The Science of Summer Sports Hydration:
Risk Factors & Prevention Strategies for Football Coaches and Players
(Bulleted Version)

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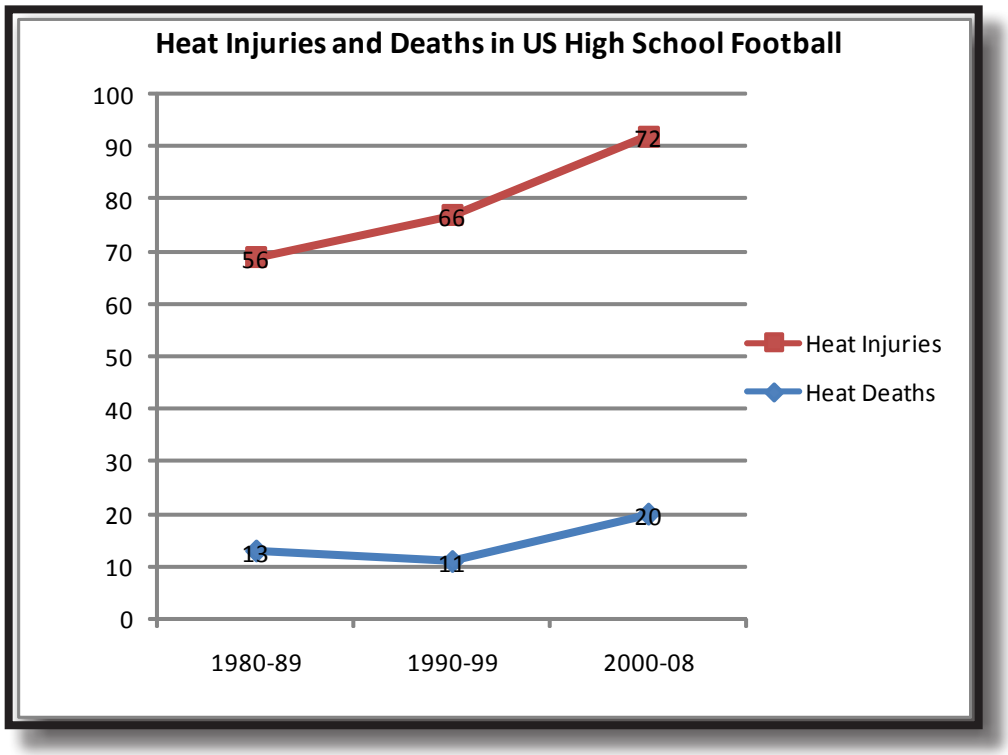
Why Be Concerned?

- The majority of heat illnesses and fatalities occur at the high school level.
- 39 football players died from heat stroke from 1995-2007; 74% were high schoolers (1).
- In 2008, there were six heatstroke deaths in football athletes; four were in high school (1).



Graph created from data from: Mueller FO, Colgate B. Annual survey of football injury research 1931-2008. The American Football Coaches Association, the National Collegiate Athletic Association and the National Federation of State High School Associations 2009:1-29. Available at http://www.unc.edu/depts/nccsi/FootballAnnual.pdf. [Accessed March 29, 2009]

How Body Heat is Dissipated

- By conduction (2%), convection (10%), radiation (65%), and evaporation (30%) (2).
- If the outside temperature is >93°F, radiation from the skin is negligible and the body has to rely on evaporation (2). As the humidity rises, evaporation is reduced, and the body is not cooled.
- For proper physiologic functioning, core body temperatures should be 97-100°F. An increase of only 2°F beyond these levels will increase skin blood flow and heart output at the expense of other vital organs (4).
- In football huddles, the "penguin effect" occurs when players in the middle of the huddle absorb heat given off by surrounding players and are unable to release this additional heat. Middle huddlers have a higher risk of heat injury even on days when the temperature doesn't seem hot (5).

Dehydration: Definition and Impact of

- Rapid loss of body weight of 2% or more (ie: 4 lbs for a 200 lb person) (6-7).
- 2.2 lbs (1 kg) of body weight lost = 1 liter of body water lost (10).
- Average daily adult water needs: 3.7 Liters/day for men and 2.7 L/day for women (9).
- Impairs performance: lowers stamina, focus, speed, coordination, accuracy, cognition, and strategizing plays (7, 11, 13).
- Increases body temp, heart/respiratory rate, heart strain and decreases blood pressure (7, 11, 13).

Heat Illnesses Defined

- In footballers, 73% of heat illnesses were heat cramps, 21% were heat exhaustion, and 6% were heat syncope (14).
- **Heat cramps** are due to dehydration (loss of body water), electrolyte losses (mainly sodium and chloride), and/or muscle fatigue (16). Heat cramps most commonly affect calf, hamstring or quadriceps muscles (17); are common in unconditioned players and those not acclimatized to the weather (17). Incidence increases with higher intensity and longer duration of exercise (18). Profuse sweaters with large sodium losses (via sweat) are most susceptible (7). Remove player from the heat, stop exercising, orally rehydrate with water and electrolytes (sodium, chloride, potassium), and watch their urine for the next 24 hours. If urine becomes cola colored or bloody – go to the ER.
- **Heat Exhaustion and Heat Stroke** are hard to differentiate on the field. Excessive sweating, fatigue, dizziness, headache, muscle aches/cramps, fainting, nausea, vomiting, and irritability are all signs of heat exhaustion (2, 19) and heat stroke. Remove player from the heat, rehydrate with water and electrolytes (sodium, chloride, potassium), and cool the body. Any change in mentation (confusion, strange behavior, disorientation, poor judgment) is a sign of high body temperature and requires rapid cooling of the player & a trip to the ER (19).

I. Environmental Risk Factors and Solutions

Risk Factor: Heat and Humidity

- An outside temp of 96°F with a relative humidity of 70% = heat index of 126°F.
- The majority (96%) of heat illnesses happen during preseason practices (20) with the first three weeks in August having the highest risk (14) in college players.
- As dehydration increases so does the body's core temperature during exercise in the heat (15).

Solution

- Field temperature and humidity should be monitored before and during practice on a regular basis (38).
- Schedule practices early in the morning (6 – 9 am) to avoid heat. Practice indoors when heat index is high.)See attached heat index graph.)
- Use a wet bulb globe thermometer in the field or a heat index chart & local weather data.
- Spirit Airport weather data (attached): In August, in St. Louis, temperatures are highest in the late afternoon and do not return to 8 am temps until 9 pm.
- Utilize any shaded area on or near the practice field, open tents, misting tents, or filled kiddie pools during rest breaks to reduce the radiant heat load (42).
- Free program (for computer or PDA) for converting local temperature and humidity to heat stress level is available online at www.zunis.org/sports_p.htm.

Risk Factor: Synthetic Turf vs. Grass

- Summer syn. turf surface temperatures can reach 160°F and run 60°F hotter than grass (21).
- A study done in July 2007 with an outdoor temperature of 78°F measured the grass field temperature at 85°F and the turf at 140°F (21).
- Games played on turf have 10% more injuries, ingestion of chemical particulates from the rubber infill, and a greater number of turf burns that increase the probability of infection (especially methicillin-resistant staph aureus) (21).

Solution: Change Practice Environment or Adjust to Effects

- Practice on a natural grass, not synthetic turf field.
- If only turf available, adjust practice and hydration accordingly.

II. Practice Risk Factors and Solutions

Risk Factor: Lack of Acclimatization to Heat and Sequential Training

- Proper acclimatization takes about 7-15 days for the human body (8, 13, 14, 16).
- Sequential daily training and two-a-days lead to a loss of body fluids (22) and don't allow enough time between sessions for full rehydration.
- Dehydration is cumulative -- players may already have a fluid deficit from the previous practice or the day before (7). Three days of 1% daily dehydration adds up to a serious dehydration total of 3% by Day 3.

Solution: Institute an Acclimatization Period

- Overall consensus for high school football acclimatized practice is (8, 20, 42):
  - One practice not to exceed 3 hours, no live contact (Days 1-6)
  - Practice includes warm-up, conditioning, instruction, breaks, and cool-down
  - Conditioning should not exceed 60-90 min/day (Days 1-6)
  - May use blocking sleds and tackling dummies (Days 4-6)
  - Helmets only (Days 1, 2), helmets & shoulder pads (Days 3, 4, 5), full pads (Day 6)
  - No more than 6 sequential days of practice
  - Alternate two-a-day (5 hours combined total with 3 hours off between practices with one-a-day (3 hours) practices, full pads (Days 8-13)
  - Scrimmages should not begin before Day 12
  - Modify practice daily according to heat/humidity/radiation
- Players with sweat patterns only on the forehead and chest triangle down to abdomen may not be acclimated (13). Acclimated players sweat over their entire body.

Risk Factor: Intensity and Duration of Practice

- Short breaks, practices > 3 hours, and two-a-days increase risk of heat illnesses.

Solution: Rest Periods to Cool Down

- During 60 minutes of conditioning exercise in the heat, it is good practice to break every 15-20 minutes (38).
- Practice not to exceed 3 hours. Alternate two-a-days as recommended above.

Risk Factor: Insulation of Uniforms/Equipment

- Clothing and pads increase the skin's humidity & create an evaporative barrier (23).
- A full uniform (NCAA regulation) covers 50% of the body's surface (8), triples heat insulation, and decreases the evaporation of sweat by two-thirds (25).

Solution: Decrease Skin Coverage

- Progressively add equipment over a period of days (as suggested earlier) to allow acclimatization.
- Practice in shorts, shoulder pads, jersey and helmet (half uniform) -- this only doubles the heat insulation and only cuts the sweat evaporation by half (25).
- Fish-net fabric allows greater air circulation (23) and light colored clothing can block reflective heat (16).
- Remove helmets whenever possible to dissipate heat (42).

III. Player Risk Factors

Risk Factor: Adolescent vs. Adult

- Adolescents are at greater risk for dehydration and hyperthermia because they have fewer sweat glands, produce less sweat per sweat gland, are less able to transfer heat from their muscles to the skin, have a smaller cardiac output which reduces internal heat transfer to the skin, and acclimatize slower than adults.

Solution: Acclimatize, Hydrate, Monitor Teen Athletes

- A teen may take 5-6 sessions to an adult's 2-3 sessions to acclimatize(26).

Risk Factor: Non-Aerobic Preexisting Level of Fitness

- Many football players are not aerobically conditioned. Footballers tend to do weightlifting and plyometrics in the offseason in an air-conditioned gym (27) rather than aerobic exercises.

Risk Factor: Large Body Size (High Body Mass Index)

- Body weight and height varies with the sport and the position played. Cross country runners often weigh 143-165 lbs. (27) while college offensive linemen average weight runs 291-316 lbs, linebackers 220-238 lbs, tight ends & defensive tackles 266-291lbs (8).
- Lean body tissue holds more water than fat body tissue. A 220 lb obese male adult has 30% of his total body weight in water while a 220 lb lean adult male has 70% (10), so an obese male will dehydrate quicker.
- Heavily muscled or overweight players have a higher body mass to surface ratio, fewer sweat glands, and more fat insulation. All of this leads to a higher metabolic rate, retention of heat, rapid increases in body temperature, and increased risk of heat illness.

Solution: Condition Yourself

- Several weeks before camp or preseason practice, players should begin the acclimatization process by exercising outside and aerobically conditioning (running, swimming, cycling) with 15-20 minutes/day and increasing by 5-10 minutes daily (25).

Risk Factor: High Sweat Rates → Sodium and Chloride Losses

- Non-acclimated players, heavy sweaters, sweaters with high salt concentrated sweat (16), and practices > 3 hours (15) lose more sodium chloride which predisposes them to heat illness
- Diet, sweat rate, level of hydration and acclimatization will vary the salt lost in sweat (47).
- Drinking water instead of a carbohydrate electrolyte drink will not provide the needed sodium and chloride ions. Armstrong found that youngsters who receive only plain water do not drink enough to correct their fluid deficit (33).

Solution: Ingest Sports Drinks, Salty Snacks

- Footballers with a previous heat cramp history had sodium losses twice the normal and ingestion of additional salt ended the cramps (15).
- Flavored drinks & cooler drinks (59-70°F) (7) increase consumption by 44.5% (33).
- Ingesting a small amount of carbohydrate (4-8% as in sports drinks) with sodium increases fluid consumption (23), is beneficial to energy needs (11), and slows the onset of fatigue (47).
- Sports drinks also supply glucose to replace depleted muscle glycogen stores. Naughton found that with a 6% glucose drink, time to fatigue was increased by 25% (23). When the drink was 6% glucose with 3% fructose added, time to fatigue increased to 40% (23).
- Rehydrating with a 6% carbohydrate electrolyte drink increased the "maximum power of high school football players" when compared to drinking only water (51).

- Gatorade is a mixture of sucrose (38%), glucose (34%), fructose (28%) and maltodextrins (8%) while Powerade is mostly high fructose corn syrup (HFCS) (48). A mixture of sugars and complex glucose polymers such as maltodextrin (49) increases the oxidation and absorption of carbohydrates (50) leading to more fuel for athletes' bodies. HFCS is associated with spikes in blood sugar and obesity.
- Carbohydrate and sodium chloride in a beverage also raises the uptake of water through channels in the small intestine and accelerates gastric emptying (50) allowing more water to be absorbed by the body = quicker rehydration.
- The Institute of Medicine recommends drinks that contain 20-30 mEq/L (115-172mg/8 ounces) sodium chloride, 2-5 mEq/L (19-49mg/8 ounces) potassium and 5-10% carbohydrate as ingredients (7) in fluid replacement beverages for heat exercise. (See attached table for optimal sports drinks).

Risk Factor: High Sweat Rates → Fluid Losses

- As a sport, football has the highest sweat rate & dehydration percentage of all sports-Table 2(5).
- Sweat loss in this environment can range from 1.3-3.45 liters/day (12), averaging >2L/day (27).
- Summer football players wearing full gear can have sweat losses >8L/d (7).
- Footballers required an intake of 12.2 liters/day with 2.9 liters ingested immediately after practice compared to 4.6 L/d with 0.7 liters immediately for the runners (27).
- A study of Australian rugby players showed that fluid losses of 3% can significantly decrease the body's capacity to work (22).

Solution: Measure Pre- and Post-Exercise Body Weights & Offer Hydration on the Field

- Measuring pre- and post-practice change in body weight is a reliable way to assess how much fluid a player needs to replace (38, 44).
- Weights should be done at the same time daily, without sweaty clothes (preferably nude), recorded on a wall chart, and averaged over a week.
- % dehydration = (Pre-practice body weight – post-practice body weight) x 100/pre-practice body weight. Example: (200 lbs - 196 lbs) X 100 = 400/200 = 2% loss.
- 2% acute loss of body wt = dehydration.
- Fluid replacement should be 130-150% (2.2 lbs=1 L fluid loss, replace with 1.3 to 1.5 L)
- Water should be available in several sites on the field and offered in a way that will allow players to easily drink what they need.
- Larger quantities of cold fluids are more readily consumed by hot athletes (7, 42).

TABLE 2. Observations of sweat rates, voluntary fluid intake and levels of dehydration in various sports. Values are mean, plus (range) or [95% reference range].

		Sweat rate ($L \cdot h^{-1}$)		Voluntary fluid intake ($L \cdot h^{-1}$)		Dehydration (% BM) (= change in BM)	
Sport	Condition	Mean	Range	Mean	Range	Mean	Range
Waterpolo [41]	Training (males)	0.29	[0.23–0.35]	0.14	[0.09–0.20]	0.26	[0.19–0.34]
	Competition (males)	0.79	[0.69–0.88]	0.38	[0.30–0.47]	0.35	[0.23–0.46]
Netball [16]	Summer training (females)	0.72	[0.45–0.99]	0.44	[0.25–0.63]	0.7	[+0.3–1.7]
	Summer competition (females)	0.98	[0.45–1.49]	0.52	[0.33–0.71]	0.9	[0.1–1.9]
Swimming [41]	Training (males & females)	0.37		0.38		0	(+1.0–1.4 kg)
Rowing [22]	Summer training (males)	1.98	(0.99–2.92)	0.96	(0.41–1.49)	1.7	(0.5–3.2)
	Summer training (females)	1.39	(0.74–2.34)	0.78	(0.29–1.39)	1.2	(0–1.8)
Basketball [16]	Summer training (males)	1.37	[0.9–1.84]	0.80	[0.35–1.25]	1.0	[0–2.0]
	Summer competition (males)	1.6	[1.23–1.97]	1.08	[0.46–1.70]	0.9	[0.2–1.6]
Soccer [130]	Summer training (males)	1.46	[0.99–1.93]	0.65	(0.16–1.15)	1.59	[0.4–2.8]
Soccer [89]	Winter training (males)	1.13	(0.71–1.77)	0.28	(0.03–0.63)	1.62	[0.87–2.55]
American football [62]	Summer training (males)	2.14	[1.1–3.18]	1.42	[0.57–2.54]	1.7 kg (1.5%)	[0.1–3.5 kg]
Tennis [15]	Summer competition (males)	1.6	[0.62–2.58]	~1.1		1.3	[+0.3–2.9]
	Summer competition (females)		[0.56–1.34]	~0.9		0.7	[+0.9–2.3]
Tennis [14]	Summer competition (cramp–prone males)	2.60	[1.79–3.41]	1.6	[0.80–2.40]		
Squash [18]	Competition (males)	2.37	[1.49–3.25]	0.98		1.28 kg	[0.1–2.4 kg]
Half marathon running [21]	Winter competition (males)	1.49	[0.75–2.23]	0.15	[0.03–0.27]	2.42	[1.30–3.6]
Cross–country running [62]	Summer training (males)	1.77	[0.99–2.55]	0.57	[0–1.3]	~1.8	
Ironman triathlon [133]	Temperate competition (males & females]						
	Swim leg					1 kg	(+0.5–2.0 kg)
	Bike leg	0.81	(0.47–1.08)	0.89	(0.60–1.31)	+0.5 kg	(+3.0–1.0 kg)
	Run leg	1.02	(0.4–1.8)	0.63	(0.24–1.13)	2 kg	(+1.5–3.5 kg)
	Total race			0.71	(0.42–0.97)	3.5%	(+2.5–6.1 %)

+ = gain in BM; ^not corrected for change in BM that occurs in very prolonged events due to factors other than fluid loss (e.g. metabolic fuel losses).

Table from Sawka MN, Burke LM, Eichner ER, Maughan RJ, Montain SJ, Stachenfeld NS. Exercise and fluid replacement. American College of Sports Medicine. *Medicine & Science in Sports & Exercise 2007*; Position Stand:377-390.

Risk Factor: Dehydrated Before Practice & Accumulated Dehydration

- Football and rugby players are often inadequately hydrated pre-practice (18, 27).
- Cumulative day to day dehydration can amount to 5-8% of body weight (33). Example: 200 lb player loses 2# each day for 3 days = 1% fluid loss X 3 = 3% cumulative loss.
- It takes 48 hours to replace intracellular fluids after 2-3 days of progressive dehydration (33).
- Heat illness arises quicker and at a lower outdoor temp in dehydrated players.
- Data on high school football athletes showed as many as 70% attended practice significantly dehydrated (18).
- Other research showed that players who exercised in the heat took four hours to replace half of the body fluids lost and those who were already dehydrated took three days to attain their beginning body weight (22).

Risk Factor: Voluntary Hydration Does NOT Work

- Adolescents' fluid replacement is insensitive to heat and exercise stress conditions (12) and both inconsistent and insufficient to restore water balance if left to drinking on a voluntary basis (22-23) = thirst does not make them drink.
- Most studies show that athletes only voluntarily replace 50-66% of their actual fluid needs (11).

Solution: Replace Fluids Before and After Practice, Monitor Weight and Urine Color

- American College of Sports Medicine suggests drinking 0.4-0.8 L/h (2-4 cups/hr) of fluid during exercise to meet fluid requirement for most people (32).
- To prevent nausea, break every 15 minutes and consume ½-1 cup fluid. This will also help to "train the gut" to tolerate the liquids (46). This "forced fluid consumption to maintain body weight during practice" kept leg power performance from decreasing compared to voluntary liquid intake (18).
- For practices > 1 hour, fluid intake should be increased to 0.6-1.0 L/h based on stomach comfort (22).
- An easy, successful rehydration strategy used in high school footballers was to have each player drink a bottle (591 ml) of water or sports drink (the majority chose a sports drink) after dinner in the evening and another bottle 1.5 hours before practice the next morning (18).
- To reflect the hydration state, urine color should be checked first thing in the morning (7).
- Urine should be clear to light yellow like lemonade. If it is dark (apple juice colored) then more fluids need to be ingested. Check the urine color before taking vitamins as large doses of B vitamins will discolor urine a brilliant fluorescent yellow. If it is tan or reddish-brown, the player should seek medical care as this may indicate blood in the urine or rhabdomyolysis (severe muscle breakdown).

Risk Factor: Preexisting Condition or Illness

- Preexisting medical conditions, concurrent illness, previous history of heat illness (27), or the use of medications can increase a player's propensity to develop heat illness.
- Asthma, diabetes, sickle cell trait, migraines, and attention deficit hyperactive disorder (ADHD) can predispose the athlete to heat stress.
- 16-18% of heat stroke patients were sick on the days before the incident (29).

Risk Factor: Use of Medications

- A study of 60 US high schools showed a 16.6% use of the stimulants amphetamine, pseudoephedrine, cocaine, Ecstasy and phentermine (listed in order of greatest use) (35).
- Stimulants block the sweat response, dry the mouth, increase the heart's work, and decrease heat tolerance.
- Medications such as over the counter anticholinergics (antihistamines, antidepressants, and acid reflux drugs to name a few) have been linked to serious heat illness, and macrolide antibiotics (Zithromax, erythromycin, etc.), decongestants, methylxanthines (asthma drugs), and beta-agonists (asthma drugs) have been associated with irregular heart rhythms (45).
- Attention deficit hyperactive medications, diuretics, and urine concentrations of caffeine exceeding 15 micrograms/ml are banned at the college and international level by the NCAA. A banned drug list is available at www.ncaa.org.

Solutions: Monitor At-Risk Players, Use an Additional Medical Form

- Asthma, obesity, diabetes, sickle cell trait, insect allergies, and heart problems are rising in incidence and require special care in that heat exercise can cause earlier and more severe symptoms.
- Footballers with medical conditions or on medications should have a buddy player who knows their condition and treatment.
- Sustained sprints (> 500 meters) and timed miles should not be required of players with sickle cell trait; muscle cramping in these players should be considered and treated as sickling (42) and they should be taken to the hospital.
- Players with a previous history of heat illness are more likely to experience it again. Those who are currently sick (mono, strep throat, vomiting, diarrhea, bad head cold) should stay home or be sent home.
- Players that are overweight, unconditioned, partially dehydrated, ill, taking medications or have a medical history are at greater risk.
- Monitor players for heat stress: Football players also tend to have a "warrior" mentality so they won't stop when they are feeling ill; they "play through it."
- Have players answer a form (Player Health Record form attached) that outlines risk factors as an addendum to the required physical exam.
- The American Academy of Pediatrics has listed two definitive No's to sports participation -- inflammation of the heart (carditis) and fever (>100.4°F) and a qualified no – diarrhea, based on increased dehydration and heat illness risk.

Risk Factor: Use of Protein Supplements

- Protein ingested at the doses recommended on supplement products puts a significant solute load on the kidneys and liver because it takes almost seven times more water to metabolize body protein than fat or carbohydrate (26).
- Excessive protein intake (for 14-18 year olds >0.85 grams/kg of body weight) (36) combined with the dehydration that occurs during preseason practice, places the kidneys at risk for acute failure (35). Excessive protein intake for a 200# (91 kg) player is > 78 grams/day.
- From a performance standpoint, superfluous protein intake will replace carbohydrate intake. Carbohydrates are necessary for peak training and competition levels as they are the main fuel source during practice (26).

Solution: Use in Moderation and Increase Fluids, Eat Properly, Drink Milk

- Protein replacement after exercise is acceptable and will help with muscle rebuilding, but should not be excessive.
- Increase fluid intake if ingesting large amounts of protein supplements to help dilute the solute load.
- Nutritional goals before exercise are to be well-fueled; after exercise they are to boost glycogen recovery in the muscles and replace fluids (52).
- For a high school male athlete, a balanced diet equals 50-60% carbohydrates, 20-30% fats, and 12-15% proteins with a 3000-6000 calories/day intake (26).
- Drinking 500 ml (two 8 ounce cups) of fat-free milk immediately after exercise and one hour post-exercise resulted in greater gains in muscle fiber mass and a reduction of fat mass when compared to ingesting a "soy protein isonitrogenous, isoenergetic carbohydrate" matched beverage (53).
- Low-fat milk was also found to be better than sports drinks in **post-exercise** rehydration since it was absorbed more slowly into the bloodstream and didn't cause fluctuations in the blood's osmolality, thus it promoted a reduction in urine output (53) and quicker rehydration.
- Fat-free milk increases muscle mass, decreases fat mass, increases hydration, is full of electrolytes and protein, and is a quick and easy teen food.

Risk Factor: Ingestion of Energy Drinks

- A survey of 540 US high school football programs from 26 states found that 45.2% of players used energy drinks (38).
- Stimulant effects are due mainly to caffeine, taurine, glucuronolactone, and guarana; ingredients that are not currently regulated by the FDA and whose amounts are often not listed on the product container.
- Taurine is an amino acid (39) and a mood modulator that when combined with caffeine and guarana is responsible for increasing physical endurance to a certain extent.
- Glucuronolactone is thought to provide extra energy when combined with the other ingredients, but there is not much data available.
- Guarana is a stimulant that contains not only caffeine (3-5 grams of guarana equals about 250 mg of caffeine), but also theobromine, theophylline, and tannins which may increase the length of action of guarana (40).
- Caffeine increases blood pressure and heart rate. A cup of coffee has approximately 100 mg of caffeine; a cup of Coke has 34 mg. Energy drinks contain from 80 mg (Red Bull) to 400 mg (Fixx Extreme) caffeine per serving.
- Caffeine toxicity (500 mg) can cause fast abnormal heart rhythms, seizures, profound vomiting, and high blood pressure (37, 40).
- Caffeine is a diuretic (causes increased urine output). In small doses (< 180 mg/day) (7) and moderate doses (<300 mg/d)(15), it generally doesn't cause dehydration during exercise. However, combining it with the other stimulants and/or alcohol (a diuretic in high amounts) and ingesting them on a hot, humid day can lead to a dehydrated state with a fast heart and respiratory rate, and a concomitant drop in blood pressure.

Risk Factor: Ingestion of Alcohol

- Alcohol in large amounts is a diuretic (7), but more importantly, it can be toxic to the system and cause severe vomiting.
- CDC's 2007 Youth Risk Behavior Survey of male 9th-12th graders in Missouri: 44.4% of students were current alcohol users, 30.1% were episodic heavy drinkers, and 72.3% had tried alcohol (41).
- High school footballers who party the night before a practice or game may be moderately to severely dehydrated before workouts and are predisposed to heat illnesses and low potassium.

Solution: Limit Intake of Energy Drinks and Alcohol Before, During, & After Heat Exercise

- Limit intake of energy drinks and alcohol during football.
- Ingesting 5-7 ml/kg (two 8 ounce cups for a 200# player) four hours pre-practice, if urine is not white or white-yellow, increase liquids to 8-10 ml/kg (3 cups for a 200# player) for the remaining two hours (7).

Risk Factor: Player Heat Injury or Fatality

- High school football players are old enough to take some responsibility for their health, but will need oversight by coaches, trainers and parents.

Solution: Educate Everyone, Have Emergency Plan in Place, Coaches Rule

- Team members, coaches, trainers and parents should all be educated regarding the recognition, prevention, and treatment of heat illness symptoms; proper hydration techniques before, during and after practice; good nutritional intake at meals; and the influence of heat exercise on medical conditions.
- Implement a mandatory pre-season parent-player meeting where these issues can be presented and discussed.
- All players, coaches, and parents should be aware of players with existing medical conditions, what medications they use, where these are stored, and how to treat exacerbations.
- Each player should have a buddy.
- Emergency Plan: Specific persons should be assigned to each action plan task. Tasks include those who will contact EMS, bring the paramedics to the field, take care of the downed player, and supervise the emergency (38). For exertional heat illness, equipment (cooled liquid drinks, iced water in coolers and/or kiddie pools, wet towels, fans, shaded area or tent) should be readily accessible (on the field).
- The gold standard of caring for heat illness is to “cool first, transport second” emphasizing the importance of rapidly reducing the core temperature (54). However, heat stroke is a medical emergency and should be treated in the ER. If unable to differentiate between heat stroke and heat exhaustion or the player is not recovering quickly, take the player to the ER.
- Players listed those who had the greatest influence on hydration practices as coaches (65%), sports dieticians (30%), and physicians (25%) with the coach additionally listed as the best information source on supplement use (35).

Attachments

NOAA's National Weather Service. Table 1. Heat Index and Heat Stress Chart. Available at: http://www.crh.noaa.gov/jkl/?n=heat_index_calculator [Accessed 04-01-09]

Appendix B. National Oceanic & Atmospheric Administration (NOAA) Quality controlled local climatological data: Spirit of St. Louis Airport (August 2006, 2007, 2008, August 15 2007 & 2008). http://cdo.ncdc.noaa.gov/qclcd/QCLCD. Accessed 04-09-09 [Accessed 04-10-09]

Lickerman, S. Table 3. Fluid and Electrolyte Composition in Various Beverages. 2009.

Lickerman, S. Figure 4. Player Health Record. 2009.

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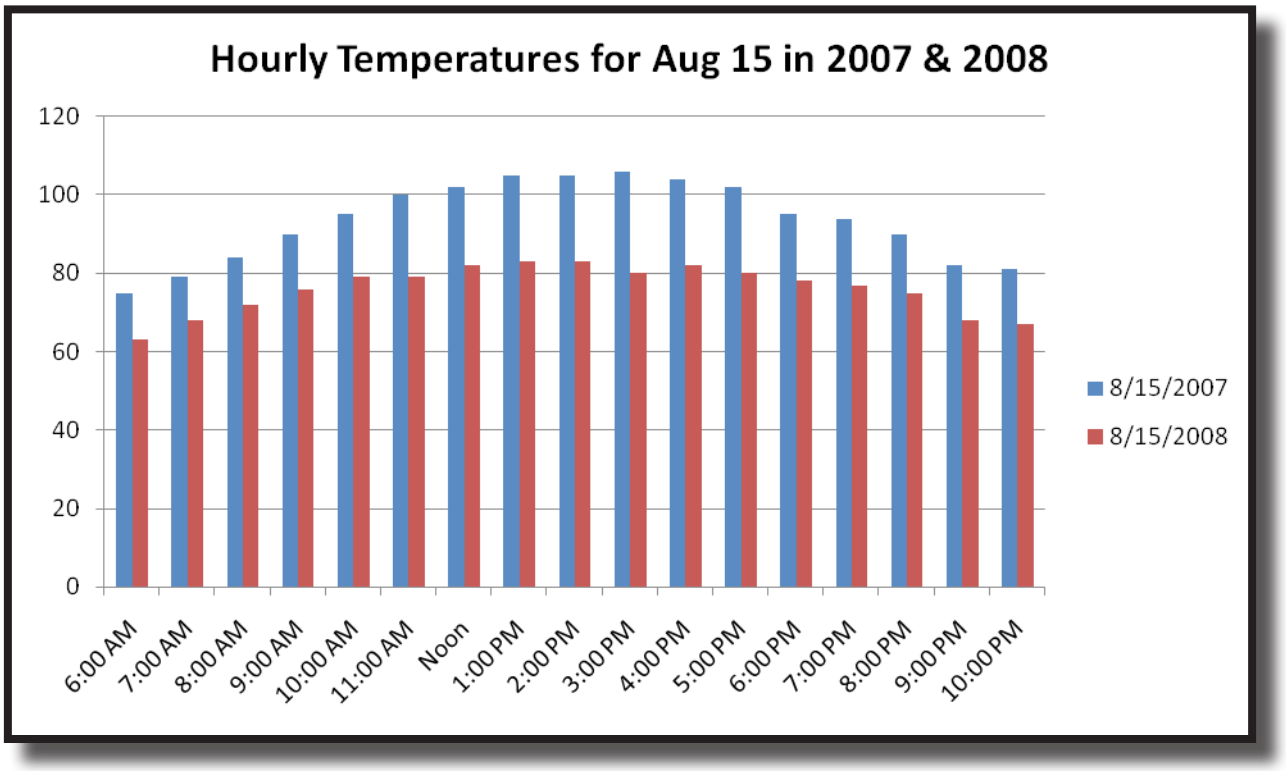
Appendix A. Heat Index and Heat Stress Chart (From NOAA's National Weather Service. Available at: http://www.crh.noaa.gov/jkl/?n=heat_index_calculator [Accessed 04-01-09])

HEAT INDEX °F (°C)													
	RELATIVE HUMIDITY (%)												
Temp.	40	45	50	55	60	65	70	75	80	85	90	95	100
110 (47)	136 (58)												
108 (43)	130 (54)	137 (58)											
106 (41)	124 (51)	130 (54)	137 (58)										
104 (40)	119 (48)	124 (51)	131 (55)	137 (58)									
102 (39)	114 (46)	119 (48)	124 (51)	130 (54)	137 (58)								
100 (38)	109 (43)	114 (46)	118 (48)	124 (51)	129 (54)	136 (58)							
98 (37)	105 (41)	109 (43)	113 (45)	117 (47)	123 (51)	128 (53)	134 (57)						
96 (36)	101 (38)	104 (40)	108 (42)	112 (44)	116 (47)	121 (49)	126 (52)	132 (56)					
94 (34)	97 (36)	100 (38)	103 (39)	106 (41)	110 (43)	114 (46)	119 (48)	124 (51)	129 (54)	135 (57)			
92 (33)	94 (34)	96 (36)	99 (37)	101 (38)	105 (41)	108 (42)	112 (44)	116 (47)	121 (49)	126 (52)	131 (55)		
90 (32)	91 (33)	93 (34)	95 (35)	97 (36)	100 (38)	103 (39)	106 (41)	109 (43)	113 (45)	117 (47)	122 (50)	127 (53)	132 (56)
88 (31)	88 (31)	89 (32)	91 (33)	93 (34)	95 (35)	98 (37)	100 (38)	103 (39)	106 (41)	110 (43)	113 (45)	117 (47)	121 (49)
86 (30)	85 (29)	87 (31)	88 (31)	89 (32)	91 (33)	93 (34)	95 (35)	97 (36)	100 (38)	102 (39)	105 (41)	108 (42)	112 (44)
84 (29)	83 (28)	84 (29)	85 (29)	86 (30)	88 (31)	89 (32)	90 (32)	92 (33)	94 (34)	96 (36)	98 (37)	100 (38)	103 (39)
82 (28)	81 (27)	82 (28)	83 (28)	84 (29)	84 (29)	85 (29)	86 (30)	88 (31)	89 (32)	90 (32)	91 (33)	93 (34)	95 (35)
80 (27)	80 (27)	80 (27)	81 (27)	81 (27)	82 (28)	82 (28)	83 (28)	84 (29)	84 (29)	85 (29)	86 (30)	86 (30)	87 (31)

Category	Heat Index	Possible heat disorders for people in high risk groups
Extreme Danger	130°F or higher (54°C or higher)	Heat stroke or sunstroke likely.
Danger	105 - 129°F (41 - 54°C)	Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity.
Extreme Caution	90 - 105°F (32 - 41°C)	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Caution	80 - 90°F (27 - 32°C)	Fatigue possible with prolonged exposure and/or physical activity.

Appendix B.

Graphs created from data from the National Oceanic & Atmospheric Administration (NOAA) Quality controlled local climatological data: Spirit of St. Louis Airport (August 2006, 2007, 2008, August 15 2007 & 2008). http://cdo.ncdc.noaa.gov/qclcd/QCLCD. Accessed 04-09-09 [Accessed 04-10-09]



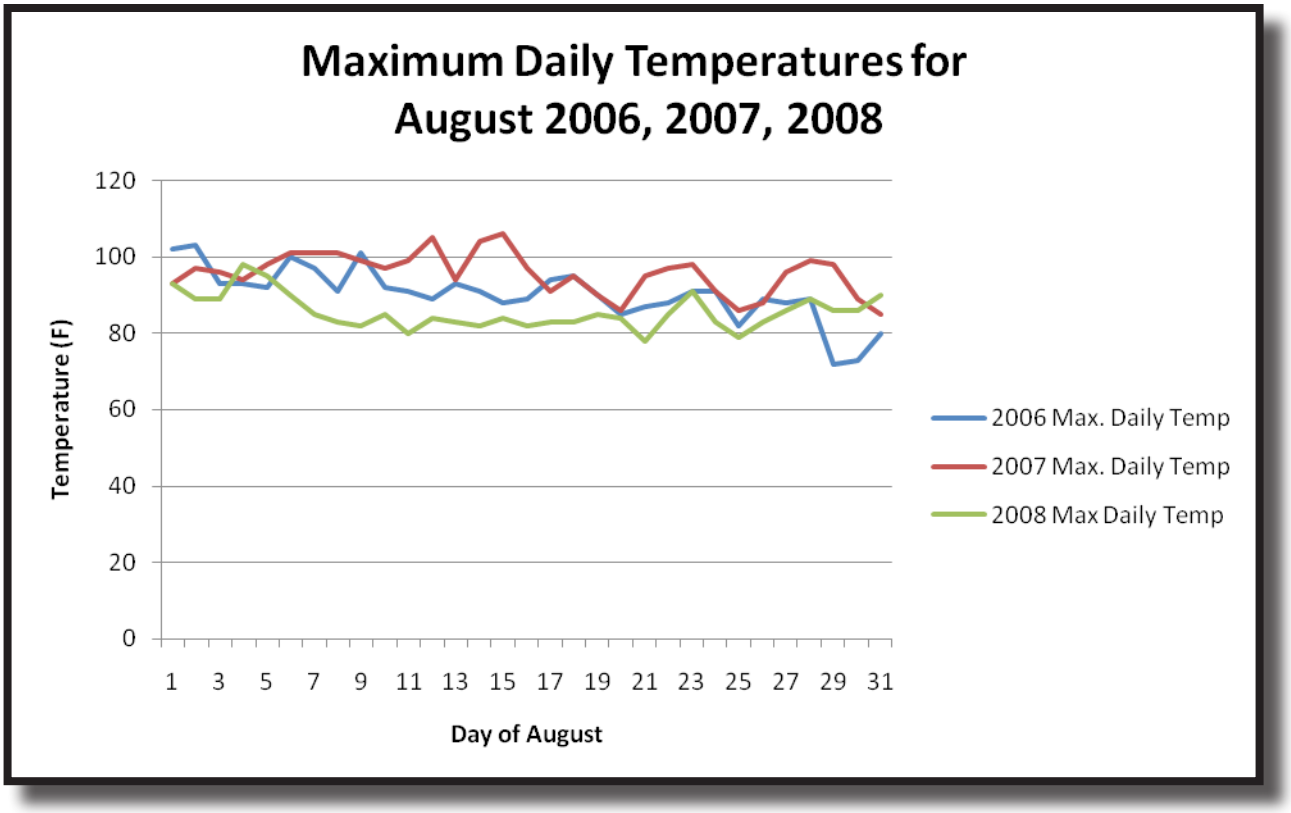


Table 3. Fluid and Electrolyte Composition in Various Beverages

Name of drink[1]	Cal	Fat[2]	Na(mg)	K(mg)	K(mEq)	CHO[3]	CHO%	Pro[2]	Vit A[4]	B3	B5	B6	B12	Vit C	Vit D	Vit E	Ca	Folate	Fe	Mg+	Zinc
Apple juice 100% (Simply Apple)	120	0	5	250	6.4	30/28	12.5	0												2%	
Diet Coke	0	0	22.5	0	0	0	0	0													
Diet Pepsi	0	0	26	0	0	0	0	0													
Gatorade	25	0	110	30	0.8	7/7	2.9	0													
Gatorade A.M.	50	0	110	30	0.8	14/14	5.8	0						20%							
Gatorade (dry mix)	50	0	90	25	0.6	13/13	5.4	0													
Gatorade Endurance	50	0	200	90	2.3	14/14	5.8	0									<2%			<2%	
Gatorade Fierce	50	0	110	30	0.8	14/14	5.8	0		20%	20%	20%									
Gatorade G2	25	0	110	30	0.8	7/7	2.9	0		25%	25%	25%		10%		10%					
Gatorade Rain	50	0	110	30	0.8	14/14	5.8	0													
Gatorade Tiger	50	0	135	40	1	14/14	5.8	0													
Gatorade Tiger Focus	25	0	135	40	1	7/7	2.9	0								10%					
Gatorade X Factor	50	0	110	30	0.8	14/14	5.8	0								20%					
Life Water (Sobe)	40	0	20	0	0	16/10	6.7	0		10%	10%	10%	10%	100%		20%					
Milk Fat-free (Prairie Farms)	80	0	120	382	9.8	11/11	4.6	8	10%					2%	25%		30%				
Milk 2% (Nature's Pride)	130	5	130	366	9.4	12/12	5	8	10%					4%	25%		30%				
Orange juice 100% (Orchid Is.)	110	0	0	500	12.8	25/21	10.4	2		4%		4%	15%	140%				20%	2%		
Pedialyte (flavored)	24		212	183	4.7	6	2.5	0													
Powerade	56	0	112.5	28.5	0.7	15/15	6.3	0		11%		11%	11%								
Powerade Adv. Electrolye Ion4	50	0	100	25	0.6	14/14	5.8	0		10%		10%	10%								
Powerade Zero	0	0	55	35	0.9	0	0	0		10%		10%	10%								
Propel (made by Gatorade)	10	0	70	0	0	2/2	0.8	0		25%	25%	25%		10%		10%					
Propel Fit Water	10	0	5	0	0	2/2	0.8	0		25%	25%	25%	4%				10%				
Propel Fit (dry mix)	10	0	30	0	0	3/3	1.3	0		25%	25%	25%	25%	10%							
Root Beer (Mug)	120	0	49	0	0	43/43	18	0													
Red Bull (8.3 oz)[5]	110	0	200	0	0	28/28	11.7	<1		100%	50%	250%	80%								
Smart Water (Glaceau)	0	0	2.5	2.5	0.06	0	0	0												4%	
Snapple Antioxidant Water	50	0	0	0	0	13/13	5.4	0	10%	20%	20%	20%	20%			10%	2%			2%	2%
Vitamin Water (Glaceau)[6]	50	0	0	0	0	13/13	5.4	0													

1. All values are based on a measurement of eight (8) fluid ounces and taken from label on bottle or can.
2. Fat and protein are measured in grams.
3. Carbohydrates with two values are the total carbohydrates in grams over the sugars in grams.
4. Percent daily values (DV) of all vitamins and minerals are based on a 2000 calorie diet.
5. Contains taurine, glucuronolactone, and caffeine but no amounts listed.
6. Glaceau Vitamin Water has varied amounts of added vitamins and stimulants depending upon flavor. Included only basic caloric and electrolye content that is the same for all flavors.

Optimal drink during exercise

Optimal drink after exercise

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Figure 4.

Player Health Record

Name/Age:_____

Circle any of the below that you have experienced in the past or have now:
ADHD or ADD
Allergies (hay fever/food/mold-dust/other)
Asthma
Bee or insect sting reaction
Cold, flu, stomach virus
Diabetes
Fainting
Headaches
Heart condition
Heat illness
Kidney condition
Mono or Strept throat
Muscle cramps
Seizures
Sickle cell trait/disease
Other:_____

Circle any you take:
ADHD/ADD medications
Antibiotics
Antihistamines
Caffeine, Guarana, Taurine
Decongestants/ Neosynephrine
Diabetic medications
Diuretics
Ephedrine, phenylephrine, pseudoephedrine
Epinephrine pen for insect sting
Heart medicine
Inhalers for asthma or allergies
Oral medication for asthma or allergies
Protein supplements/Creatine
Tobacco (inhaled or chewed)
Other:_____

Do you exercise outside of school sports?
Yes
No

When you exercise, what do you do the most:
Weight lifting
Running indoors
Running outdoors
Using resistance machines
Don't exercise outside of school sports

When you exercise, is it mostly done:
Indoors
Outdoors
Don't exercise outside of school sports

Is this exercise done:
All year long
Seasonally

In the summer heat, during a 1 week period, how often are you outside either working or exercising that causes you to sweat?
½ hour
1-2 hours
3-5 hours
6 or more hours

During football camp or preseason practice, how often do you drink fluids:
About every 15 min
About every 30 min
About every hour
Don't drink until done

During camp or practice, how much do you drink each time you drink:
2-3 swallows
About a ½ cup
About a cup

During camp or practice, what do you drink:
Energy drink
Sports drink (Gatorade, Powerade, etc)
Water from the Waterboy on field
Water that I bring in a bottle
Vitamin water
Don't drink until done

What do you mostly eat for breakfast before camp/ practice (circle all that apply):
Cereal and milk
Coffee drink
Eggs, toast
Energy drink or bar
Protein shake or bar
Don't have time to eat
Don't eat because I don't want to feel sick

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