Prevention of Heat Related Illness in Young Athletes

Edmund K. Kerut, MD FACC
West Jefferson Heart Clinic of Louisiana

Athletic associated heat related illness is common in Louisiana, with children and adolescents at higher risk than adults. Over 9,000 cases in the United States occur each year, with the highest rate among football players (10x that of other sports), occurring mostly in the month of August.

Risk Factors for Heat Related Illness

Young athletes do not adapt to extreme temperatures as effectively as do adults and are more susceptible to heat related illness as a result of:

1. a greater body surface area to mass ratio (increased heat gain hot day and increased heat loss cold day)
2. greater metabolic heat/unit body mass
3. lower sweating capacity and subsequently reduced dissipation of body heat (air temp > 95º F)
4. failure to "feel" the need to replenish fluid loss
5. a higher core body temperature for a given level of reduced hydration

The extent to which the body is affected by the environment is termed "heat stress", and is due in large part to humidity, followed by solar radiation and air temperature. The "heat index", a measure of temperature and humidity, is most often used in determination of risk of heat illness. For a specific locale, the heat index may be obtained from a free mobile phone APP "OSHA Heat Safety Tool" or at the following web address:

http://www.hpc.ncep.noaa.gov/heat_index_MAX.shtml

For example, an air temperature of 86º F and relative humidity of 50% would be equivalent to a heat index of 88º F. In a similar way, an air temperature of 86º F and relative humidity of 90% would be a heat index of 105º F. In this example, the body must sweat as much to rid extra heat as a dry desert at 105º F. From this it is evident that the core body temperature increases quickly in a humid environment due to an inability to dissipate heat.

The following table demonstrates the relationship of temperature and humidity for determination of the heat index. Values in red indicate “extreme risk” and those in yellow “caution” (from: Steadman RG. The Assessment of Sultriness. Part I: A Temperature-Humidity Index Based on Human Physiology and Clothing Science 1979. July: 861-873)

Humidity

Temp	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
105°	100	105	113	123	135	149				
104°	98	104	110	120	132	143				
102°	97	101	108	117	125	139				
100°	95	99	105	110	120	132	144			
98°	93	97	101	106	110	125	132			
96°	91	95	98	104	106	120	123			
94°	89	93	95	100	105	111	122	128		
92°	87	90	92	96	100	106	115	122		
90°	85	88	90	92	93	100	106	114	122	130
88°	82	86	87	89	93	95	100	106	115	125
86°	80	84	85	87	90	92	96	100	109	111
84°	78	81	83	85	86	89	91	95	99	105
82°	77	79	80	81	84	86	89	91	95	96
80°	75	77	78	79	81	83	85	86	89	91
78°	72	75	77	78	79	80	81	83	85	86
76°	70	72	75	76	77	77	77	78	79	80

Values are Heat Index

Table I

In addition to the heat index, other risk factors for heat related illness include:

Past history of heat related illness
Lack of physical “fitness”
Overweight / obesity
Dehydration
Fever
Gastrointestinal illness
Sodium deficiency
Skin condition (sunburn, rash)
Medications (antihistamines, diuretics, dietary supplements-ephedra)
Motivated athlete to push oneself
Reluctance to report problems
Pre-adolescent

"Preventable" risk factors include:

Prolonged exercise with minimal breaks
Exercise on a day with a high heat index
Lack of awareness signs heat related illness among coaches and athletes
No emergency plan to identify and treat heat related illness
Minimal access to fluids before and during exercise

Lack of heat acclimatization increases an athlete's risk for heat related illness. It is a process through which the body deals with being introduced to a hot environment. After 5-10 days of exposure to a warm environment, the sodium concentration in sweat will decrease. Sweat rate will increase after 10-14 days. Generally, children and adolescents become acclimatized slower than adults. Youth need 8 – 10 (30-45 min each) exposures to a hot climate (one/day or every other day). Intensity and duration of exercise should gradually increase over 10-14 days.

Signs of Heat Related Illness

Thirst is not a reliable indicator of hydration. An athlete may lose 5-10% body weight before feeling "thirsty". In an attempt to maintain the same level of intensity, the athlete will "work harder" than other competitors. A fluid loss of 2% (1.5 liter in a 155 lb athlete) will affect athletic performance.

As dehydration progresses risk of heat related illness increases. Dehydration and an increased heat index will significantly shorten the time to exhaustion.

Heat related illness progress from heat cramps to heat exhaustion, and if it progresses to heat stroke, the most serious and deadly form. Heat and dehydration related symptoms, however, are not always "additive" and do not occur necessarily in progression.

Signs of heat related illness include**:**

irritability
decreased performance
fatigue and weakness
weakness
headache
muscle cramping
dark yellow urine / low urine volume
lightheaded feeling / dizzy
difficult paying attention

Athletes should be removed from competition and treated immediately with removal of clothing or equipment, rest in a cool place and provided fluids – sports drink with electrolytes.

Heat cramps are painful involuntary whole-body cramps due to depletion of salt and water from profuse sweating.

Signs: "knotting" of muscles and muscle pain
excessive sweat
excessive "salty" sweat on skin or visibly dried salt on skin
excessive dehydration

Treatment: drink fluids with electrolytes – sports drinks / Pedialyte
Gentle stretch / massage cramped muscles
Rest cool place
Ice to cramps
Intravenous saline for those that fail to respond

Heat exhaustion is fatigue and exhaustion occurring as a result of an inability of the body to support exercise and core body temperatures. ***Athletes with heat exhaustion improve quickly with management, whereas athletes with heat stroke get worse.***

Signs: dizziness / fatigue
Feeling "chilly"
Rapid pulse
Profuse sweat or pale skin
Headache, nausea, vomiting or diarrhea
Abdominal cramps or persistent muscle cramps

Treatment: cool, shaded rest with ice cold towels to cool down
sports drink with electrolytes
lie down with legs elevated to improve circulation
athlete should feel better quickly…
if not assume ***heat stroke***

Heat stroke occurs as heat exhaustion to thermoregulatory failure. Core temperature approaches 104º F, and as a result, organ damage may occur. This is a medical emergency. When not recognized and promptly treated properly it may result in death.

Signs: - heat exhaustion progresses, however …
(may occur suddenly without preceding signs)
- usually unconscious with hot dry skin
(may sweat profusely, contrary to popular belief)
- high core body temperature (measured by rectal temperature)
- altered central nervous system function –
Confusion /unconsciousness / altered mental status
Feel "out of sorts"
Extreme lethargy
Healthy athlete collapses during exercise in heat

Treatment: Immediate transport nearest medical services facility. Begin cooling while waiting for emergency services.
Rapid cooling is imperative by whatever means possible.
Generally cooling source removed when temperature lowered to $\leq$ 102ºF.
Ice bath preferred – hold head out of bath
Ice packs over as much body as possible
Cool shower
Cool wet towels
Water spray

Always transport a suspected heat stroke patient to the hospital.
Consider not provide oral fluid as nausea and vomiting are common.

Prevention of Heat Related Illness

Clothing

Suggestions for clothing include:

Lightweight, light-colored, loose-fitting
Loose-wicking "breathable" one layer garment.
Breathable socks
Light color hat
Sun block SPF ≥ 15,
Replace sweat-saturated garments with dry garments
Avoidance of "rubberized" sweat suits,
Wet cold towels

Monitoring Urine Color

Athletes should be fully hydrated before exercise. They should learn to recognize urine color as a sign of hydration status. A light/clear or lemonade color indicates proper hydration, but yellow or apple juice color indicates dehydration.

Proper Hydration

Many young athletes are chronically, inadequately hydrated. An athlete's fluid requirements are generally about 0.5 – 1.0 liter/day above normal "baseline" requirements for youth. General fluid guidelines for normal hydration are:

Normal Baseline Fluid Guidelines

Age/Sex	Daily Fluid Need
4-8 yrs boys/girls	5 cups (1.2 L)
9-13 boys	8 cups (1.8 L)
9-13 girls	7 cups (1.7 L)
14-18 boys	11 cups (2.6 L)
14-18 girls	8 cups (1.8 L)

There is no benefit of sports drinks over water when exercising for less than one hour. Non-carbonated, lightly sweetened and flavored drinks with electrolytes are preferred, as the athlete may drink more. Beverages should be preferably cool, in general about 50-59ºF.

Drinks to avoid include fruit juices (high sugar content with subsequent slow fluid absorption and cramps), caffeinated beverages (diuretic effect), carbonated drinks (less volume intake from stomach fullness), energy drinks (caffeine and high sugar content), and alcohol.

The National Athletic Trainers' Association (NATA) recommends adequate hydration beginning 4 hours prior to exercise and heat exposure. In general 5-7 ml/kg body weight (12 – 20 oz fluid) of fluids is recommended.

Fluids for a practicing football team should be based on the relative humidity and temperature (from: Kulka J, Kenney WL. Heat Balance Limits in Football Uniforms: How Different Uniform Ensembles Alter the Equation. Physician Sportsmedicine 2002; 30(7): 29-39)

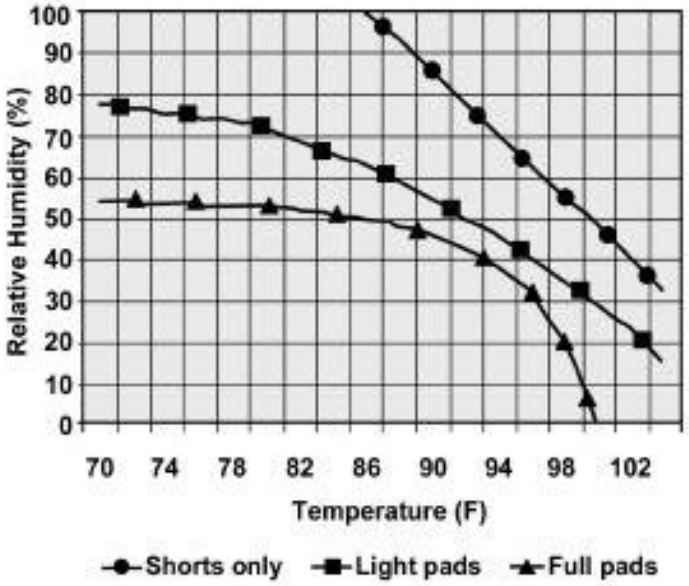

Table II

(below triangles)	5-10 min rest/fluids every 25-30 min
(triangles to squares)	5-10 min rest/fluids every 20-25 min Shorts/t-shirts Football- helmet/shoulder pads only
(squares to circles)	5-10 min rest/fluids every 15-20 min Shorts/t-shirts No equipment
(above circles)	Postpone practice

Add 5º F to temperatures between 10:00am to 4:00pm mid-May to mid-September on bright, sunny days. In general, one should consume about 7-10 oz fluid every 10-20 minutes, based on sweat rate, exercise intensity, and individual tolerance.

The following precautions are summarized recommendations from the Alabama High School Athletic Association:

http://www.ahsaa.com/Portals/0/pdf/other/Heat%20Stress%20and%20Athletic%20Participation.pdf

1. Each athlete should have a physical examination/ medical history and annual update. History of prior heat illness should be included.

2. Lack of physical fitness impairs performance in high temperatures. Coaches should set practice schedules accordingly.

3. Acclimatization to hot weather is essential.

4. Withholding water has no scientific foundation. Water must be on the field and available at all times in unlimited quantity. Minimum 10-minute water breaks should be scheduled every 20 minutes of heavy exercise in the heat.

5. Make sure athletes are drinking water. Replacement by thirst is inadequate.

6. Although the wet bulb globe temperature index (WBGT index) is based on air temperature, relative humidity, radiant heat and air movement, the method used most often is the heat index to define "risk zones" (see Table I).

7. Cooling is proportional to exposed skin area. Reduce clothing covering the body as much as possible in heat. Never use rubberized clothing.

8. Athletes should weigh each day before and after practice with weight charts followed. Generally < 3% weight loss through sweating is safe, but >3% weight loss is "in the danger zone". When over a 3% weight loss the athlete should not be allowed to practice in hot and humid conditions. Do not allow athletes to practice until weight is adequately replaced.

9. Observe athletes for signs of trouble including nausea, incoherence, fatigue, weakness, vomiting, cramps, weak rapid pulse, visual disturbance and unsteadiness.

10. Hot weather occurring during the season, through travel or after an unseasonably cool period should be physically fit but not environmentally fit. Substitute more frequently during games.

11. Have emergency plans written with copies to all staff. Be familiar with immediate first aid with rearranged procedures for obtaining medical care, including ambulance service.

Selected References

Climatic Heat Stress and the Exercising Child and Adolescent. American Academy of Pediatrics: Committee on Sports Medicine and Fitness. Pediatrics 2000; 106(1): 158-159.

Armstrong LE, Anderson JM. Heat Exhaustion, Exercise-Associated Collapse, and Heat Syncope. In: Exertional Heat Illnesses, LE Armstong. Chmpaign, IL: Human Kinetics, pp. 57-90, 2003.

American College of Sports Medicine, Postion Stand: Exertional Heat Illness During Training and Competition. Med Sci Sports Exerc. 39(3): 556-572, March 2007.

Bytomski JR, Squire DL. Heat Illness in Children. Current Sports Medicine Reports 2003; 2(6): 320-324.

Steadman RG. The Assessment of Sultriness. Part I: A Temperature-Humidity Index Based on Human Physiology and Clothing Science 1979. July: 861-873.

Casa DJ, Csillan D. Preseason Heat-Acclimatization Guidelines for Secondary School Athletics. J of Athletic Training 2009. 44(3): 332-333.

Inter-Association Task Force on Exertional Heat Illness Consensus Statement. National Athletic Trainers' Association. 2006.

Casa DJ, Armstrong LE, Hillman SK, et al. National Athletic Trainers' Association Position Statement: Fluid Replacement for Athletes. J Athletic Training 2000; 35(2): 212-224.

Heat Illness Prevention Tips. Gatorade Sports Science Institute 2002.

Parents and Coaches' Guide to Dehydration and Other Heat Illnesses in Children. National Athletic Trainers' Association. June 2003.

Kulka J, Kenney WL. Heat Balance Limits in Football Uniforms: How Different Uniform Ensembles Alter the Equation. Physician Sportsmedicine 2002; 30(7): 29-39.

Mueller FO. Heat Stress and Athletic Participation. Alabama High School Athletic Association.
http://www.ahsaa.com/Portals/0/pdf/other/Heat%20Stress%20and%20Athletic%20Participation.pdf