

SSIDE LINE

Heat and Stress in Football: Role of the Uniform

What does it take to keep your players from overheating?

By **W. Larry Kenney, PhD, FACSM**

Early season football practices coincide with brutal temperatures that combine with physical exertion to put great strain on an athlete's cardiovascular and temperature regulation systems. For athletes who are not yet acclimated to the heat, the combination of warm temperatures and football uniforms combine to amplify the heat stress and create dangerous environments for heat illness.

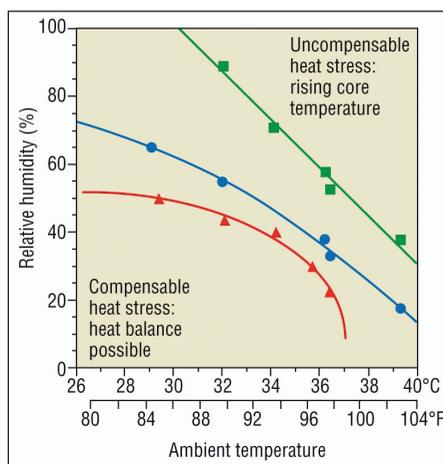
Initial research conducted in the 1960s showed that wearing a football uniform during exercise increased heart rate, heat production, body temperature, and sweat loss compared to the same exercise in light clothing. Since 2002, two new studies have helped to demonstrate the additional heat burden of wearing a football uniform.

Determining "safe" environmental conditions for football

High temperatures and humidity often prompt the question: How hot is too hot for football practice in full uniform? Heat-related illness occurs when an athlete produces body heat faster than it can be lost. Body temperature then rises, sometimes to dangerous levels. Football uniforms provide protection from injury; however, they also add potential harm by creating a barrier to heat loss. A Penn State University study set out to determine the maximal environmental conditions in which an athlete could maintain an elevated but steady core temperature during exercise in a football uniform. Combinations of temperature and humidity above an athlete's ability to lose heat are associated with a rapid rise in body temperature and an increased risk of heat illness in susceptible athletes.

The results of this research enabled us to create guidelines for three different types of typical football uniforms. Upper limit lines created for shorts and a tee shirt, a practice uniform (shorts replacing padded football pants), and a full uniform are shown in the figure

below. Above each of the uniform-specific lines, core temperatures will continue to rise throughout the practice, creating a potentially dangerous situation. In environments below the upper-limit guidelines, periodic breaks in the shade, ensuring hydration, and preparation for cooling overly hot athletes can create a safe environment for practice.



Heat balance guidelines for exercise at 35% VO₂max in a full football uniform, a practice uniform and shorts. Combinations of temperature and humidity below and to the left of each line represent zones in which a stable core temperature is possible. Sound practice management, including proper hydration, can create a safe environment for practice. Above and to the right of each line indicate zones where core temperature is predicted to rise continuously creating a potentially dangerous situation.

The mathematics of heat and football

In this research, subjects exercised at an average of 30 to 40 percent of their maximal capacities to simulate the overall effects of stop-and-go football practices and games. This enabled us to understand how the football uniform affected the subjects' body temperatures under a range of environment temperatures and humidity.

In a follow-up study conducted jointly by Penn State and Kansas State universities, five configurations of NCAA regulation football uniforms and practice ensembles were tested for insulation and resistance to sweat evaporation. The studies used a heated manikin covered with cotton knit to replicate skin and sprayed with distilled water to simulate sweating. The results showed that, compared with shorts and a tee shirt:

- A practice uniform of shorts, shoulder pads, jersey and helmet doubled the insulation and decreased the sweat evaporation by half.
- A full NCAA regulation game uniform almost tripled insulation and cut sweat evaporation by two-thirds.

Heat acclimation and hydration – a final comment

There is little doubt that football uniforms add to the heat strain experienced by an athlete. However, the lack of heat acclimation of some athletes during the first few days of practice, often coupled with poor hydration, is a major culprit in most heat-related illnesses among football players. Every athlete should be encouraged to:

- Spend the week immediately before summer practices gradually adjusting to hot conditions. Start with 15-20 minutes of continuous exercise and add five to ten minutes of activity each day. Maintain a steady sweat throughout the activity.
- During exercise, drink enough to minimize weight loss. Drink liberally in the evenings after practice sessions, favoring properly formulated sports drinks over water to aid in electrolyte replacement. After practice, always drink enough to get back to baseline weight before the next practice session begins, however be careful not to over drink.

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For more information on heat stress, please visit the Sports Science Center at www.gssiweb.com.



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