Introduction to Exercise Physiology & Sports Performance

Prof. Anup Krishnan

IIT Madras

Lecture – 29

Health Risks during Exercise in Heat and Cold

Good morning, ladies and gentlemen and welcome back to this course on exercise physiology and sports training. We are now in week 6 and this is lecture 4 and we will be dealing with health risks during exercise in the heat and cold. And I am Colonel Dr. Anup Krishnan, your instructor for this week.

I shall be covering this topic under the following headings. Introduction, health risks in heat, heat related disorders, prevention of hypothermia, guidelines for sports in heat, health risks in cold, cold related disorders, and conclusion.

There are several health risks during exercise in heat and it happens because when the muscles are active there is lot of heat production. There is heat which is gained from the environment and there may be conditions which prevent the dissipation of the body heat and this will elevate the internal body temperature to levels that impair normal cellular functions.

There are several variables to exercise in heat. The air temperature. The rate of metabolic heat production. Ambient water vapor pressure. Air velocity. Radiant heat sources and clothing.

Let us talk about some heat related disorders. The most common one is something called heat cramps and it is characterized by severe painful cramping of large skeletal muscles and it usually involves muscles which are most heavily used during exercise and it is caused by the sodium losses and dehydration that accompany the high rates of sweating during exercise in heat. There are several different opinions to the causes of heat cramps and we will not dwell into those but some say it is because of dehydration, some say it is because of electrolyte imbalance, some say it is a neurological issue. So, we will not get into that controversy and we will follow what is given in our reference book.

Prevention of heat cramps involves proper hydration. You have to have liberal salt intake with whatever you are eating and whatever drinks you are consuming during the exercise. And if somebody develops heat cramps, move him to a cooler location and start administering a saline solution or an electrolyte solution either orally or if you have the expertise then intravenously.

Heat exhaustion. It is caused by the cardiovascular system's inability to meet the body's needs as it becomes severely dehydrated. It occurs when blood volume decreases as a result of excessive fluid loss from profuse sweating which causes dehydration. The patient shows symptoms like fatigue, dizziness, nausea, vomiting, fainting and a weak rapid pulse. The thermoregulatory mechanisms are functioning but cannot dissipate heat quickly enough because insufficient blood volume is available to allow adequate blood flow to the skin. Heat exhaustion is not necessarily accompanied by extremely high core temperatures and unfit non-acclimated athletes are more susceptible. Treatment for the victims of heat exhaustion involves rest in a cooler environment, limb elevation and administration of oral fluids with electrolytes

if the patient is conscious. If the patient is unconscious, you may need to give intravenous IV fluids and it should be done under medical supervision.

It is a life-threatening heat disorder that requires urgent and immediate medical attention. It is caused by failure of the body's thermoregulatory mechanisms and it is generally characterized by a core temperature more than 40 degree centigrade, confusion, disorientation or unconsciousness. Please note in any heat related disorders keep a check on the mental status because if somebody starts developing altered mental status, it is a sign of impending heat stroke because the brain is very very heat sensitive. Cessation of active sweating may occur but sweat may remain on the skin. This means that the patient's sweating mechanisms may stop but what he has already sweated may remain on the skin.

If left untreated, core temperature will continue to rise progressing to coma and ultimately death. Appropriate treatment always involves cooling the body as rapidly as possible. Studies have reported rectal temperatures above 40.5 degree centigrade in marathon runners who have successfully completed races which have been conducted in even normal temperate conditions. So, that means in events like the marathon, you should always be prepared for athletes having heat stroke and cool them down immediately after they finish the race.

How do you prevent hyperthermia? First things you should look at the weather. You must either move the exercise session indoors or reduce the effort to reduce the risk of overheating. Athletes, coaches and sports organizers should all be able to recognize the symptoms of heat illnesses. Competition and practice should not be held outdoors if the wet bulb globe thermometer shows more than 28 degrees centigrade. Schedule practices and events in the early morning or in the late evening. Fluids should be readily available and drink breaks should be scheduled every 15 to 30 minutes with a goal of matching the fluid intake to sweat.

Clothing. Coaches and athletic trainers should try and avoid practice sessions in full uniforms wherever possible. Distance athletes should wear as little clothing as possible. Clothing should be loosely woven to allow sweat to be absorbed and wicked away from the skin and it should be light colored to reflect heat. Hat should be worn during exercise in bright sunlight or when cloud cover is limited.

Hydration. Maintain adequate hydration since the body loses considerable water through sweating. Drink fluid before, during and after exercise to reduce the negative effects of exercising in heat. Adequate fluid intake will attenuate the increase in core body temperature and heart rate and will allow the exercise to be continued longer.

There are several guidelines for conducting sports events in heat. Athletic events should be scheduled to avoid the hottest times of the day. If the wet bulb globe thermometer is above 28 degrees centigrade, consider cancelling the event, moving it indoors, reducing the intensity of practice or otherwise alter it in a suitable manner. Make sure there is adequate supply of palatable fluid available. Athletes should be educated and encouraged to replace their sweat losses to prevent dehydration. Estimate individual set rates by measuring body weight before and after exercise and hydrate accordingly.

Fluids containing electrolytes and carbohydrates can provide benefits more than simple water alone. Athletes should be aware of the signs and symptoms of heat illness, specifically of the central nervous system signs and symptoms. Cold water immersion is the most efficient method available right now for cooling hyperthermic athletes in the field. Organizers and medical

personnel should have the right to cancel or terminate events and to stop individual athletes who show signs and symptoms of heat illnesses.

During cold, if humans had retained the ability of lower animals such as reptiles to tolerate lower body temperatures, we could survive extreme hypothermia. Unfortunately, the evolution of thermoregulation in humans has diminished the ability of tissues to function effectively outside a narrow temperature range.

Let us talk about some cold related disorders. Hypothermia. Individuals who are immersed in water will die within a few minutes when their rectal temperature drops to 24 degrees centigrade. Once the core temperature drops below 34.5 degrees centigrade, the hypothalamus begins to lose its ability to regulate body temperature. And if the core temperature drops below 29.5 degrees centigrade, the ability to regulate temperature by the hypothalamus is completely lost. This slowing of metabolic reactions and low core body temperatures can cause drowsiness, lethargy and even coma.

Cardiorespiratory effects. Death from hypothermia has resulted in cardiac arrest even while the respiration was still going on. Cooling primarily influences the sinoatrial node, the heart's pacemaker, which leads to a substantial decrease in heart rate and ultimately cardiac arrest. Cold air that passes into the mouth and trachea is rapidly warmed even at temperatures less than minus 25 degrees centigrade and hence it does not affect the respiratory system much. Excessive cold exposure may affect the respiratory system by decrease in respiratory rate and respiratory volume.

Frostbite. Another common cold related disorder. The environmental air temperature which is required to freeze exposed fingers, nose and ears is about minus 29 degrees centigrade. In extreme cold, the circulation in the skin reduces to the point that the tissues can die from lack of oxygen and nutrients commonly called frostbite. If not treated early, frostbite injuries can be serious leading to gangrene and loss of tissue. Frostbitten parts should be left untreated unless they can be thawed preferably in a hospital without the risk of refreezing.

Exercise induced asthma. It affects as many as 50% of winter sports athletes and it is caused by drying of the airways due to high respiratory rate associated with the exercise and the extreme dry cold air. Basically, what happens is if you exercise in cold weather conditions, the air is cold, the respiratory rate is high and this causes drying of the airways and it will lead to exercise induced asthma. This results in airway narrowing and it often leaves athlete gasping for breath. There are preventive drugs available in the form of inhalers to relieve the symptoms which should be taken before exercising in cold temperature and it should be taken before exercise in all athletes who are prone to exercise induced asthma.

Treatment for the hypothermia. Mild hypothermia can be treated by removing the affected person from the cold, providing dry clothing and blankets for insulation and consumption of warm beverages. Moderate to severe cases of hypothermia require gentle handling to avoid initiating a cardiac arrhythmia and this requires slow rewarming of the victim. Do not be in a hurry to rewarm a person with moderate to severe hypothermia. Severe cases of hypothermia require hospital facilities and specialized medical care.

Heat stress involves more than just the air temperature. Exercise intensity and clothing must be considered separately along with the wet bulb globe thermometer reading. Heat cramps are caused by loss of fluid and salt that results from the excessive sweating in susceptible athletes.

Heat exhaustion results from dehydration caused by excessive loss of fluids and electrolytes which results in reduced blood volume. Heat exhaustion can deteriorate to heat stroke if left untreated. Heat stroke is caused by failure of the body's thermoregulatory mechanisms and is fatal if left untreated.

Hypothermia critically reduces cardiac output. Exposure to extreme cold decreases respiratory rate and volume. Frostbite occurs due to the body's attempt to prevent heat loss by skin vasoconstriction of the peripheries. Because cold air is inherently dry, many athletes experience the symptoms of exercise induced asthma during high intensity exercise in cold environments.

These are the references which have been used to prepare this lecture and I strongly urge you to go through them because there are limitations to what can be covered in a short lecture and in case you need to know more and for better understanding of these topics, I request you to go through these references.

Thank you for your time and patience ladies and gentlemen. You can put in your comments, your questions and any other suggestions on the email below. Thank you, ladies and gentlemen. Thank you and Jai Hind.