night.

Slide 4: The master clock is sometimes referred to as the circadian pacemaker. The master clock is found in the hypothalamus in the brain, specifically in the suprachiasmatic nucleus (SCN). A tiny cluster of 20,000 neurons controls the body's circadian rhythms. At different times of the day, clock genes in the SCN send signals to regulate the body's activities. The SCN is extremely sensitive to light, which is an external clue that influences the signals that are sent by the SCN to coordinate the body's internal clocks. Light is the most powerful influencer on circadian rhythms.

As the sun sets at the end of the day, the visual system sends signals to the SCN. Then, the SCN sends a message to the pineal gland telling it to start increasing the production of melatonin, which helps you reduce activity and feel increasingly sleepy.

Slide 5: Research shows that during the adolescent and teenage years, the hormonal response to the 24-hour light/dark exposure that influences circadian rhythm is altered. Meaning, teenagers yearn to stay awake later at night and remain asleep later in the morning. Studies have found that teenagers have a delayed release of melatonin, causing them to become sleepy later at night, hours after it becomes dark. With the internal clock establishing a need for 8-10 hours of sleep, it is not unusual for teenagers to want to sleep in later in the morning. Also, light exposure suppresses melatonin release, so when teenagers are on their phones, computers, or tablets, along with being in a well-lit room, melatonin release is delayed even further.

Suggestions to decrease the light exposure are to stop using cell phones, tablets, and computers 2 to 3 hours before bed. Since this is nearly impossible for most, wearing blue-blocking glasses will

decrease the amount of light impacting the circadian rhythm.

Many studies have been conducted on circadian rhythms and how they affect a person's health. It has been determined that people who get up earlier in the morning are happier and healthier than those who get up later in the day. One study found that people who stay up late have decreased cardiac function, which affects their heart rate and blood pressure. This group was also found to have poorer sleep and were less likely to be physically active. When circadian rhythms are not working properly, the body can be impacted in several ways, including changes in body temperature, pain sensitivity, physical strength, mental alertness, and senses.

Slide 6: Looking at this chart, you can see that the circadian rhythm can greatly affect athletic performance and recovery. For athletes, research has shown that based on the circadian rhythm of hormones, average body temperature, and gene expression, the best training time is between 14:30 hours (2:30 pm) and 18:00 hours (6:00 pm) if your biorhythm is normal and you sleep from midnight to 08:00 (8:00 am). In this optimal training time, your physical coordination, reaction time, cardio efficiency, and muscular strength are enhanced.

Slide 7: A circadian dysrhythmia is a circadian rhythm disorder, also known as sleep-wake cycle disorder. When your sleep-wake cycle is disturbed or out of sync with your environment, you can have poor sleep, difficulty sleeping, and performance and recovery issues. Circadian dysrhythmias can cause daytime sleepiness, decreased alertness, insomnia, and problems with memory and decision-making.

External factors that affect sleep patterns include:

- **Environment:** Changes in the seasons affect the amount of daylight and daylight savings time.
- **Travel:** Commonly known as “jet lag,” when there is a time change due to travel, people may need several days to recover and get the circadian rhythm back in sync. Studies have shown that it takes one day for every hour of the time difference in your travels to recover. For example, if you fly across the country and there is a 3-hour time difference, it will take

you three days for your circadian rhythm to adjust back to normal.

- **Work:** Late-night work hours and shift work can severely interfere with your sleep-wake cycle.
- **Sleep habits:** Going to bed late or not getting a sufficient amount of sleep will cause circadian dysrhythmias. Some people take melatonin supplements to help them sleep better at night.

Internal factors include:

- **Age:** As we learned earlier, adolescents and teenagers are more prone to sleep-wake cycle disorders due to the late release of melatonin. Also, older adults are susceptible to sleep disorders as the circadian rhythm changes as we age.
- **Genes:** Genetics can also play a role in circadian dysrhythmias. Studies show that insomnia is hereditary and is passed down through genes.
- **Medical condition:** Certain medical conditions and medications can disturb the circadian rhythm, especially if a person is hospitalized and constantly exposed to bright lights.

Slide 8: When there are disorders with the circadian rhythm, athletes face certain complications. Studies have been done on beginner athletes up to professional athletes. The consensus is that all levels of athletes are affected by circadian dysrhythmias, some more than others. Here are the most common complications seen:

- **Decreased performance:** Circadian dysrhythmias cause decreased performance due to cognitive issues, sleepiness, and poor recovery time.
- **Increased injuries:** Research shows that athletes who sleep less than 7 hours per night have a 1.7 times greater chance of becoming injured than those who sleep more than 7 hours per night. Research conducted by the CDC has found that about 69% of high school students get less than 7 hours of sleep per night. The connection between poor sleep and injuries is attributed to a cognitive mistake, such as running the wrong play and becoming injured. Lack of sleep also contributes to injuries not healing properly because cellular

regeneration cannot occur, leading to an injury that becomes chronic.

- Decreased recovery time: Less sleep equals less recovery time and cellular regeneration.
- Health problems: Athletes can develop health problems when they do not get enough sleep and do not have enough time to recover.

Slide 9: The digital lux meter quickly and accurately measures light intensity within a space. The terms light meter and lux meter are used interchangeably, but they both perform the same function of measuring light.

The terminology used with light meters:

- Lumens: The unit of measurement used to quantify the amount of visible light the human eye can see, like a light bulb, for example. High lumen output produces a brighter light, and low lumen output produces a dimmer light.
- Lux: The unit of measurement used to describe the number of lumens falling on a square foot (footcandles) or a square meter (lux) of a surface.

****Instructor Note**** The students will use the light meter to measure lux in their environment during the activity. Follow the manufacturer's instructions for use.

Slide 10: Here are some examples of common light levels for context:

- Direct sunlight: 100,000-130,000 lux
- Full daylight: 10,000-25,000 lux
- Overcast day: 1,000 lux
- Classrooms: 300-500 lux
- Sunrise/sunset on a clear day: 300-500 lux (Note how classrooms have the same lux as sunrise and sunset)
- Common stairway: 50-100 lux
- Full moon: <1 lux

It is recommended to have a lux of 180 or lower in your home during the evening to help facilitate a good night's rest. Classrooms are designed to have a lux of 300-500 to help students stay awake.

****Instructor Note**** This slide will be used during the activity for reference. Please keep the slide presentation open for reference during the activity.

Lesson Three – Circadian Dysrhythmia Impact on Athletes

REVIEW: Practice Measuring Light Intensity with a Light Meter

30 minutes

Purpose:

Participants will practice using the light (lux) meter to measure light intensity in their environment and record their readings. Students will be given questions based on these readings, and they will suggest ideas to improve circadian rhythms. Once the practice and assessment are complete, a post-test will be given.

Materials:

- Light meter
- *Circadian Dysrhythmia Impact on Athletes Activity Sheet*
- *Circadian Dysrhythmia Impact on Athletes Activity Sheet – Answer Key*
- *Circadian Dysrhythmia Impact on Athletes Post-Test*
- *Circadian Dysrhythmia Impact on Athletes Post-Test – Answer Key*

Facilitation Steps:

1. Hand out the *Circadian Dysrhythmia Impact on Athletes activity sheet* (One per person or group). Explain that you will demonstrate using the light meter, then participants will use their light meters to take readings in different locations. Starting with **slide 10**, demonstrate how to use a light meter based on the manufacturer's recommendations. Once participants are comfortable using the meter, move on to the next step.
2. **Slide 10.** Have participants take light readings for the different locations on the activity sheet and record their findings. Have them add other locations if desired. Instruct participants to compare their

findings to the common light levels on the slide and make any comments in the observations box.

3. Have participants complete the questions on the activity sheet. If they have any questions based on the lesson, help them refer to the slide presentation. When they are finished, you can ask questions and provide answers; **OR** you can make the activity interactive where you ask questions, and they can fill out the sheet as they go.
4. Instruct participants to take a few minutes to complete the post-test. Have participants self-check their answers as you share from the answer key.

Name: _____ Class: _____

Circadian Dysrhythmia Impact on Athletes Activity Sheet

Use the following table to record your data when using the light meter to measure light intensity. Feel free to add additional locations that are specific to your environment.

Location	Source of Light (natural or artificial)	Light Intensity (Lux)	Observations
Classroom window			
Classroom with lights off			
Classroom with lights on			
Restroom			
Outside in the full sun			
Outside in the shade			

Using the data collected, answer the following questions.

- Based on the data you collected, if students were in the classroom with the lights off for two hours without going outside, how do you think the students would feel?
- Using question 1 as the example, do you think the students' circadian rhythm would be affected by these light levels? If so, what would be some symptoms they might notice?

Environmental Factors in Sports Medicine Curriculum

3. What could the students do to avoid having circadian dysrhythmia from being in a classroom for two hours with the lights off?
4. What light intensity differences did you notice in areas with natural light versus artificial light?
5. Explain why light exposure matters regarding circadian rhythm.
6. Does the exposure of light differ for students in classrooms with windows compared to those in classrooms that do not have windows?
7. If an athlete flew to a meet with a three-hour time difference, how long would they need to acclimate and get their circadian rhythm back in sync?
8. Based on the last question, what could the athletes do to keep from developing circadian dysrhythmia?
9. How do you think athletes' circadian rhythms are in areas like Alaska that encounter sun for 24 hours a day at certain times of the year? What can they do to help their circadian rhythms?
10. Using the same example as question 9, what can athletes do if they encounter 24 hours of darkness?

Circadian Dysrhythmia Impact on Athletes

Activity Sheet – Answer Key

The participants will use the following table to record their data when using the light meter to measure light intensity. They can feel free to add additional locations that are specific to their environment.

Location	Source of Light (natural or artificial)	Light Intensity (Lux)	Observations
Classroom window			
Classroom with lights off			
Classroom with lights on			
Restroom			
Outside in the full sun			
Outside in the shade			

Using the data collected, either have participants as a group or individually answer the following questions. This activity can also be interactive, where you ask questions and brainstorm with participants. Some of the participants' answers may be different from the answers provided, which are only guidelines.

- Based on the data you collected, if students were in the classroom with the lights off for two hours without going outside, how do you think the students would feel?

The students might feel sleepy, lethargic, confused, unmotivated, and less alert. Students may not be immediately affected, but they may have insomnia and poor sleep in the evening since the circadian rhythm was disrupted.

- Using question 1 as the example, do you think the students' circadian rhythm would be affected by these light levels? If so, what would be some symptoms they might notice?

Depending on the students' circadian rhythm, they could develop a circadian dysrhythmia being in a dark classroom for two hours in the middle of the day. The symptoms they might notice would be sleepiness, cognitive issues, decreased athletic performance, and insufficient recovery time.

- What could the students do to avoid having circadian dysrhythmia from being in a classroom for two hours with the lights off?

Turn the lights on, move to a classroom with windows, or take breaks and go outside in direct sunlight every hour.

- What light intensity differences did you notice in areas with natural light versus artificial light?

The differences will vary in each environment. Have participants make comparisons on their findings after using the light meter.

5. Explain why light exposure matters regarding circadian rhythm.

Circadian rhythms are directly tied to light exposure. During the day, light exposure causes the master clock to send signals to the brain to keep the body awake and alert.

6. Does the exposure of light differ for students in classrooms with windows compared to those in classrooms that do not have windows?

The differences will vary in each environment. Have participants make comparisons on their findings after using the light meter.

7. If an athlete flew to a meet with a three-hour time difference, how long would they need to acclimate and get their circadian rhythm back in sync?

Approximately three days. Studies have shown that it takes one day for every hour of the time difference in your travels to recover. For example, if you fly across the country and there is a 3-hour time difference, it will take you three days for your circadian rhythm to adjust back to normal.

8. Based on the last question, what could the athletes do to keep from performing poorly at their meet?

To give time for their circadian rhythms to get in sync, they could go to the meet three days early to have time to acclimate. Since that is not usually possible in school athletics, they could focus on getting at least seven or eight hours of sleep per night in the weeks leading up to the event.

9. How do you think athletes' circadian rhythms are in areas like Alaska that encounter sun for 24 hours a day at certain times of the year? What can they do to help their circadian rhythms?

The athletes' circadian rhythms would be out of sync with 24 hours of sunlight. Their master clock would have difficulty with the sleep-wake cycle if there were no darkness. To help the circadian rhythm, they could sleep with blackout shades and have dim lights in the home, preferably 180 lux or less. They could also focus on getting seven to eight hours of good sleep each night. Some athletes may choose to take melatonin supplements to help their circadian rhythm.

10. Using the same example as question 9, what can athletes do if they encounter 24 hours of darkness?

The athletes' circadian rhythms would be out of sync with 24 hours of darkness since they are not receiving a high amount of light exposure. To help the circadian rhythm, the athletes could surround themselves in areas with higher light intensity by artificial means throughout the day.

Name: _____ Class: _____

Circadian Dysrhythmia Impact on Athletes Post-Test

Select the best answer to the following multiple-choice questions:

1. What timetable do circadian rhythms follow?
 - a. A 24-hour timetable
 - b. A 25-hour timetable
 - c. A 12-hour timetable
 - d. A 16-hour timetable
2. What are circadian rhythms directly tied to?
 - a. Dark exposure
 - b. Cold exposure
 - c. Heat exposure
 - d. Light exposure
3. What is the master clock sometimes called?
 - a. The circadian peacekeeper
 - b. The circadian alarm clock
 - c. The circadian pacemaker
 - d. The circadian defibrillator
4. What hormone is delayed in teenagers that alters their circadian rhythm?
 - a. Melatonin
 - b. Serotonin
 - c. Insulin
 - d. Testosterone
5. What are common light levels for classrooms?
 - a. 10,000-15,000 lux
 - b. 100-250 lux
 - c. 300-500 lux
 - d. 100,000-130,000 lux

Circadian Dysrhythmia Impact on Athletes Post-Test – Answer Key

1. What timetable do circadian rhythms follow?
 - a. **A 24-hour timetable**
 - b. A 25-hour timetable
 - c. A 12-hour timetable
 - d. A 16-hour timetable
2. What are circadian rhythms directly tied to?
 - a. Dark exposure
 - b. Cold exposure
 - c. Heat exposure
 - d. **Light exposure**
3. What is the master clock sometimes called?
 - a. The circadian peacekeeper
 - b. The circadian alarm clock
 - c. **The circadian pacemaker**
 - d. The circadian defibrillator
4. What hormone is delayed in teenagers that alters their circadian rhythm?
 - a. **Melatonin**
 - b. Serotonin
 - c. Insulin
 - d. Testosterone
5. What are common light levels for classrooms?
 - a. 10,000-15,000 lux
 - b. 100-250 lux
 - c. **300-500 lux**
 - d. 100,000-130,000 lux

Sources

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Lesson Four – Developing an Emergency Action Plan (EAP) and Policy for Thunder and Lightning As It Relates To Athletics

Lesson Overview

In this lesson, participants will learn about thunder and lightning, why lightning is dangerous to athletes and spectators, how to determine how close lightning is to a venue, and how to develop an 8-point lightning safety plan.

Lesson Objectives

After completing this lesson, participants will be able to:

- Define thunder and lightning.
- Explore how lightning is particularly dangerous to athletes and spectators.
- Learn the “flash to bang” method.
- Describe and implement the 8-point lightning safety plan.

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS:	• <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Pre-Test</i> • <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Pre-Test – Answer Key</i>	1. Print/photocopy <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Pre-Test</i> (one per participant).	10 minutes
LEARN	• <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics</i> slide presentation • <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Notes</i> • <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Notes – Answer Key</i>	1. Prepare <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics</i> slide presentation for viewing. 2. Print/photocopy the <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Notes</i> (one per participant).	20 minutes
REVIEW	• Notebook and writing utensil or word processing program to develop an EAP • <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics</i> activity sheet • <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Instructor Resource Sheet</i> • <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Post-Test</i> • <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Post-Test – Answer Key</i>	1. Print/photocopy the <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics</i> activity sheet (one per participant or group). 2. Print/photocopy <i>Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Post-Test</i> (one per participant).	40 minutes

Lesson Four – Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics

FOCUS: Pre-Test

10 minutes

Purpose:

To help participants develop an awareness of the dangers of lightning for athletes and spectators.

Materials:

- *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Pre-Test*
- *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Pre-Test – Answer Key*

Facilitation Steps:

1. Distribute the *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Pre-Test*.
2. Have the *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Pre-Test – Answer Key* available. The answers will be given after the post-test is given since the tests are the same.
3. Have the participants complete the pre-test.
4. Collect the pre-tests.

Name: _____ Class: _____

Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Pre-Test

Select the best answer to the following multiple-choice questions:

1. Which sport experiences the most lightning fatalities in the United States?
 - a. Football
 - b. Running
 - c. Soccer
 - d. Golf
2. Using the “flash to bang” method, how long does it take the sound of thunder to travel one mile?
 - a. 5 seconds
 - b. 1 second
 - c. 10 seconds
 - d. 2 seconds
3. What is considered “low risk” on the danger levels scale using the “flash to bang” method?
 - a. 10-15 seconds
 - b. 5-10 seconds
 - c. More than 50 seconds
 - d. 30-50 seconds
4. What agency is recommended to use to monitor local weather?
 - a. The National Weather Service
 - b. AccuWeather
 - c. The local radio station
 - d. World Weather Information Service
5. How long should you wait to resume activities after the last lightning strike is seen and thunder is heard?
 - a. 60 minutes
 - b. 10 minutes
 - c. 30 minutes
 - d. 45 minutes

Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Pre-Test – Answer Key

1. Which sport experiences the most lightning fatalities in the United States?
 - a. Football
 - b. Running
 - c. Soccer**
 - d. Golf
2. Using the “flash to bang” method, how long does it take the sound of thunder to travel one mile?
 - a. 5 seconds**
 - b. 1 second
 - c. 10 seconds
 - d. 2 seconds
3. What is considered “low risk” on the danger levels scale using the “flash to bang” method?
 - a. 10-15 seconds
 - b. 5-10 seconds
 - c. More than 50 seconds
 - d. 30-50 seconds**
4. What agency is recommended to use to monitor local weather?
 - a. The National Weather Service**
 - b. AccuWeather
 - c. The local radio station
 - d. World Weather Information Service
5. How long should you wait to resume activities after the last lightning strike is seen and thunder is heard?
 - a. 60 minutes
 - b. 10 minutes
 - c. 30 minutes**
 - d. 45 minutes

Lesson Four – Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics

LEARN: Developing an EAP and Policy for Thunder and Lightning Slide Presentation

20 minutes

Purpose:

Participants will receive a thorough introduction to thunder and lightning and how lightning is particularly dangerous to athletes and spectators. Participants will learn how to measure the distance of lightning using the “flash to bang” method and how to implement an 8-point lightning safety plan for a specific venue.

Materials:

- *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics* slide presentation
- *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics* Notes
- *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics* Notes – Answer Key

Facilitation Steps:

1. Hand out the notes page and share the following information as you show the slide presentation.

Slide 1: Introduction slides.

Slide 2: The goals and objectives of this lesson are to:

- Define thunder and lightning
- Explore how lightning is particularly dangerous to athletes and spectators
- Learn the “flash-to-bang” method
- Describe and implement the 8-point lightning safety plan:
 1. Develop an Emergency Action Plan (EAP)
 2. Weather Awareness
 3. Safe Locations
 4. Unsafe Locations

5. Postponement and Resumption of Activities
6. Large Venue Protocols
7. Provide First-Aid
8. Notify Participants

Slide 3: Lightning is a powerful electrical discharge in the atmosphere between clouds, the air, or the ground. Air acts as an insulator between the positive and negative charges in a cloud, and between the cloud and the ground in the early stages of development. When the opposite charges build up enough, the air’s insulating abilities break down, resulting in a rapid discharge of electricity called lightning.

Slide 4: Thunder is the sound caused by lightning. The loud noises of thunder occur from the rapid expansion of the air surrounding the lightning bolt. When lightning strikes, it increases the air temperature and air pressure. Under so much pressure, the heated air explodes outward, compressing the surrounding air. As the heated air expands, the pressure drops, and the air cools and contracts. The result is a shock wave, with a loud, booming sound called thunder that is sent in every direction. Typically, lightning is seen before the thunder is heard since the speed of light is much greater than the speed of sound.

Slide 5: Lightning is dangerous to anyone that is outside. In the United States, approximately 49 people are killed and hundreds injured every year. The reason lightning is hazardous to athletes and spectators is that many sports events are conducted outside. According to data collected by weather.gov, leisure activities account for 64% of lightning fatalities. When leisure activities are broken down into different categories, sports are the second-highest percentage of lightning fatalities. Here is a breakdown of the sports most affected:

- Soccer (34%)
- Golf (29%)
- Running (23%)
- Baseball (9%)
- Football (3%)
- Disc golf (3%)

Slide 6: The “flash to bang” method is used to determine approximately how close a lightning strike is to you. This technique involves counting the time in seconds between a visible lightning bolt (flash) and the audible thunderclap (bang). Due to light traveling faster than sound waves, there will be a delay between the two. After seeing the flash, count “one thousand one, one thousand two, one thousand three,” etc. That will correctly give you one second each. Stop counting when you hear the bang (thunder). It takes the sound of thunder about 5 seconds to travel 1 mile. So, if you counted 10 seconds, the lightning is roughly 2 miles from your location. Agencies who promote lightning awareness recommend seeking shelter when the flash to bang is 30 seconds or less, which means the lightning is 6 miles away.

Slide 7: These are the following danger levels from the “flash to bang” method:

- Less than 10 seconds= **Highest risk**
- 10 to 15 seconds= **High risk**
- 15 to 30 seconds= **Moderate risk**
- 30 to 50 seconds= **Low risk**
- More than 50 seconds= **Minimal risk**

This chart will be used as a reference when developing an Emergency Action Plan and policies for thunder and lightning.

Slide 8: Having an 8-point lightning safety plan is recommended by the National Athletic Trainers Association (NATA), which encourages proper lightning safety policies for athletic trainers, coaches, parents, athletes, and administrators. The lightning safety plan consists of the following:

1. Develop an Emergency Action Plan (EAP)
2. Weather Awareness
3. Safe Locations
4. Unsafe Locations
5. Postponement and Resumption of Activities
6. Large Venue Protocols
7. Provide First-Aid

8. Notify Participants

Slide 9: Establish a lightning-specific Emergency Action Plan (EAP). Formalize and implement a comprehensive EAP and rehearse annually. The EAP should include:

- Promote National Weather Service lightning safety slogans, such as “When Thunder Roars, Go Indoors.” Promote these slogans within your school and athletic groups.
- Establish a chain of command that identifies a specific person to make decisions to remove individuals from the field.
- Use a reliable means of monitoring the local weather.
- Identify safe locations from lightning hazards in advance of events, such as the school, buses, or cars. ****Instructor Note**** See slide 11 for more detail on safe locations.
- Identify specific criteria for suspending and resuming activity, allowing time for evacuation of the premises. All activities should be suspended until 30 minutes after the last lightning strike or sound of thunder.

Slide 10: Ensure lightning and general weather awareness, with the lightning hazard being of utmost importance. Follow these steps:

- Use a designated weather watcher to actively look for signs of approaching or developing bad weather, such as darkening clouds, high winds, or thunder and lightning. The peak months for lightning activity across the US are June, July, and August, which are also the peak months for outdoor activities. But lightning can strike any day or month of the year.
- Use the National Weather Service to monitor local weather by going to the weather.gov website. You can enter your state or zip code where you can receive weather alerts and follow weather patterns. However, the NWS does not always issue lightning warnings, so the designated weather watcher will need to report that.
- Organizers of events should watch the skies for approaching thunderstorms in addition to having a designated weather watcher. The organizers should also be monitoring the local weather.

- Consider subscribing to a commercial, real-time lightning detection service that has been independently verified so you can determine when a storm is getting close and decide to go inside.

Slide 11: Safe locations are where athletes and spectators can retreat in the case of lightning, and they need to be identified for each venue. The following are recognized as safe locations:

- Fully enclosed buildings with wiring and plumbing, such as schools, libraries, homes, gymnasiums, or other habitable buildings. When a building has wiring and plumbing, they act as a ground, so the risk of being electrocuted by lightning is diminished. It is recommended to stay away from the windows and avoid using the plumbing or wiring if possible. There have been reported injuries to people inside a building who were near a window or using the plumbing or wiring from lightning hitting that object and transferring to the victim.
- Fully enclosed metal vehicles such as cars, vans, and school buses, but **not** convertible vehicles or open vehicles like golf carts, motorcycles, and off-road vehicles.

Slide 12: Identify unsafe locations from lightning. Anything that was not identified as a safe location is unsafe. However, many people think certain areas would be safe, but they are not. Examples of unsafe locations:

- Covered picnic areas and gazebos
- Athletic storage sheds
- Open areas such as tents, dugouts, refreshment stands, press boxes, and open garages
- Tall objects such as trees, telephone poles, and elevated areas are potential lightning targets (**never** seek shelter under or near a tree during a thunderstorm)
- Large bodies of water, including swimming pools

Slide 13: Establish criteria for postponement and resumption of activities:

- Postpone or suspend activities if a thunderstorm appears imminent before or during the activity. Watch the skies for developing or approaching storms and realize

that blue skies or the absence of rain does not mean there cannot be lightning.

- Everyone must be completely within a safe location when thunderstorms are producing lightning and/or the distance between the edge of the lightning storm, and the outdoor activity is 6 miles (using the flash to bang method).
- Allow time for individuals to evacuate the premises, leave all outdoor facilities, and to be completely within the designated safe location. Many victims fatally injured by lightning were trying to seek a safe location and did not make it in time.
- Resume activities 30 minutes after the **last** strike of lightning is seen and after the **last** sound of thunder is heard. If 28 minutes have passed from the last thunderclap or lightning strike and another lightning strike occurs, the clock starts again, and 30 minutes needs to pass. Research has shown that lightning fatalities occur at equal rates at the onset, in the middle, and towards the end of the thunderstorm.

Slide 14: Prepare large venue planning protocols. Specific lightning safety plans should be established for large-scale events and include:

- Use of a reliable weather monitoring system.
- A way to keep spectators from entering a venue that is suspended due to lightning. For example, signs can be quickly placed at all entrances and exits while spectators and athletes are evacuating.
- Identification of close, safe locations. Every venue is different, so when the lightning safety plan is established, the venue should be visited to identify close, safe locations.
- Means to order a safe and orderly evacuation. Depending on the size of the venue, this can be a laborious, time-consuming ordeal. Develop a plan with a sufficient number of people in order to safely and orderly evacuate everyone.
- Consideration for the time necessary to move everyone safely. There are some large stadiums who have protocols in place to evacuate when thunder and lightning is 10 miles away, instead of 6 miles away. That one protocol can gain the venue a lot of valuable time to safely evacuate.

Slide 15: Provide first aid for those struck by lightning if it is safe to do so. Most lightning deaths are due to respiratory or cardiac arrest, so CPR will most likely be needed with an AED if available:

- Activate 911.
- Move the patients to a safe location if possible. Rescuers should not sacrifice their safety to help others. Patients struck by lightning are safe to touch, as their bodies cannot store the energy from the lightning strike.
- Evaluate and treat patients for the absence of breathing and heartbeat while assessing their level of consciousness. Provide CPR if warranted.
- Evaluate and treat for the possibility of spinal injuries.
- Evaluate and treat for hypothermia.

Slide 16: Notify participants of lightning danger. Organizations have a responsibility by law to warn others of danger. Public service announcement systems and bullhorns are great notification tools.

Proactive lightning-injury prevention keeps individuals away from lightning risk:

- If thunder is heard, people should go to a safe location immediately. It is better to start evacuation procedures immediately instead of waiting for the thunder to get closer. The closer the sound of thunder, the closer lightning will be.
- Those in control of outdoor events need to immediately warn spectators of danger while remaining calm and in control.
- Individuals have the right to vacate an unsafe area without penalty or repercussion to seek a lightning-safe location if they feel they are in danger of a possible lightning strike.

Name: _____ Class: _____

Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Notes

_____ is a powerful electrical discharge in the atmosphere between clouds, the air, or the ground.

What is thunder?

The Flash to Bang Method

The “flash to bang” method is used to determine approximately how close a lightning strike is to you. This technique involves:

These are the following danger levels from the “flash to bang” method:

- Less than 10 seconds = _____
- ____ to ____ seconds = High risk
- 15 to 30 seconds= _____
- ____ to ____ seconds = Low risk
- More than ____ seconds= Minimal risk

Environmental Factors in Sports Medicine Curriculum

The 8-Point Lightning Safety Plan

The lightning safety plan consists of the following:

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.

True or False When establishing an EAP, identify safe locations from water hazards.

True or False Use the Department of Health and Human Services to monitor local weather.

What are safe locations where athletes and spectators can retreat in the case of lightning? Give two examples.

What are unsafe locations from lightning? Give two examples.

Resume activities 30 minutes after the _____ strike of lightning is seen and after the _____ sound of thunder is heard.

True or False Most lightning deaths are due to respiratory or cardiac arrest.

True or False Individuals have the right to vacate safe areas without penalty.

Developing an EAP and Policy for Thunder And Lightning As It Relates To Athletics Notes – Answer Key

Lightning is a powerful electrical discharge in the atmosphere between clouds, the air, or the ground.

What Is Thunder? **Thunder is the sound caused by lightning. The loud noises of thunder occur from the rapid expansion of air surrounding the lightning bolt.**

The Flash to Bang Method

The “flash to bang” method is used to determine approximately how close a lightning strike is to you.

This technique involves: **counting the time in seconds between a visible lightning bolt (flash) and the audible thunderclap (bang). Due to light traveling faster than sound waves, there will be a delay between the two.**

These are the following danger levels from the “flash to bang” method:

- Less than 10 seconds = **Highest risk**
- **10** to **15** seconds = High risk
- 15 to 30 seconds = **Moderate risk**
- **30** to **50** seconds = Low risk
- More than **50** seconds= Minimal risk

The 8-Point Lightning Safety Plan

The lightning safety plan consists of the following:

1. **Develop an Emergency Action Plan (EAP)**
2. **Weather Awareness**
3. **Safe Locations**
4. **Unsafe Locations**
5. **Postponement and Resumption of Activities**
6. **Large Venue Protocols**
7. **Provide First-Aid**
8. **Notify Participants**

True or **False** When establishing an EAP, identify safe locations from water hazards.

True or **False** Use the Department of Health and Human Services to monitor local weather.

What are safe locations where athletes and spectators can retreat in the case of lightning? Give two examples. **Answers will vary but may include: Fully enclosed buildings with wiring and plumbing, such as schools, libraries, homes, gymnasiums, or other habitable buildings. Fully enclosed metal vehicles such as cars, vans, and school buses, but not convertible vehicles or open vehicles like golf carts.**

What are unsafe locations from lighting? Give two examples. **Answers will vary but may include:**

- **Covered picnic areas and gazebos**
- **Athletic storage sheds**
- **Open areas such as tents, dugouts, refreshment stands, press boxes, and open garages**
- **Tall objects such as trees, telephone poles, and elevated areas**
- **Large bodies of water**

Resume activities 30 minutes after the **last** strike of lightning is seen and after the **last** sound of thunder is heard.

True or False Most lightning deaths are due to respiratory or cardiac arrest.

True or **False** Individuals have the right to vacate safe areas without penalty.

Lesson Four – Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics

REVIEW: Develop an EAP Using The 8-Point Lightning Safety Plan

40 minutes

Purpose:

Participants will develop an Emergency Action Plan for a specific venue using the 8-point lightning safety plan. Once the activity is completed, a post-test will be given.

Materials:

- Notebook and computer
- *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics* slide presentation
- *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics* activity sheet
- *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Instructor Resource Sheet*
- *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Post-Test*
- *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Post-Test – Answer Key*

Facilitation Steps:

1. Decide how you want to structure this activity. Participants will be developing an Emergency Action Plan (EAP) specific to thunder and lightning emergencies. This EAP will be for their school, so you may want to have the whole class participate in coming up with one EAP. You can either assign participants a particular section of the 8-point lightning safety plan or break participants into small groups with a specific assignment. Hand out the *Developing an EAP and Policy for Thunder and Lightning*

As It Relates To Athletics activity sheet (1 per participant or group). Explain that they will be developing an Emergency Action Plan for the scenario given on the activity sheet, following the 8-point lightning safety plan.

2. **Slide 8:** Open the slide so participants can write down the steps in the safety plan as an outline.
3. **Slides 9-16:** After participants have written the outline, move on to **slide 10**. Continue through the slides until participants have completed the EAP following the 8-point lightning safety plan. If they have any questions based on the lesson, help them refer to the slide presentation.
4. Once the EAP is completed, instruct participants to take a few minutes to complete the post-test. Have participants self-check their answers as you share from the *Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Post-Test – Answer Key*.

Name: _____ Class: _____

Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics

Use the following scenario to develop a thunder and lightning Emergency Action Plan (EAP) for your school. Make sure to include the 8 points required to be in your EAP.

Scenario:

Your high school football team is 2-0, and the whole town has been attending the games and rooting on the team. Next week is the homecoming game, and the crowd is expected to exceed 5,000 people. The head coach wants a thunder and lightning Emergency Action Plan (EAP) drawn up before the game since this will be the largest attendance in school history. He doesn't think the current EAP can cover that many people.

Using your school as an example, follow the 8-point lightning safety plan, which includes developing the thunder and lightning specific EAP. Be sure to cover all of the bullet points and assign positions where needed.

Point 1	
Point 2	
Point 3	
Point 4	
Point 5	
Point 6	
Point 7	
Point 8	

Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics

Instructor Resource Sheet

The participants will use the following scenario to develop a thunder and lightning Emergency Action Plan for their school. Use your discretion in how you want participants to work on the EAP, whether individually or in groups. Have them use their school to determine safe and unsafe locations and look up local weather. Once the EAP is complete and if time allows, you can read the EAP to the class and see if you or the students suggest any changes.

Scenario:

Your high school football team is 2-0, and the whole town has been attending the games and rooting on the team. Next week is the homecoming game, and the crowd is expected to exceed 5,000 people. The head coach wants a thunder and lightning Emergency Action Plan (EAP) drawn up before the game since this will be the largest attendance in school history. He doesn't think the current EAP can cover that many people.

Using your school as an example, follow the 8-point lightning safety plan, which includes developing the thunder- and lightning-specific EAP. Be sure to cover all of the bullet points and assign positions where needed.

Suggested rubric:

	Action Plan Included	Action Plan Not Complete	Action Plan Step Not Included
Point 1	12 ½ points	6 points	0
Point 2	12 ½ points	6 points	0
Point 3	12 ½ points	6 points	0
Point 4	12 ½ points	6 points	0
Point 5	12 ½ points	6 points	0
Point 6	12 ½ points	6 points	0
Point 7	12 ½ points	6 points	0
Point 8	12 ½ points	6 points	0
Total	100 points		

Name: _____ Class: _____

Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Post-Test

Select the best answer to the following multiple-choice questions:

1. Which sport experiences the most lightning fatalities in the United States?
 - a. Football
 - b. Running
 - c. Soccer
 - d. Golf
2. Using the “flash to bang” method, how long does it take the sound of thunder to travel one mile?
 - a. 5 seconds
 - b. 1 second
 - c. 10 seconds
 - d. 2 seconds
3. What is considered “low risk” on the danger levels scale using the “flash to bang” method?
 - a. 10-15 seconds
 - b. 5-10 seconds
 - c. More than 50 seconds
 - d. 30-50 seconds
4. What agency is recommended to use to monitor local weather?
 - a. The National Weather Service
 - b. AccuWeather
 - c. The local radio station
 - d. World Weather Information Service
5. How long should you wait to resume activities after the last lightning strike is seen and thunder is heard?
 - a. 60 minutes
 - b. 10 minutes
 - c. 30 minutes
 - a. 45 minutes

Developing an EAP and Policy for Thunder and Lightning As It Relates To Athletics Post-Test – Answer Key

1. Which sport experiences the most lightning fatalities in the United States?
 - a. Football
 - b. Running
 - c. Soccer**
 - d. Golf
2. Using the “flash to bang” method, how long does it take the sound of thunder to travel one mile?
 - a. 5 seconds**
 - b. 1 second
 - c. 10 seconds
 - d. 2 seconds
3. What is considered “low risk” on the danger levels scale using the “flash to bang” method?
 - a. 10-15 seconds
 - b. 5-10 seconds
 - c. More than 50 seconds
 - d. 30-50 seconds**
4. What agency is recommended to use to monitor local weather?
 - a. The National Weather Service**
 - b. AccuWeather
 - c. The local radio station
 - d. World Weather Information Service
5. How long should you wait to resume activities after the last lightning strike is seen and thunder is heard?
 - a. 60 minutes
 - b. 10 minutes
 - c. 30 minutes**
 - d. 45 minutes

Sources

1. Wikipedia Website. (2021, July 16). *Thunder*. Retrieved from <https://en.wikipedia.org/wiki/Thunder>
2. The National Severe Storms Laboratory Website. (2021). *Severe Weather 101—Lightning*. Retrieved from <https://www.nssl.noaa.gov/education/svrwx101/lightning/>
3. Jensenius, Jr., John S. (2020, February). *A Detailed Analysis of Lightning Deaths in the United States from 2006 through 2019*. Retrieved from <https://www.weather.gov/media/safety/Analysis06-19.pdf>
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5. Barton Straus, Lindsey. (2015, July 30). *Lightning Safety Policies: Every Club Or League Needs One*. Retrieved from <https://www.momsteam.com/lightning-safety-policies-every-sports-club-or-league-needs-one>

Lesson Five – Sun Exposure and Risks to Athletes

Lesson Overview

In this lesson, participants will learn about UVA and UVB rays, the risks associated with repeated overexposure to the sun, and how certain medications can increase the risk of sunburn. Participants will be educated on the sun protection factor (SPF), how to determine the appropriate SPF for athletes, and learn about sun safety guidelines. After the lesson, participants will participate in a sunscreen SPF experiment to correlate sun exposure to the SPF value of sunscreen.

Lesson Objectives

After completing this lesson, participants will be able to:

- Define UVA and UVB rays.
- Explore the risks associated with repeated overexposure to the sun.
- Learn how certain medications can increase your risk of sunburn.
- Describe SPF.
- Determine the appropriate SPF for athletes.
- Learn about sun safety guidelines.
- Perform a sunscreen SPF experiment.

Lesson at a Glance

Activity	Materials	Preparation	Approximate class time
FOCUS:	• <i>Sun Exposure and Risks to Athletes Pre-Test</i> • <i>Sun Exposure and Risks to Athletes Pre-Test – Answer Key</i>	1. Print/photocopy <i>Sun Exposure and Risks to Athletes Pre-Test</i> (one per participant).	10 minutes
LEARN	• <i>Sun Exposure and Risks to Athletes</i> slide presentation • <i>Myths and Truths About Sun Exposure and Tanning</i> handout	1. Prepare <i>Sun Exposure and Risks to Athletes</i> slide presentation for viewing. 2. Print/photocopy the <i>Myths and Truths About Sun Exposure and Tanning</i> handout (one per participant).	30 minutes
REVIEW	• Kit components: Sun Print photo paper, transparency film, index cards, and cotton balls • Pencils • 1 office file folder per group • 1 shallow pan of water large enough to hold and submerge the sun print photo paper • 4 or more different value SPF sunscreens • Optional: 2 or more SPF sunscreens with the same value, but different brands • <i>Sun Exposure and Risks to Athletes Lab Form</i> • <i>Sun Exposure and Risks to Athletes Instructor Resource Sheet</i> • <i>Sun Exposure and Risks to Athletes Post-Test</i> • <i>Sun Exposure and Risks to Athletes Post-Test – Answer Key</i>	1. Print/photocopy the <i>Sun Exposure and Risks to Athletes Lab Form</i> (one per participant or group). 2. Print/photocopy <i>Sun Exposure and Risks to Athletes Post-Test</i> (one per participant).	40 minutes

Lesson Five – Sun Exposure and Risks to Athletes

FOCUS: Developing Awareness of Sun Exposure and Risks to Athletes

10 minutes

Purpose:

To help participants develop an awareness of sun exposure and risks to athletes. Take the *Sun Exposure and Risks to Athletes Pre-Test*.

Materials:

- *Sun Exposure and Risks to Athletes Pre-Test*
- *Sun Exposure and Risks to Athletes Pre-Test – Answer Key*

Facilitation Steps:

1. Distribute the *Sun Exposure and Risks to Athletes Pre-Test*.
2. Have the *Sun Exposure and Risks to Athletes Pre-Test – Answer Key* available. The answers will be given after the post-test is given since the tests are the same.
3. Have the participants complete the pre-test.
4. Collect the pre-tests.

Name: _____ Class: _____

Sun Exposure and Risks to Athletes Pre-Test

Select the best answer to the following multiple-choice questions:

1. What are the most damaging rays to the skin called?
 - a. Ultraviolet rays
 - b. Ultraharmful rays
 - c. Ultraviolent rays
 - d. Ultradamaging rays
2. What rating is considered **very high** on the UV ray index?
 - a. 20-25
 - b. 5-10
 - c. 25-30
 - d. 10-15
3. What is SPF short for?
 - a. Sun protective factor
 - b. Skin protective factor
 - c. Sun protection factor
 - d. Skin protection factor
4. Which of the following is the recommended sunscreen for athletes?
 - a. Broad-spectrum, water-resistant sunscreen with an SPF of 20 or greater
 - b. Sunscreen with an SPF of 30 or greater
 - c. Water-resistant sunscreen with an SPF of 50 or greater
 - d. Broad-spectrum, water-resistant sunscreen with an SPF of 30 or greater
5. When are the sun's rays the strongest?
 - a. Between 11 a.m. and 3 p.m.
 - b. Between 10 a.m. and 6 p.m.
 - c. Between 10 a.m. and 4 p.m.
 - d. Between 12 p.m. and 5 p.m.

Sun Exposure and Risks to Athletes Pre-Test – Answer Key

1. What are the most damaging rays to the skin called?
 - a. **Ultraviolet rays**
 - b. Ultraharmful rays
 - c. Ultraviolent rays
 - d. Ultradamaging rays
2. What rating is considered **very high** on the UV ray index?
 - a. 20-25
 - b. 5-10
 - c. 25-30
 - d. **10-15**
3. What is SPF short for?
 - a. Sun protective factor
 - b. Skin protective factor
 - c. **Sun protection factor**
 - d. Skin protection factor
4. Which of the following is the recommended sunscreen for athletes?
 - a. Broad-spectrum, water-resistant sunscreen with an SPF of 20 or greater
 - b. Sunscreen with an SPF of 30 or greater
 - c. Water-resistant sunscreen with an SPF of 50 or greater
 - d. **Broad-spectrum, water-resistant sunscreen with an SPF of 30 or greater**
5. When are the sun's rays the strongest?
 - a. Between 11 a.m. and 3 p.m.
 - b. Between 10 a.m. and 6 p.m.
 - c. **Between 10 a.m. and 4 p.m.**
 - d. Between 12 p.m. and 5 p.m.

Lesson Five – Sun Exposure and Risks to Athletes

LEARN: Sun Exposure and Risks to Athletes

Slide Presentation

30 minutes

Purpose:

Participants will receive a thorough introduction of UVA and UVB rays, the risks associated with repeated overexposure to the sun, how certain medications increase the risk of sunburn, the appropriate sun protection factor (SPF) for athletes, and sun safety guidelines.

Materials:

- *Sun Exposure and Risks to Athletes* slide presentation
- *Myths and Truths About Sun Exposure and Tanning* handout

Facilitation Steps:

1. Introduce the concept of sun exposure and risks by sharing a short video clip from YouTube. Here is a recommended link:
<https://www.youtube.com/watch?v=Rj1VqISXFE0> (1:56)
2. Give participants the *Myths and Truths About Sun Exposure and Tanning* handout. Have participants read through and answer each statement. If desired, have participants pair up and choose an answer.
3. After 2-3 minutes, share the answers to the *Myths and Truths* handout.

Myth: A base tan is healthy.
Truth: No tan is healthy.

Myth: A base tan will protect you from future sunburn.
Truth: A base tan does little to protect you from future UV exposure and sunburn.

Myth: Only certain ultraviolet B (UVB) rays are bad for your skin.
Truth: Ultraviolet A (UVA) rays are not safe, either.

Myth: If you have darker skin pigmentation, you do not need to protect against the sun.

Truth: All skin types should use sunscreen to protect against the sun.

Myth: SPF doesn't matter after a certain number.

Truth: Higher SPFs may offer extra protection if too little sunblock is applied.

Myth: Sunblock only needs to be applied once on a given day.

Truth: Sunblock should be reapplied every 2 hours and after engaging in water activities.

Myth: Sunblock should only be worn in the summer.

Truth: Sunblock should be worn all year round.

4. Share the following information as you show the slide presentation.

Slide 1: Introduction slide.

Slide 2: The goals and objectives of this lesson are to:

- Define UVA and UVB rays
- Explore the risks associated with repeated overexposure to the sun
- Learn how certain medications can increase your risk of sunburn
- Describe SPF
- Determine the appropriate SPF for athletes
- Learn about sun safety guidelines
- Perform a sunscreen SPF experiment

Slide 3: There are many different rays present in sunlight. The most damaging rays to our skin are called ultraviolet (UV) rays. Two types of UV rays reach Earth's surface, UVA and UVB rays. UVA rays penetrate deep into the skin and play a role in skin cancer

formation, premature aging (photoaging), wrinkling, and loss of elasticity.

UVB rays are responsible for producing sunburn and play the greatest role in causing skin cancers, including the deadly black mole type of skin cancer called malignant melanoma.

UVA rays also increase the damaging effects of the UVB rays, including skin cancer and cataracts.

Ultraviolet rays react with the body's melanin, which is the natural skin pigment found in all organisms. Melanin is the body's first defense against the sun, absorbing the dangerous UV rays that cause serious skin damage. When a person develops a sunburn, the amount of UV damage exceeds the melanin's protection. For this reason, sunscreen was formulated to protect against harmful UV rays.

Slide 4: The UV ray index is specific to your city and can be found through the National Weather Service website. A number is given between 0 and 15 to rate the strength of ultraviolet rays. This information can be used to determine your risk factors and take necessary precautions when outdoors.

Slide 5: The most common risk associated with repeated overexposure to the sun is **skin cancer**, with one in five U.S. adults developing some form of skin cancer during their life. Exposure to the sun at an early age contributes to these statistics, and those with fair skin, light hair, and blue or green eyes are at the highest risk of developing skin cancer. However, darker-skinned individuals are also at risk and need to follow the same sun protection guidelines discussed later in the lesson.

Prolonged sun exposure while engaging in athletic activities is no less damaging than the UV exposure sustained while sunbathing, swimming in a pool, or using a tanning bed. Using sun protection makes a significant difference in reducing risks from repeated overexposure to the sun. Other risks associated with repeated overexposure to the sun are:

- Eye damage and cataracts: Depending on the length and duration of exposure, the sun's UV rays can damage the eyes, causing cataracts, blurred vision, sensitivity to light, blindness, and more. Wearing sunglasses with UV protection can help protect the eyes from sun damage.
- Damage to the immune system: Studies have shown that a moderate dose of ultraviolet light can damage or kill certain cells near the surface of the skin that are the body's "first line of defense against infectious agents and chemical toxins that invade the skin." Studies have also found that white blood cells are decreased in the bloodstream, reducing the body's infection-fighting capabilities.
- Long-term skin damage: Even if you don't receive many sunburns in your lifetime, extended exposure to ultraviolet rays accelerates your skin's aging process.
- Heat stroke: Often seen while performing strenuous exercise in high temperatures or direct sunlight. Dehydration often accompanies heat stroke, causing the body's temperature control systems to fail.
- Dehydration: When water is moving into and out of the body's cells faster than water is coming in through drinking, dehydration can occur. Once the body's fluid levels and electrolytes are imbalanced, severe dehydration can occur and lead to death.
- Hives: Large, itchy welts that occur from sun exposure are called hives. When hives are a result of sun exposure, they are called solar urticaria. Hives can appear within five minutes of sun exposure and usually disappear within one to two hours after leaving sunlight.

Slide 6: Many medications contain ingredients that can cause a chemically induced change in the skin, called photosensitivity. There are two types of photosensitivity: photoallergy and phototoxicity.

Photoallergy is an allergic reaction to the skin. Phototoxicity is an irritation of the skin and is more commonly seen. Both types of

photosensitivity can cause a rash, sunburn-like symptoms, or other unwanted side effects. Some medications that cause photosensitivity are:

- Antibiotics
- Birth control pills
- Acne medication
- Antifungals
- Antihistamines
- Non-steroidal anti-inflammatories

Many more medications cause photosensitivity, but these are the most common medications taken by the younger population. Some reactions may be immediate, and some may take hours or days of sun exposure to develop a sensitivity.

Slide 7: SPF is short for “sun protection factor.” In sunscreen, SPF helps to block the skin from the sun’s harmful ultraviolet rays. SPF works by extending your skin’s natural defenses (melanin) against the sun’s rays. For example, an SPF of 30 provides 30 times more protection against the sun than your skin does, and an SPF of 50 provides 50 times more protection than your skin. It is recommended to choose a “broad spectrum” sunscreen which will protect the skin from both UVA and UVB rays.

Slide 8: For athletes, it is recommended to use a broad-spectrum, water-resistant sunscreen with an SPF of 30 or greater. Sunscreens with Zinc or titanium dioxide are particularly effective. Using a water-resistant sunscreen with an SPF of 30 or greater will provide protection for approximately two hours. For the lips, using a lip balm with an SPF of 15 or greater is the recommendation for athletes. Dark-skinned athletes also need to follow the same guidelines as their skin can be damaged as easily as lighter-skinned athletes. Sunscreen should also be used on overcast days, as ultraviolet exposure occurs even when cloudy.

Slide 9: Sun Safety Guidelines:

- Generously reapply SPF 30 water-resistant sunscreen every 2 hours or after swimming or sweating profusely
- Use lip balm of SPF 15 or greater, reapply often
- Wear UV blocking sunglasses
- Wear UV protective clothing whenever possible
- Use extra caution near sand, water, pavement, and snow, which reflects the ultraviolet rays
- Seek shade when possible. The sun’s rays are strongest between 10 a.m. and 4 p.m.

When an athlete is consistently exposed to the sun, it is suggested to examine the skin regularly, looking for anything growing, changing, or bleeding on your skin. If there is something unusual, consult a healthcare provider. Skin cancer is treatable if it is caught in the early stages.

Myths and Truths About Sun Exposure and Tanning

Read through the following statements and identify which is truth and which is a myth relating to sun exposure and tanning.

Myth	Truth	Statement
		A base tan is healthy.
		A base tan will protect you from future sunburn.
		Only certain ultraviolet B (UVB) rays are bad for your skin.
		If you have darker skin pigmentation you do not need to protect against the sun.
		SPF doesn't matter after a certain number.
		Sunblock only needs to be applied once on a given day.
		Sunblock should only be worn in the summer.

Lesson Five – Sun Exposure and Risks to Athletes

REVIEW: Perform a Sunscreen SPF Experiment

40 minutes

Purpose:

Participants will practice using the kit components and required materials to perform a sunscreen SPF experiment to correlate sun exposure to the SPF value of sunscreen. Once the experiment is complete, a post-test will be given.

Materials:

- Kit components: Sun Print photo paper, transparency film, index cards, and cotton balls
- Pencils
- 1 office file folder per group
- 1 shallow pan of water large enough to hold and submerge the sun print photo paper
- 4 or more different value SPF sunscreens
- Optional: 2 or more SPF sunscreens with the same value, but different brands
- *Sun Exposure and Risks to Athletes Lab Form*
- *Sun Exposure and Risks to Athletes Instructor Resource Sheet*
- *Sun Exposure and Risks to Athletes Post-Test*
- *Sun Exposure and Risks to Athletes Post-Test – Answer Key*

Facilitation Steps:

1. Hand out the *Sun Exposure and Risks to Athletes* sheet (1 per person or group).
2. Follow the instructions on the *Sun Exposure and Risks to Athletes Instructor's Lab Form*. Participants can work independently following the instructions on their activity sheet, or you can work interactively with the class. If participants work independently, they will need to be instructed when to go outside and when to take the sun prints paper out of their folders (steps 4 and 5 on the lab form.)

3. Once the experiment is complete, instruct participants to take a few minutes to complete the post-test. Have participants self-check their answers as you share from the answer key.

Name: _____ Class: _____

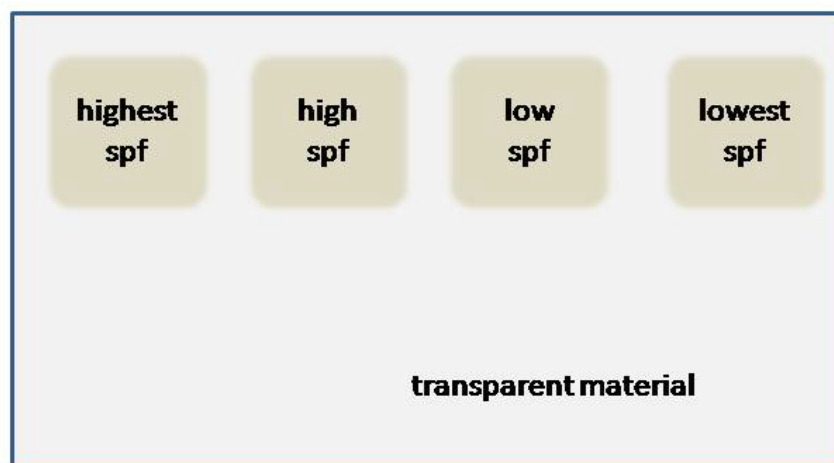
Sun Exposure and Risks to Athletes Lab Form (Sunscreen SPF Experiment)

Have you ever wondered if the sunscreen you're smearing all over your body does anything to protect your skin? This experiment will test sunscreens with different sun protection factors (SPFs) using a special type of paper called sun print paper to find out. The sun print paper is coated with light-sensitive chemicals, which react to light waves and particles when exposed to sunlight. After the paper has been exposed to sunlight for a certain amount of time, the paper is submerged in water, stopping the process and fixing your images on the paper.

The sun's ultraviolet (UV) rays can cause sunburn, premature aging, and skin cancer. Since the chemicals on the sun print paper react with these damaging rays, you can experiment on paper to show how well your sunscreen protects you. You can also compare different brands with the same SPF ratings to see if there are any differences between them.

To conduct the experiment, follow these steps:

1. Collect your materials from the instructor. Refer to the diagram below and apply the information to the transparency film and the **dark side** of the sun print paper, keeping the squares as close to the same size as possible. In addition to drawing the four squares, add another square that will say "no sunscreen." You can fit four different sunscreens on the same piece of transparency film, plus an additional square for "no sunscreen."



2. Write the brand name and the SPF rating at the bottom of each square on the transparency film and the sun print paper. Label the last square "no sunscreen." If you are experimenting with the same SPF sunscreen but a different brand, repeat the process, labeling the SPF factor and the brand name. Place the sun print paper in the file folder to avoid overexposure.
3. Use a cotton ball to place a 1-2" diameter circle of each of the various sunscreens onto the transparency film. Use the small piece of the index card to spread the sunscreen into an even layer. Carefully place the transparency film with the sunscreen on top of the file folder, sunscreen side up.

4. When instructed, move outside into a sunny area. Each group will take their folder containing the sun print paper and transparency film, holding it level while you walk. Remember to keep the sun print paper in the folder until your instructor tells you to take it out.
5. When your instructor tells you to, remove the sun print paper and place the plastic piece directly on top of it with the sunscreen side up, aligning the squares. Then, place the paper with the transparency film over it in direct sunlight. The paper should change color or intensity as it is exposed to light. Expose the paper for 5 minutes, or until the “no sunscreen” square turns white. The exposure time may be less than 5 minutes, depending on the intensity of the sun.
6. Once the exposure is complete, you will move back inside. Remove the transparency film and set it aside. To stop further exposure to the sun print paper, place each group's paper in a pan of water (so that it is completely submerged). The image will completely disappear and then reappear. Leave the paper in the water for 30 seconds to one minute, remove it from the water, and let it dry.
7. Record observations in the space below about the color differences between areas protected by the various sunscreens. The bluer the paper is, the more UV rays came through. The whiter the paper is, the more the sunscreen blocked the UV rays. After your observations are recorded, your instructor will ask questions about the experiment.

OBSERVATION



Sun Exposure and Risks to Athletes (Sunscreen SPF Experiment) Instructor Resource Sheet

Have the participants read the following passage on their lab form, or you can read aloud to the class:

Have you ever wondered if the sunscreen you're smearing all over your body does anything to protect your skin? This experiment will test sunscreens with different sun protection factors (SPFs) using a special type of paper called sun print paper to find out. The sun print paper is coated with light-sensitive chemicals, which react to light waves and particles when exposed to sunlight. After the paper has been exposed to sunlight for a certain amount of time, the paper is submerged in water, stopping the process and fixing your images on the paper.

The sun's ultraviolet (UV) rays can cause sunburn, premature aging, and skin cancer. Since the chemicals on the sun print paper react with these damaging rays, you can experiment on paper to show how well your sunscreen protects you. You can also compare different brands with the same SPF ratings to see if there are any differences between them.

What each group/pair/or participant will need:

- Pencil
- 1 square of sun print UV paper, approximately 4" x 6" (each sheet is 8" x 12" so you can cut it in half)
- 1 piece of transparency film
- 1 office file folder to keep the sun prints paper in before exposing it to sunlight
- 4-8 cotton balls
- 1 small strip of an index card to evenly spread the sunscreen
- 1 shallow pan of water, big enough to cover the square of sun print paper

Materials that can be shared with the entire class:

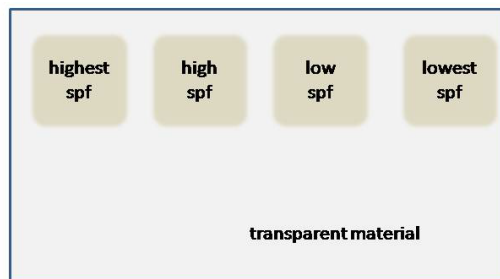
- 4 or more different SPF value sunscreens of a broad range (for example, SPF 2, SPF 10, SPF 30, and SPF 50)
- **Optional:** 2 or more SPF value sunscreens of the same value and likeness but a different brand (for example, a Hawaiian Tropic broad-spectrum SPF 30 and a Banana Boat broad-spectrum SPF 30). Choosing an SPF of 30 is optimal, since that is the minimum recommended for athletes. The participants can decide if one brand offers more protection than the other.

Before the Activity

- In a dimly lit room (so as not to expose the sun print paper), prepare the materials by cutting the sun print paper and the 1" index card strips down to size for each group. This step can also include the participants if you wish. Place each sun print paper in a file folder to keep it unexposed until participants are ready to begin the experiment.
- Bring a shallow pan of water to the classroom.
- If possible, arrange to have the participants complete this activity in the middle of the day, when the sun is at its highest point. Be sure to begin the experiment indoors (with the room dimly lit) while the participants collect their materials and input data onto the transparency film and sun print paper.

With the Participants

1. Have each group/participant collect their materials. Have the participants refer to the diagram on the activity sheet and apply the information to the transparency film and the **dark side** of the sun print paper, keeping the squares as close to the same size as possible. In addition to drawing the four squares, add another square that will say "no sunscreen." You can fit four different sunscreens on the same piece of transparency film, plus an additional square for "no sunscreen."
2. Write the brand name and the SPF rating at the bottom of each square on the transparency film and the sun print paper. Label the last square "no sunscreen." If you are experimenting with the same SPF sunscreen but a different brand, repeat the process, labeling the SPF factor and the brand name. Place the sun print paper in the file folder.
3. Direct participants to use a cotton ball to place a 1-2' diameter circle of each of the various sunscreens onto the transparency film. Use the small piece of the index card to spread the sunscreen into an even layer. Carefully place the transparency film with the sunscreen on top of the file folder, sunscreen side up.
4. Move the class outside into a sunny area. Have each group bring their folder containing their sun print paper and transparency film, holding it level while they walk. Remind participants to keep the sun print paper in the folder until you tell them to take it out.
5. When ready, have the participants remove the sun print paper and place the plastic piece directly on top of it with the sunscreen side up, aligning the squares. Then, place the paper with the transparency film over it in direct sunlight. The paper should change color or intensity as it is exposed to light. Expose the paper for 5 minutes, or until the "no sunscreen" square turns white. The exposure time may be less than 5 minutes, depending on the intensity of the sun.
6. Once the exposure is complete, move the project back inside. Have the participants remove the transparency film and set it aside. To stop further exposure to the sun print paper, place each group's paper in a pan of water (so that it is completely submerged). The image will completely disappear and then reappear. Leave the paper in the water for one minute, remove it from the water, and let it dry.
7. Ask participants to record observations about the color differences between areas protected by the various sunscreens. The bluer the paper is, the more UV rays came through. The whiter the paper, the more the sunscreen blocked the UV rays.
8. Some questions to ask:
 - What differences do you notice in the squares after developing your print?
 - Which product blocked the most UV rays? How can you tell?
 - Do different brands carrying the same SPF rating block out the same amount of UV rays?
 - What was the reason for leaving one square free of sunscreen? Answer: Leaving one square free of sunscreen shows how UV rays can penetrate the skin if sunscreen is not used.



Name: _____ Class: _____

Sun Exposure and Risks to Athletes Post-Test

Select the best answer to the following multiple-choice questions:

1. What are the most damaging rays to the skin called?
 - a. Ultraviolet rays
 - b. Ultraharmful rays
 - c. Ultraviolent rays
 - d. Ultradamaging rays
2. What rating is considered **very high** on the UV ray index?
 - a. 20-25
 - b. 5-10
 - c. 25-30
 - d. 10-15
3. What is SPF short for?
 - a. Sun protective factor
 - b. Skin protective factor
 - c. Sun protection factor
 - d. Skin protection factor
4. Which of the following is the recommended sunscreen for athletes?
 - a. Broad-spectrum, water-resistant sunscreen with an SPF of 20 or greater
 - b. Sunscreen with an SPF of 30 or greater
 - c. Water-resistant sunscreen with an SPF of 50 or greater
 - d. Broad-spectrum, water-resistant sunscreen with an SPF of 30 or greater
5. When are the sun's rays the strongest?
 - a. Between 11 a.m. and 3 p.m.
 - b. Between 10 a.m. and 6 p.m.
 - c. Between 10 a.m. and 4 p.m.
 - d. Between 12 p.m. and 5 p.m.

Sun Exposure and Risks to Athletes Post-Test – Answer Key

1. What are the most damaging rays to the skin called?
 - a. **Ultraviolet rays**
 - b. Ultraharmful rays
 - c. Ultraviolent rays
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2. What rating is considered **very high** on the UV ray index?
 - a. 20-25
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 - d. **Broad-spectrum, water-resistant sunscreen with an SPF of 30 or greater**
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 - a. Between 11 a.m. and 3 p.m.
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