American Academy of Pediatrics
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FROM THE AMERICAN ACADEMY OF PEDIATRICS

Organizational Principles to Guide and Define the Child Health Care System and/or Improve the Health of all Children

Policy Statement—Climatic Heat Stress and Exercising Children and Adolescents

COUNCIL ON SPORTS MEDICINE AND FITNESS AND COUNCIL ON SCHOOL HEALTH

KEY WORDS

body-temperature regulation, heat stroke, primary prevention, risk management, school health, sports medicine, youth sports

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abstract

FREE

Results of new research indicate that, contrary to previous thinking, youth do not have less effective thermoregulatory ability, insufficient cardiovascular capacity, or lower physical exertion tolerance compared with adults during exercise in the heat when adequate hydration is maintained. Accordingly, besides poor hydration status, the primary determinants of reduced performance and exertional heat-illness risk in youth during sports and other physical activities in a hot environment include undue physical exertion, insufficient recovery between repeated exercise bouts or closely scheduled same-day training sessions or rounds of sports competition, and inappropriately wearing clothing, uniforms, and protective equipment that play a role in excessive heat retention. Because these known contributing risk factors are modifiable, exertional heat illness is usually preventable. With appropriate preparation, modifications, and monitoring, most healthy children and adolescents can safely participate in outdoor sports and other physical activities through a wide range of challenging warm to hot climatic conditions. *Pediatrics* 2011;128:e741–e747

INTRODUCTION

The American Academy of Pediatrics recognizes that appropriate and sufficient regular physical activity plays a significant part in enhancing and maintaining health.[1–7] However, special consideration, preparation, modifications, and monitoring are essential when children and adolescents are engaging in sports or other vigorous physical activities in warm to hot weather. Exertional heat illness, including heat exhaustion and heat stroke, might occur even in a temperate environment, but the risk is highest when children and adolescents are vigorously active outdoors in hot and humid conditions. Severe exertional heat injury or heat stroke is associated with significant morbidity and mortality, especially if diagnosis is delayed and appropriate medical management is not initiated promptly. The Appendix contains definitions of the heat-illness–related terms used in this statement.

Researchers have previously suggested that children are less effective in regulating body temperature, incur greater cardiovascular strain, and have lower exercise tolerance during exercise in the heat compared with adults.[8–13] However, more recent studies, in which both groups were exposed to *equal* relative intensity exercise workloads and environmental conditions while minimizing dehydration, have compared 9- to 12-year-old boys and girls to *similarly* fit and heat-acclimatized adults. These newer findings indicate that children and adults have similar rectal and skin temperatures, cardiovascular re-

sponses, and exercise-tolerance time during exercise in the heat.[14–17] Accordingly, modifiable evidence-based determinants of exertional heat-illness risk in youth should be the focus of prevention measures.

Current or recent illness increases the challenge of participating in physical activity safely in the heat because of the potential negative residual effects on hydration status and regulation of body temperature. This is especially true for illnesses that involve gastrointestinal distress (eg, vomiting, diarrhea) and/or fever. Notable chronic clinical conditions and medications that contribute to decreased exercise-heat tolerance and increased exertional heat-illness risk include diabetes insipidus,[18] type 2 diabetes mellitus,[19] obesity,[20,21] juvenile hyperthyroidism (Graves disease),[22] cystic fibrosis,[23] and anticholinergic drugs or certain other medications that affect hydration or thermoregulation (eg, a dopamine-reuptake inhibitor to treat attention-deficit/hyperactivity disorder or enhance performance[24] or diuretics). Any other chronic or acute medical condition[25] or injury[26] that adversely affects water-electrolyte balance, thermoregulation, and exercise-heat tolerance warrants particular concern as well. Sickle cell trait should also be considered a possible contributing clinical risk/complicating factor for vascular dysfunction, exertional rhabdomyolysis, and collapse related to red blood cell sickling in youth during strenuous physical activity in the heat.[27–29] A previous episode of heat stroke, however, generally does not seem to have long-term negative effects on thermoregulation, exercise-heat tolerance, or exertional heat-illness risk, especially for those who received prompt cooling therapy.[30]

POLICY AND RECOMMENDATIONS

Most healthy children and adolescents can safely participate in outdoor sports and other physical activities through a wide range of challenging warm to hot climatic conditions. With appropriate preparation, modifications, and monitoring, exertional heat illness is usually preventable. Table 1 summarizes key heat-illness risk factors during sports and other physical activity and recommended responses (actions) for reducing physiologic strain and improving safety and activity tolerance. As heat and humidity increase and as additional other exertional heat-illness risk factors such as those listed in Table 1 are present, the

TABLE 1 Key Exertional Heat-Illness Risk Factors During Exercise, Sports, and Other Physical Activities and Recommended Responses (Actions) for Reducing Physiologic Strain and Improving Activity Tolerance and Safety

Risk factors
Hot and/or humid weather
Poor preparation
Not heat-acclimatized
Inadequate prehydration
Little sleep/rest
Poor fitness
Excessive physical exertion
Insufficient rest/recovery time between repeat bouts of high-intensity exercise (eg, repeat sprints)
Insufficient access to fluids and opportunities to rehydrate
Multiple same-day sessions
Insufficient rest/recovery time between practices, games, or matches
Overweight/obese (BMI ≥ 85th percentile for age) and other clinical conditions (eg, diabetes) or medications (eg, attention-deficit/hyperactivity disorder medications)
Current or recent illness (especially if it involves/involved gastrointestinal distress or fever)
Clothing, uniforms, or protective equipment that contribute to excessive heat retention
Actions[a]
Provide and promote consumption of readily accessible fluids at regular intervals before, during, and after activity
Allow gradual introduction and adaptation to the climate, intensity, and duration of activities and uniform/protective gear
Physical activity should be modified
Decrease duration and/or intensity
Increase frequency and duration of breaks (preferably in the shade)
Cancel or reschedule to cooler time
Provide longer rest/recovery time between same-day sessions, games, or matches
Avoid/limit participation if child or adolescent is currently or was recently ill
Closely monitor participants for signs and symptoms of developing heat illness
Ensure that personnel and facilities for effectively treating heat illness are readily available on site
In response to an affected (moderate or severe heat stress) child or adolescent, promptly activate emergency medical services and rapidly cool the victim

With any of these risk factors or other medical conditions[25] adversely affecting exercise-heat safety present, some or all of the actions listed may be appropriate responses to reduce exertional heat-illness risk and improve well-being.

[a] As environmental conditions become more challenging (heat and humidity increase) and as additional other listed risk factors are present, the possible actions to improve safety become more urgent. Note that each listed action does not necessarily correspond or apply to any particular or every listed risk factor.

actions for improving safety become more urgent. Likewise, as the number of risk factors for exertional heat illness increases, the maximum environmental heat and humidity level for safe exercise, sports participation, or other physical activities will decrease.

Operationally, pediatricians, coaches, and administrators need to make appropriate recommendations and "on-the-field" decisions to improve safety and minimize exertional heat-illness risk for a team or event as a whole. However, given individual variations in health status, conditioning, or other circumstances, some participants might not require the same heightened concern as other young athletes who might need implementation of additional exertional heat-illness prevention measures and closer monitoring in the same or a less challenging environment. For instance, even with a heat index of 95°F (35°C), a very fit, well-hydrated, rested, healthy 12-year-old who is acclimatized to the hot and humid conditions can likely safely compete in a soccer game without significant risk to his or her well-being or safety. On the other hand, with a heat index of only 85°F (29.4°C), an overweight high school football player who recently recovered from diarrhea and is running wind sprints at the end of the second 3-hour workout on an unusually warm first day of preseason football is much more likely to be at risk of overheating and exertional collapse. These examples also underscore the infinite number of scenarios that can alter individual exertional heat-illness risk. Therefore, it is extremely difficult to impose appropriate universal measures for maintaining optimal safety for all children and adolescents while sensibly allowing sports participation and other physical activities to continue. Although Table 1 can be used to help guide the decision-making process in taking appropriate prevention measures, considerably more research is needed to examine core body-temperature responses and exertional heat-illness risk with children and adolescents in different environmental conditions during various practice,[31] competition,[32] and other physical activity scenarios.[33] With such empirical information, appropriate sport- and activity-specific "heat safety grids" and field evidence-based prevention, participation, and cancellation guidelines can be developed.

Community pediatricians can be instrumental in improving heat safety for children and adolescents engaged in youth sports and other physical activities by actively participating as school team physicians or on school wellness committees or health councils; on school boards; on local, regional, or national sport or sports medicine advisory committees; or in local parks and recreation programs to educate youth and parents and to guide coaches and administrators in developing and implementing effective exertional heat-illness prevention and management strategies. However, field evidence is not currently sufficient to optimally guide pediatricians, coaches, administrators, and youth sport governing bodies in making the most appropriate and advantageous modifications to play and practice specific to heat safety or deciding when to cancel activities altogether if necessary. Accordingly, parents, teachers, coaches, athletic trainers, and pediatricians as well as youth sports governing bodies and administrators should always emphasize and use suitable prevention strategies, to the best of their ability, to improve safety and appropriately minimize the risk of exertional heat illness for all children and adolescents during exercise, sports participation, and other physical activities in warm to hot weather. To this end, the American Academy of Pediatrics recommends the following.

1. Community and team/school physicians as well as athletic directors, community parks and recreation programs, and youth sport governing bodies should emphasize comprehensive awareness, education, and implementation of effective exertional heat-illness risk-reduction strategies to coaches and their staff, athletic trainers, teachers, administrators, and others who oversee or assist with exercising children and adolescents and youth sports, especially for those involved with youth and preseason high school American football.
2. Trained personnel and facilities capable of effectively treating all forms of heat illness, especially exertional heat stroke by rapidly lowering core body temperature, should be readily available on site during all youth athletic activities and community programs that involve vigorous physical activity and are held in the heat.
3. Children and adolescents should be regularly educated on the merits of proper preparation, ample hydration, honest reporting, and effectively managing other factors under their control, such as recovery and rest, which will directly affect exercise-heat tolerance and safety.
4. Each child and adolescent should be given the opportunity to gradually and safely adapt to preseason practice and conditioning, sport participation, or other physical activity in the heat by appropriate and progressive acclimatization. This process includes graduated exposure (typically over a 10- to 14-day period) to the environment, intensity, duration, and volume of physical activity and to the insulating and metabolic effects of

wearing various uniform and protective-equipment configurations. Specific guidelines for American youth football are available[34,35] and can be used as a basis for developing other youth sports-acclimatization and practice-modification/monitoring strategies.

5. Sufficient, sanitary, and appropriate fluid should be readily accessible and consumed at regular intervals before, during, and after all sports participation and other physical activities to offset sweat loss and maintain adequate hydration while avoiding overdrinking. Generally, 100 to 250 mL (approximately 3–8 oz) every 20 minutes for 9- to 12-year-olds and up to 1.0 to 1.5 L (approximately 34–50 oz) per hour for adolescent boys and girls is enough to sufficiently minimize sweating-induced body-water deficits during exercise and other physical activity as long as their preactivity hydration status is good. Preactivity to postactivity body-weight changes can provide more specific insight to a person's hydration status and rehydration needs. Although water is often sufficient to maintain adequate hydration, long-duration (eg, ≥1-hour) or repeated same-day sessions of strenuous exercise, sport participation, or other physical activity might warrant including electrolyte-supplemented beverages that emphasize sodium to more effectively optimize rehydration.[36–40] This is especially justified in warm- to hot-weather conditions, when sweat loss is extensive.
6. Exercise, sport participation, and other physical activity should be modified for safety in relation to the degree of environmental heat stress: air temperature, humidity, and solar radiation, as indicated by the heat index or wet-bulb globe temperature (WBGT), for those with access to such a device. Effective modifications include lowering the intensity and/or shortening the activity duration and increasing the frequency and duration of breaks, which would preferably be in the shade. Individual medical conditions[25] and other risk factors identified by a preparticipation physical examination or as indicated by a more recent change in health status that could lower tolerance for exercise in the heat and increase risk for exertional heat illness should also prompt these and additional modifications (see Table 1).
7. Any child or adolescent should avoid or limit exercise, sport participation, or other physical activity in the heat if he or she is currently ill or is recovering from an illness, especially those involving gastrointestinal distress (eg, vomiting, diarrhea) and/or fever.
8. Supervisory staff such as coaches, athletic trainers, physical education teachers, and playground aides should receive appropriate training and closely monitor all children and adolescents at all times during sports and other physical activity in the heat for signs and symptoms of developing heat illness. Any significant deterioration in performance with notable signs of struggling, negative changes in personality or mental status, or other concerning clinical markers of well-being, including pallor, bright-red flushing, dizziness, headache, excessive fatigue, vomiting, or complaints of feeling cold or extremely hot, should be sufficient reason to immediately stop participation and seek appropriate medical attention for those affected. First aid for evolving heat illness should not be delayed. Anyone experiencing exertional heat illness should not return to practice or competition, recreational play, or other physical activity for the remainder of the current session, game/match, or play/activity period.
9. An emergency action plan with clearly defined written protocols should be developed and in place ahead of time. Emergency medical services (EMS) communication should be activated immediately for any child or adolescent who collapses or exhibits moderate or severe central nervous system dysfunction or encephalopathy during or after practice, competition, or other physical activity in the heat, especially if the child or adolescent is wearing a uniform and/or protective equipment that is potentially contributing to additional heat storage. Although treatment should not be delayed pending core body-temperature verification, when feasible, rectal temperature should be promptly checked by trained personnel and, if indicated (rectal temperature > 40°C [104°F]), on-site whole-body rapid cooling using proven techniques should be initiated without delay.[41–44] This process includes promptly moving the victim to the shade, immediately removing protective equipment and clothing, and cooling by cold- or ice-water immersion (preferred, most effective method) or by applying ice packs to the neck, axillae, and groin and rotating ice-water–soaked towels to all other areas of the body until rectal temperature reaches just under 39°C (approximately 102°F) or the victim shows clinical improvement. If rectal temperature cannot be assessed

in a child or adolescent with clinical signs or symptoms suggestive of moderate or severe heat stress, appropriate treatment should not be delayed. Prompt rapid cooling for 10 to 15 minutes and, if the child or adolescent is alert enough to ingest fluid, hydration should be initiated by attending staff while awaiting the arrival of medical assistance.

10. To improve athlete safety and performance, youth sports governing bodies, tournament directors, and other event administrators should provide adequate rest and recovery periods of 2 hours or *more* between same-day contests in warm to hot weather to allow sufficient recovery and rehydration.[45,46]
11. In conditions of extreme heat or humidity when children or adolescents can no longer maintain thermal balance, safety should be the priority, and outdoor contests and practice sessions should be canceled or rescheduled to cooler times, even if it means playing or practicing very early in the day or later in the evening.

APPENDIX: DEFINITIONS

Heat stress: High air temperature, humidity, and solar radiation that lead to perceived discomfort and physiologic strain when children and adolescents are exposed to such environmental conditions, especially during vigorous exercise and other physical activity.

Exertional heat illness: A spectrum of clinical conditions that range from muscle (heat) cramps, heat syncope, and heat exhaustion to life-threatening heat stroke incurred as a result of exercise or other physical activity in the heat.

Heat exhaustion: Moderate heat illness, characterized by the inability to maintain blood pressure and sustain adequate cardiac output, that results from strenuous exercise or other physical activity, environmental heat stress, acute dehydration, and energy depletion. Signs and symptoms include weakness, dizziness, nausea, syncope, and headache; core body temperature is $<$104°F (40°C).

Exertional heat stroke: Severe multisystem heat illness, characterized by central nervous system abnormalities such as delirium, convulsions, or coma, endotoxemia, circulatory failure, temperature-control dysregulation, and, potentially, organ and tissue damage, that results from an elevated core body temperature ($>$104°F [$>$40°C]) that is induced by strenuous exercise or other physical activity and typically (not always) high environmental heat stress.

Heat injury: Profound damage and dysfunction to the brain, heart, liver, kidneys, intestine, spleen, or muscle induced by excessive sustained core body temperature associated with incurring exertional heat stroke, especially for those victims in whom signs and/or symptoms are not promptly recognized and are not treated effectively (rapidly cooled) in a timely manner.

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