AMERICAN ACADEMY OF PEDIATRICS

Committee on Sports Medicine and Fitness

Climatic Heat Stress and the Exercising Child and Adolescent

ABSTRACT. For morphologic and physiologic reasons, exercising children do not adapt as effectively as adults when exposed to a high climatic heat stress. This may affect their performance and well-being, as well as increase the risk for heat-related illness. This policy statement summarizes approaches for the prevention of the detrimental effects of children's activity in hot or humid climates, including the prevention of exercise-induced dehydration.

Heat-induced illness is preventable. Physicians, teachers, coaches, and parents need to be aware of the potential hazards of high-intensity exercise in hot or humid climates and to take measures to prevent heat-related illness in children and adolescents.

Exercising children do not adapt to extremes of temperature as effectively as adults when exposed to a high climatic heat stress.[1] The adaptation of adolescents falls in between. The reasons for these differences include:

1. Children have a greater surface area-to-body mass ratio than adults, which causes a greater heat gain from the environment on a hot day and a greater heat loss to the environment on a cold day.
2. Children produce more metabolic heat per mass unit than adults during physical activities that include walking or running.[2]
3. Sweating capacity is considerably lower in children than in adults,[1,3,4] which reduces the ability of children to dissipate body heat by evaporation.

Exercising children are able to dissipate heat effectively in a neutral or mildly warm climate. However, when air temperature exceeds 35°C (95°F), they have a lower exercise tolerance than do adults. The higher the air temperature, the greater the effect on the child.[4–7] It is important to emphasize that humidity is a major component of heat stress, sometimes even more important than air temperature.

On transition to a warmer climate, exercising persons must allow time to become acclimatized. Intense and prolonged exercise undertaken before acclimatization may be detrimental to the child's physical performance and well-being and may lead to heat-related illness, including heat exhaustion or fatal heat stroke.[8] The rate of acclimatization for children is slower than that of adults.[9] A child will need as many as 8 to 10 exposures (30 to 45 minutes each) to the new climate to acclimatize sufficiently. Such exposures can be taken at a rate of one per day or one every other day.

Children frequently do not feel the need to drink enough to replenish fluid loss during prolonged exercise. This may lead to severe dehydration.[10,11] Children with mental retardation are at special risk for not recognizing the need to replace the fluid loss. A major consequence of dehydration is an excessive increase in core body temperature. Thus, the dehydrated child is more prone to heat-related illness than the fully hydrated child.[12,13] For a given level of hypohydration, children are subject to a greater increase in core body temperature than are adults.[10] Although water is an easily available drink, a flavored beverage may be preferable because the child may drink more of it.[14,15] Another important way to enhance thirst is by adding sodium chloride (approximately 15 to 20 mmol/L, or 1 g per 2 pints) to the flavored solution. This has been shown to increase voluntary drinking by 90%, compared with unflavored water.[15] The above concentration is found in commercially available sports drinks. Salt tablets should be avoided, because of their high content of sodium chloride.

The likelihood of heat intolerance increases with conditions that are associated with excessive fluid loss (febrile state, gastrointestinal infection, diabetes insipidus, diabetes mellitus), suboptimal sweating (spina bifida, sweating insufficiency syndrome), excessive sweating (selected cyanotic congenital heart defects), diminished thirst (cystic fibrosis),[11,12] inadequate drinking (mental retardation, young children who may not comprehend the importance of drinking), abnormal hypothalamic thermoregulatory function (anorexia nervosa, advanced undernutrition, prior heat-related illness), and obesity.[7,8]

Proper health habits can be learned by children and adolescents. Athletes who may be exposed to hot climates should follow proper guidelines for heat acclimatization, fluid intake, appropriate clothing, and adjustment of activity according to ambient temperature and humidity. High humidity levels, even when air temperature is not excessive, result in high heat stress.

Based on this information, the American Academy of Pediatrics recommends the following for children and adolescents:

1. The intensity of activities that last 15 minutes or more should be reduced whenever relative humidity, solar radiation, and air temperature are above critical levels. For specific recommenda-

The recommendations in this statement do not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

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TABLE 1. Restraints on Activities at Different Levels of Heat Stress*

WBGT		Restraints on Activities
°C	°F	
<24	<75	All activities allowed, but be alert for prodromes of heat-related illness in prolonged events
24.0–25.9	75.0–78.6	Longer rest periods in the shade; enforce drinking every 15 minutes
26–29	79–84	Stop activity of unacclimatized persons and other persons with high risk; limit activities of all others (disallow long-distance races, cut down further duration of other activities)
>29	>85	Cancel all athletic activities

* From the American Academy of Pediatrics, Committee on Sports Medicine and Fitness.[16] WBGT is *not* air temperature. It indicates wet bulb globe temperature, an index of climatic heat stress that can be measured on the field by the use of a psychrometer. This apparatus, available commercially, is composed of 3 thermometers. One (wet bulb [WB]) has a wet wick around it to monitor humidity. Another is inside a hollow black ball (globe [G]) to monitor radiation. The third is a simple thermometer (temperature [T]) to measure air temperature. The heat stress index is calculated as WBGT = 0.7 WB temp + 0.2 G temp + 0.1 T temp.
It is noteworthy that 70% of the stress is due to humidity, 20% to radiation, and only 10% to air temperature.

tions, see Table 1. One way of increasing rest periods on a hot day is to substitute players frequently.

2. At the beginning of a strenuous exercise program or after traveling to a warmer climate, the intensity and duration of exercise should be limited initially and then gradually increased during a period of 10 to 14 days to accomplish acclimatization to the heat. When such a period is not available, the length of time for participants during practice and competition should be curtailed.
3. Before prolonged physical activity, the child should be well-hydrated. During the activity, periodic drinking should be enforced (eg, each 20 minutes 150 mL [5 oz] of cold tap water or a flavored salted beverage for a child weighing 40 kg (88 lbs) and 250 mL [9 oz] for an adolescent weighing 60 kg (132 lbs)), even if the child does not feel thirsty. Weighing before and after a training session can verify hydration status if the child is weighed wearing little or no clothing.
4. Clothing should be light-colored and lightweight and limited to one layer of absorbent material to facilitate evaporation of sweat. Sweat-saturated garments should be replaced by dry garments. Rubberized sweat suits should never be used to produce loss of weight.

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