Reducing Sports Heat Illness Risk
Michael F. Bergeron
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Reducing Sports Heat Illness Risk

Michael F. Bergeron, PhD

Educational Gaps

1. Exertional heatstroke is the leading cause of preventable death in youth sports. The American Academy of Pediatrics in 2011 issued guidelines designed to reduce exertional heat illness. With adequate hydration, youth athletes do not have less effective thermoregulatory and insufficient cardiovascular capacities compared with adults during exercise in the heat. However, youth athletes are capable of incurring significant body water and sodium deficits during training and competition that can affect performance negatively and increase the risk for exertional heat illness.

2. Exertional heat illness risk-reduction strategies and measures for youth should focus on readily modifiable contributing risk factors, such as acclimatization status, activity modification, uniform and protective equipment configurations, and scheduling of practice, training, and play. Close monitoring of youth athletes and a prompt response to signs of evolving exertional heat illness are critical priorities for all who are involved with youth participating in sports in the heat.

Objectives

After reading this article, readers should

1. Appreciate that exertional heatstroke is the leading cause of preventable death in youth sports.

2. Know the importance of progressive acclimatization to minimize the risk of exertional heat illness in youth sports.

3. Be able to identify other contributing risk factors and effective ways to improve exercise–heat tolerance and reduce exertional heat illness risk in youth sports.

4. Be prepared to educate others on their roles and responsibilities in improving safety and well-being of youth participating in outdoor sports in the heat.

Introduction

Regular appropriate exercise and other physical activity can provide numerous psychological and social advantages, as well as improvements in overall health and fitness for school-age youth. Participation in youth sports and associated training and practice also can be an effective way for youth to engage in physical activity that will help them to achieve and maintain beneficial gains in body composition, musculoskeletal and cardiovascular health, and overall fitness. (2,3) The benefits of regular physical activity and sports participation as a student athlete can extend even to enhanced academic achievement. (4,5,6)

Training or conditioning for or playing sports effectively and safely in the heat, however, can be particularly challenging, especially during “2-a-days” or organized tournament competition, when young athletes have to train or compete in demanding environmental conditions multiple times on the same day. (7) Until recently, there had been very few sport- or physical activity–specific studies on hydration and thermoregulatory challenges and responses in natural outdoor settings with active youth; accordingly, most hot weather recommendations and guidelines for effectively managing
hydration, reducing thermal strain, optimizing performance, and minimizing exertional heat illness risk are not amply evidence based or sport specific. (8)

Recent research, however, has provided new insights into the physiologic responses and tolerance of young athletes during exercise and sports in the heat, as well as the risk for significant accumulated body water deficits and thermal strain that can affect perception of effort, performance, and safety. In particular, there has been a long-standing perspective that children are less effective than adults in regulating body temperature during exercise in the heat and consequently are less tolerant of and capable of performing well in a hot environment. Accordingly, the concern has been that youth are at greater risk for incurring exertional heat illness compared with adults. However, more current research does not support this viewpoint, indicating that children (9 to 12 years old) do not have insufficient cardiovascular capacity, less effective thermoregulation, or lower exercise-heat tolerance when hydration is maintained sufficiently. (9,10,11,12)

Thus, appropriate and effective safety and performance guidelines for youth athletes training and competing in the heat should focus on readily modifiable risk factors, such as intensity and duration of activity, hydration management, and scheduling of play versus any purported inherent thermoregulatory disadvantages. The information presented here addressing this perspective can help pediatricians and other healthcare clinicians, parents, coaches, and youth sports governing bodies to improve the health and safety of youth athletes during practice, training, and competition in the heat so that they can continue to participate, have fun, and enjoy the health-enhancing benefits of sports.

Responses and Challenges During Sports in the Heat

Hydration

As environmental heat stress (air temperature, humidity, and solar radiation) and intensity and duration of practice, training, or play increase, the need for evaporative cooling and sweating increases proportionately, and the risk for incurring a measurable body water deficit is augmented. Myriad adolescent athletes are capable of sweating rates in excess of 1.0 L/h during practice, training, and tournament competition in the heat. (13) In older adolescents, sweating rates often can reach 2.5 L/h or more with strenuous physical activity in hot and humid weather. (14) Reports on sweat losses in younger athletes during sports practice, training, or competition are limited; however, sweat loss rates in 9- to 12-year-old boys and girls have been reported to be 300 to 700 mL/h during nonsport exercise in the heat. (9,10,12,15,16)

Considering these sweat rates, it is easy to appreciate how a young athlete can readily incur a significant total body water deficit during practice, training, and competition, especially when participating in multiple sessions on the same day over several days in a row. Even when a young athlete voluntarily drinks regularly in response to thirst during activity, a postexercise body water deficit often is significant following a long practice, training session, or contest. This deficit can potentially have a measurable effect on subsequent cardiovascular and thermal strain, as well as exercise-heat tolerance, performance, and safety, to the detriment of the athlete.

Accordingly, effective strategies to encourage sufficient fluid intake and optimize hydration status can play an important role in maintaining performance and reducing the risk of exertional heat illness. Generally, 100 to 250 mL (~3-8 oz) every 20 minutes for 9- to 12-year-olds and up to 1.0 to 1.5 L (~34-50 oz) per hour for adolescent boys and girls is enough to minimize sweating-induced body water deficits sufficiently during exercise and other physical activity, as long as preactivity hydration status is good.

Notably, the effects of poor or casual hydration habits of young athletes developed during practice often are magnified by the more extensive sweat losses and repeated recovery demands of competitive tournament play. Therefore, it may be helpful for young players (and their parents and coaches) to emphasize beginning all practice sessions in a well-hydrated state, consuming fluids regularly (eg, every 10 to 15 minutes), and deliberately beginning rehydration promptly after practice to recover any remaining body water deficit. The goal would be to promote better hydration behavior that, it is hoped, would carry over to and minimize body water deficits during competition.

Minimizing voluntary dehydration in young boys has been more effective during exercise in the heat when a more preferred (compared with flavored or unflavored water) carbohydrate-electrolyte drink was available. (17,18) However, more recently, unflavored water has been shown to be equally effective as a carbohydrate-electrolyte sports drink in maintaining body weight in physically active young girls during intermittent exercise in the heat. (19) These conflicting findings may be related to sex, fitness, or athletic experience.
In high-level, fit junior tennis players, Bergeron et al (13) observed only a small difference in ad libitum fluid consumption between water and a commercial sport drink during intense on-court training in the heat. This behavior may reflect a more disciplined fluid consumption behavior characteristic of experienced competitive tennis players and other well-informed skilled competitors. That is, elite young athletes are encouraged regularly to rehydrate sufficiently and may be more likely to maintain a consistent fluid intake rate during training and competition regardless of beverage flavoring and appeal. In contrast, in nonathletic children, the flavoring of a sports drink may prompt more measurable differences in fluid intake volume.

Optimal rehydration, during and after extensive physical activity, often involves more than simply ample fluid intake. With growth and maturation, a young athlete’s sweat rate increases through the adolescent years. Concomitantly, sweat electrolyte losses (particularly of sodium and chloride) during sports practice, training, and play generally increase as well, due to a larger volume of sweat and a greater sweat sodium concentration. Acclimatization to the heat typically lowers one’s sweat sodium concentration; however, sweat sodium losses still can be substantial, even for a young athlete who is well acclimatized to the heat.

With pre- or early pubescent athletes, the potential sweat-induced sodium deficit incurred during a single practice or training session or game/match is not likely to have a significant physiologic or performance impact. A normal diet typically will be sufficient to maintain daily electrolyte balance, even if only water is consumed while on-court or on the field. This situation often is not the case with older adolescents, who generally sweat considerably more and can lose 2000 to nearly 5000 mg/h of sodium via sweating. (14,20)

Therefore, to offset these greater electrolyte losses and to better retain and distribute the large volume of ingested water to all body fluid compartments, (21,22,23,24) a more deliberate effort to match sodium intake during and between each session or event with individual sweat sodium losses is imperative; otherwise, insufficient sodium intake will hinder complete rehydration, may affect physiologic function and performance, and can increase the risk of incurring exertional heat cramps. (25)

**Thermoregulatory Responses and Contributing Factors**

Although recent research with 9- to 12-year-olds indicates that youth are at no greater risk for incurring exertional heat illness compared with adults, cardiovascular and thermoregulatory capacity and exercise-heat tolerance certainly can be strained during youth sports in the heat. Even with adequate hydration, a child’s metabolic heat production, heat storage, and thus body core temperature will progressively and rapidly increase during long-term and high-intensity physical activity, respectively, in the heat.

Repeated complex, intermittent exercise patterns with varying workload and recovery periods (characteristic of many competitive youth sports) has been shown to induce greater physiologic strain and yield higher heat storage and body core temperature compared with continuous exercise, (26) suggesting a particularly great clinical risk during certain sports (eg, soccer, singles tennis, or football conditioning drills) when there is a long period of recurring high-intensity activity in the heat.

Fortunately, to date there have been very few reported exertional heat stroke deaths in most youth sports held outdoors, with the stark exception of American football, in which 40 high school football players have died from exertional heatstroke (EHS) between 1995 and 2010. (27) At the same time, extensive thermal strain is observed routinely in young athletes in a variety of sports during hot-weather training and competition. Accordingly, the Centers for Disease Control and Prevention examination of the incidence and characteristics of exertional heat illness among high school athletes and those treated in emergency departments more closely underscores the true extent of this problem, as well as the predominant frequency and severity associated with football. (28,29) Unfortunately, however, the prevalence and extent of significant body core temperature responses that do not result in emergency department treatments and specific sport-, activity-, and environment-related exertional heat illness risks are largely unknown in youth sports.

Much of the limited thermal strain assessment in youth sports has been conducted in tennis. Bergeron et al (13) indicated that a carbohydrate-electrolyte drink may have been more effective than water in maintaining hydration status and minimizing thermal strain in highly skilled, fit junior tennis players during intense on-court training in a very warm environment. Although a number of players began the monitored training sessions not well hydrated, as indicated by prepractice urine specific gravity, these young athletes generally incurred a sweat-induced body weight deficit of only less than 1% of initial body weight.

This effect may have been facilitated by the regular (ie, every 10 minutes) 3-minute breaks implemented
matches with an apparent greater body water deficit. Some players who began the match not well hydrated were penalized (affected) as severely for insufficient fluid intake, even though body core temperature responses approached or reached 39°C for some players during the 2-hour practice sessions. This behavior does not, however, reinforce good hydration habits for sanctioned hot-weather tournament events, in which there is a smaller margin of error and in which a significant total body water deficit is more likely to be reflected in greater thermal strain and lower on-court performance.

Bergeron et al (30) also studied 8 elite-level, early-adolescent boys during the first round of singles and doubles play in a national championships event during the first week in August in San Antonio, Texas. These monitored singles matches were contested mostly in the morning, so environmental conditions were not particularly challenging. Of note, preplay hydration status (indicated by urine specific gravity) was associated with on-court thermal strain, and this relationship was stronger as the matches advanced. That is, those players who began the match not well hydrated were more likely to incur a high body core temperature as play continued because the measured on-court core temperature responses exceeded 39°C for some players.

Because this was a national tournament, players maintained a strong effort; thus, it was not surprising to see greater thermal strain in those players starting off their matches with an apparent greater body water deficit. In fact, the players been monitored during longer, more intense, 3-set matches played in the afternoon during later rounds of the tournament, the author speculated that on-court thermal strain would have been consistently even higher than observed during the less challenging opening matches of the first round of play because of greater heat stress, intensity and duration of play, and potential body water deficits incurred. This study also highlighted how even doubles play in junior tournament-level tennis can elicit appreciable metabolic heat production and storage.

Fairly high levels of thermal strain also have been demonstrated during high school preseason football practice sessions, even when environmental conditions were not very stressful, when the coaches progressively phased in the wearing of protective equipment and of the full uniform, and when only one practice session was held per day. (31) This observation underscores the critical importance of providing an appropriate acclimatization period at the beginning of preseason practice outdoors in the heat, especially in youth football.

**REPEATED-BOUT EFFECTS AND SCHEDULING CHALLENGES.** One of the biggest challenges for a youth athlete in the maintenance of hydration (sufficient water and electrolyte balance and distribution to all fluid compartments), minimizing of thermal strain, and achievement of optimal performance is hot-weather tournament play, when multiple matches/games are scheduled on the same day with inappropriately short rest and recovery periods between contests. (7) This packed schedule is a common scenario in youth sports tournaments, especially at the state- and regional-level events. Not all tournament administrators and youth sports governing bodies’ guidelines for minimum rest periods between multiple matches/games scheduled on the same day provide sufficiently for adequate rest and recovery and for the safety of the young athlete.

The specific impact of previous competition-related physical activity and heat exposure on subsequent same-day physiologic strain and on performance has not been examined well in youth. However, the potential for physiologic “carryover” effects from previous same-day strenuous physical activity has been demonstrated by Bergeron et al. (15) In this research, healthy young athletes (not tennis) were examined during two 80-minute intermittent exercise sessions in the heat with a 1-hour rest and recovery period in a cool environment between bouts. Even with ample hydration and body core temperature returning to baseline before starting the second bout of exercise, a 1-hour rest and cool-down period was not sufficient to avert greater perception of effort and, for some children, greater cardiovascular and thermal strain during the second session of identical exercise. In fact, such “ideal” conditions are not typical of hot-weather youth sports tournament scenarios because players often do not have the opportunity to rest immediately and recover adequately in a cool location. Accordingly, it is less likely that, when given only 1 hour or so between matches/games, a young athlete will begin the next round fully recovered. This outcome is
especially true following a very long, intense contest involving a heavily sweating older adolescent, who might be facing a substantial body water and sodium deficit at the end of play.

**MEDICAL CONDITIONS.** A number of notable chronic clinical conditions and medications can contribute to decreased exercise-heat tolerance and increased exertional heat illness risk. These disorders include diabetes insipidus, (32) type 2 diabetes mellitus, (33) obesity, (34,35,36) juvenile hyperthyroidism (Graves disease), (37) and cystic fibrosis. (38) Similar effects can result from the use of anticholinergic drugs and certain other medications that inherently affect hydration or thermoregulation (eg, a dopamine reuptake inhibitor used to treat attention-deficit/hyperactivity disorder or enhance performance (39) and diuretics). Other chronic or acute medical conditions (40) that adversely affect water-electrolyte balance, thermoregulation, and exercise-heat tolerance must call for particular concern and monitoring as well. Notably, a history of concussion may increase the risk of exertional heat illness, secondary to autonomic nervous system dysfunction. (41,42) Sickle cell trait also should be considered a possible contributing clinical risk or complicating factor for vascular dysfunction, exertional rhabdomyolysis, and collapse related to red blood cell sickling in youth athletes during strenuous physical activity in the heat. (43,44,45)

Current or recent illness increases the risk associated with participating in physical activity in the heat because of the potential negative residual effects on hydration status and regulation of body temperature. The risk is especially significant for illnesses involving gastrointestinal distress (eg, vomiting, and diarrhea) or fever. A prior episode of EHS, however, generally does not have long-term negative effects on subsequent thermoregulation, exercise-heat tolerance, or exertional heat illness risk, especially for those who received prompt cooling therapy. (46)

**American Academy of Pediatrics Policy Statement**

Exertional heatstroke is the leading cause of preventable death in youth sports. The American Academy of Pediatrics (AAP) maintains that, with sufficient preparation, appropriate modification of known contributing risk factors (Table), and close monitoring, exertional heat illness usually is preventable. Accordingly, most healthy children and adolescents can participate safely in outdoor sports, even when it is hot. (8) This latest AAP policy statement, as with other recent guidelines designed to reduce exertional heat illness risk in high school sports, (47,48) puts a strong emphasis on acclimatization, that is, allowing youth athletes to get used to the environment progressively, increasing the intensity and duration of practice and conditioning incrementally, and altering uniform and protective equipment configurations progressively.

There are other essential elements of preseason conditioning and practice periods and other offsetting measures to reduce exertional heat illness risk that become more urgent as conditions and circumstances warrant. These essential elements, along with appropriate acclimatization, are the foundation of the AAP recommendations selected below to improve safety for youth athletes in the heat.

**AAP Recommendations**

- Education and training about exertional heat illness risks and effective prevention and risk-reduction strategies should be provided regularly and emphasized to children and adolescents, coaches, and staff, as well as others overseeing or assisting with youth athletes participating in outdoor sports.
- Effective protocols should be in place and trained personnel and readily accessible facilities should be available for treating all forms of exertional heat illness for

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**Table. Fundamental Factors Contributing to Exertional Heat Illness Risk During Youth Athletic Activities in the Heat**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
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<tbody>
<tr>
<td>Hot or humid climate</td>
<td>Insufficient acclimatization to exercising in the heat and humidity</td>
</tr>
<tr>
<td>Insufficient acclimatization to the intensity or duration of activity</td>
<td>Insufficient acclimatization to the intensity or duration of activity or the</td>
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<tr>
<td>or the uniform and protective equipment</td>
<td>uniform and protective equipment configuration that promotes excessive</td>
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<tr>
<td>Excessive physical exertion: intensity, duration, or both</td>
<td>heat retention</td>
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<tr>
<td>Inappropriate clothing or uniform or protective equipment</td>
<td>Poor hydration status</td>
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<tr>
<td>Insufficient rest and recovery time</td>
<td>Insufficient cardiorespiratory fitness</td>
</tr>
<tr>
<td>Inadequate sleep or rest</td>
<td>Inadequate rest and recovery time</td>
</tr>
<tr>
<td>Current or recent illness and other clinical conditions (or medications)</td>
<td>Current or recent illness and other clinical conditions (or medications)</td>
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<tr>
<td>that affect hydration status and thermoregulation</td>
<td>that affect hydration status and thermoregulation</td>
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Youth athletic activities that involve moderate to vigorous exercise or training in the heat.

- Youth athletes should be well prepared before participating in any outdoor athletic activity in the heat. This preparation includes conveying their responsibility to be well hydrated and well nourished, sufficiently fit and rested, and honest about promptly reporting any symptoms or signs of developing exertional heat illness for themselves or their teammates.
- Progressive acclimatization—that is, graduated appropriate exposure to a hot or humid environment, to the uniform and protective equipment, and to the intensity and duration of practice or training and competition—is essential to minimize the risk of exertional heat illness in the preseason or when traveling to a more stressful (greater heat or humidity) environment.
- Water and other appropriate fluids should be readily accessible and youth athletes should be given regular opportunities to consume these fluids throughout athletic activities to offset sweat losses and maintain adequate hydration status.
- Outdoor athletic activities should be modified appropriately for safety in relation to the environmental conditions and the athlete’s health and fitness status. Effective modifications include lowering intensity or duration of activities, increasing frequency and duration of breaks to rehydrate and cool down, minimizing uniforms and protective gear, or canceling an activity altogether or rescheduling it to a cooler time of day.
- All youth athletes should be monitored closely in the heat, and a prompt and appropriate response, including immediately stopping participation and seeking appropriate medical attention, should be implemented at the earliest signs of exertional heat illness.
- A written emergency action plan for managing severe exertional heat illness and other medical emergencies should be in place and practiced ahead of time for all youth athletic activities in the heat.
- Coaches and tournament or event administrators should provide sufficient rest and recovery time between multiple same-day training sessions and contests in the heat.

**Diagnosis and Management**

Exertional heat illness in youth sports includes a spectrum of clinical conditions that range from muscle (heat) cramps and heat exhaustion to life-threatening heat stroke that result from moderate to vigorous repeated or long-term physical activity typically in hot or humid conditions. As emphasized throughout this review, EHS and other heat-related illnesses in youth sports are preventable in almost all cases if the contributing risk factors are considered and addressed sufficiently with the appropriate recommended offsetting measures. Early recognition and prompt, effective treatment of exertional heat illnesses also can readily and successfully reduce the incidence of severe heat illness and heat-related catastrophic events in youth sports.

**Exertional heat cramps** occur during or after physical exertion and generally are concomitant with extensive sweat losses, which is characteristic of repeated or long-term exercise in the heat. However, a hot environment is not a prerequisite, and young athletes (usually adolescent) experiencing exertional heat cramps are not necessarily overheated. Affected athletes often report feeling and observing subtle fasciculations (muscle “twitches”) or slight cramping at first that develops progressively to more severe and widespread (often bilateral) intermittent and eventually debilitating muscle spasms. Profuse sweating and a salt residue on the skin or clothing (although not always visible) and other signs and symptoms of dehydration further implicate the presence of a significant water or sodium deficit.

In contrast, comparatively sudden-onset, exertion-related muscle cramping that is localized (eg, affecting solely the calf), constant, asymmetric, and responsive to passive stretching and massage is highly likely to have been prompted by muscle overload and fatigue. The athlete afflicted with exertional heat cramps must be treated promptly with an oral high-salt solution or intravenously. Massage and icing can be applied to assist in relaxing the muscles and relieving some of the spasms.

**Heat exhaustion** is a moderate-severity heat illness that is characterized by hypotension and cardiovascular insufficiency. The disorder results typically from the combination of strenuous physical activity, environmental heat stress, acute dehydration, energy depletion, and central fatigue and often is accompanied by associated collapse. Notable signs and symptoms include weakness, dizziness, nausea, syncope, headache, and an elevated body core temperature that is less than 104°F (40°C). The athlete should be moved promptly to an air-conditioned or shaded area, have excess clothing removed, and be placed in the supine position with legs elevated. Oral fluids can be administered if the
athlete is conscious and able to swallow. Other conservative cooling therapy measures can improve medical and perceptual status as well.

Heart rate, respiratory rate, and central nervous system (CNS) status should be monitored closely. If possible, blood pressure and rectal temperature also should be monitored. If an elevated body core temperature is suspected and signs of CNS dysfunction are present, EHS cooling therapy should be initiated immediately (see below) and emergency medical services (EMS) activated.

**Exertional heatstroke** is a severe heat illness and medical emergency affecting multiple body systems that is characterized by CNS abnormalities, such as delirium, convulsions or coma, endotoxemia, circulatory failure, thermoregulatory dysregulation, and, potentially, multiple organ and tissue dysfunction and damage (brain, heart, liver, kidneys, spleen, and muscle). This disorder results from an excessively elevated body core temperature induced by strenuous exercise and, typically, high environmental heat stress.

A rectal temperature greater than 104°F (>40°C) should prompt immediate on-site whole-body rapid cooling using proven techniques (cold- or ice-water immersion is the preferred, most effective method, although applying ice packs to the neck, axillae, and groin and rotating ice-water-soaked towels to all other areas of the body can be effective as well). This process should be continued until the rectal temperature reaches just under 39°C (~102°F) or the athlete exhibits noticeable clinical improvement.

If rectal temperature cannot be assessed in a youth athlete who has clinical signs or symptoms suggestive of EHS, rapid cooling for 10 to 15 minutes should be initiated promptly while awaiting the arrival of additional medical assistance. It is important to initiate EMS communication immediately for any child or adolescent who collapses or exhibits moderate or severe CNS dysfunction or encephalopathy.

When children and adolescents are involved in sports practice or competition, any significant deterioration in performance with notable signs of struggling and developing exertional heat illness should be sufficient reason to stop participation immediately and promptly seek medical attention. Moreover, any young athlete experiencing exertional heat illness should not return to practice or competition for the remainder of the current practice or training session, game, or match.

### Summary

- With adequate hydration, youth athletes do not have less effective thermoregulatory and insufficient cardiovascular capacities compared with adults during exercise in the heat.
- However, youth athletes are capable of incurring significant body water and sodium deficits during training and competition that can affect performance negatively and increase the risk of exertional heat illness.
- Although adequate hydration is integral to the safety of youth athletes who are training and competing in the heat, myriad other contributing factors can put children and adolescents at great risk during athletic activities, even if they are well hydrated.
- With evolving evidence, it is increasingly clear that the emphasis of exertional heat illness risk-reduction strategies and measures for youth should focus on readily modifiable contributing risk factors, such as acclimatization status, activity modification, uniform and protective equipment configurations, and scheduling of practice, training, and play. Close monitoring of youth athletes and a prompt response to signs of evolving exertional heat illness are critical priorities for all who oversee and assist with youth participating in sports in the heat.
- More research needs to be done to appreciate better the dehydration and thermal strain challenges facing youth athletes so that more specific evidence-based guidelines for enhancing safety and performance can be established.

### References


**PIR Quiz**

This quiz is available online at http://www.pedsinreview.aappublications.org. Note: Learners can take *Pediatrics in Review* quizzes and claim credit online only. No paper answer form will be printed in the journal.

**New Minimum Performance Level Requirements**

Per the 2010 revision of the American Medical Association (AMA) Physician’s Recognition Award (PRA) and credit system, a minimum performance level must be established on enduring material and journal-based CME activities that are certified for AMA PRA Category 1 Credit™. In order to successfully complete 2013 *Pediatrics in Review* articles for AMA PRA Category 1 Credit™, learners must demonstrate a minimum performance level of 60% or higher on this assessment, which measures achievement of the educational purpose and/or objectives of this activity.

In *Pediatrics in Review*, AMA PRA Category 1 Credit™ may be claimed only if 60% or more of the questions are answered correctly. If you score less than 60% on the assessment, you will be given additional opportunities to answer questions until an overall 60% or greater score is achieved.

1. You live in the Southwest and are the physician for your local high school boys varsity football team. Practice will begin the first week in August. The coach asks your advice about structuring hydration breaks into practice sessions. You recommend that players drink a minimum of:
   A. 8 oz/hr.
   B. 16 oz/hr.
   C. 24 oz/hr.
   D. 32 oz/hr.
   E. 40 oz/hr.

2. The coach had been planning to have both plain water and flavored water available. You recommended that a sports drink also be available because a player’s sodium loss could be:
   A. 250 mg/hr.
   B. 500 mg/hr.
   C. 1000 mg/hr.
   D. 1500 mg/hr.
   E. 2000 mg/hr.

3. The coach also asks your advice on how often to schedule practices during the first week of training. Which of the following is an appropriate recommendation?
   A. Decrease duration and intensity of practice schedule.
   B. Limit practice to 30 minutes.
   C. Schedule practice during early afternoon.
   D. Schedule a single 15-minute break during practice.
   E. No change in practice schedule is necessary.

4. During practice, one of the players complains of increasingly severe muscle twitching and cramping in his calves; it is beginning to spread to his thighs. Among the following, the most important first step is to:
   A. Apply ice packs to the affected muscles.
   B. Apply ice packs to the axillae, groin, and neck.
   C. Massage the affected muscles.
   D. Provide high-salt rehydration.
   E. Stretch the affected muscles.
5. You remind the coach that although exertional heat cramps and heat exhaustion can often be managed on site, exertional heat stroke is a medical emergency and a plan to activate emergency services must be in place. A defining characteristic of heat stroke is a rectal temperature greater than:

A. 39º C.
B. 39.5º C.
C. 40º C.
D. 40.5º C.
E. 41º C.

Parent Resources From the AAP at HealthyChildren.org

The reader is likely to find material relevant to this article to share with parents by visiting these links:

- [http://www.healthychildren.org/English/health-issues/injuries-emergencies/sports-injuries/Pages/Heat-Related-Illnesses.aspx](http://www.healthychildren.org/English/health-issues/injuries-emergencies/sports-injuries/Pages/Heat-Related-Illnesses.aspx)
- [http://www.healthychildren.org/English/health-issues/injuries-emergencies/sports-injuries/Pages/Heat-Tolerance.aspx](http://www.healthychildren.org/English/health-issues/injuries-emergencies/sports-injuries/Pages/Heat-Tolerance.aspx)
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