Journal of Athletic Training 2010;45(2):105–106

www.nata.org/jat

Toward Ending Fatal Heat Stroke in Football Players

E. Randy Eichner, MD, FACSM

This issue of the *Journal of Athletic Training* contains 4 articles on the vital topic of heat and hydration in football players. The latest annual survey[1] of football injury research notes 39 deaths from exertional heat stroke (EHS) since 1995, 6 of them in 2008. At this writing, during the summer of 2009, it seems at least 3 more football players have died from EHS. Death from EHS in football remains a vexing problem. The 4 articles in this issue suggest answers and raise questions about how to keep football players safe in the heat.

The study by Yeargin et al[2] complements a prior study[3] of heat acclimatization, according to the new National Collegiate Athletic Association regulations, of collegiate football players during preseason practices. This new study explores thermoregulatory responses and hydration practices in heat-acclimatized adolescents during preseason high school football. The main finding is that heat-acclimatized adolescents can safely complete the first 10 days of preseason football practices (keeping core temperature <40°C), using sensible guidelines in a cool to warm climate. Another practical point is that players remain mildly hypohydrated because they replace only two-thirds of sweat losses during practices and rehydrate inadequately between practices. A question for future researchers is how such players would fare in a hot and humid climate.

Fowkes Godek et al[4] compared collegiate with professional football players in training to explore the relationship of fluid availability to drinking and sweating rates. The main finding is that collegiate players who drank water only at breaks replaced the same volume of fluid (about two-thirds of weight loss) as did National Football League players who had constant access to both water and sports drinks. In this study, ''dehydration'' was mild; the results might have been different if the climate had been hotter and more humid. As in a prior study,[5] the larger linemen had greater sweat rates than the smaller backs and receivers. The authors emphasize that American football players can lose tremendous volumes of fluid daily, making it difficult to maintain fluid and sodium balance. Confounders here were the inability to control exercise intensity and the imperfect matching of environmental conditions.

The study by Armstrong et al[6] was designed to isolate the effect of the helmet and shoulder pads on heat gain. The partial uniform was unlike that worn in football, and the exercise protocol in a hot laboratory—10 minutes of repetitive box lifting, a 10-minute rest, then up to 60 minutes of treadmill walking—was unlike football practice in the field. Other limitations were (1) the treadmill walking was continuous, with no cooling breaks, whereas football practice is a stop-and-go pursuit with breaks for cooling; (2) no fan was used for the convective cooling that can occur in the field; and (3) the laboratory volunteers were not allowed to drink, whereas regular drinking is encouraged during football practice.

In the Armstrong et al[6] study, when players exercising with gear were compared with players exercising without gear, the football uniform did increase physiologic strain, as would be expected. In other words, exercising in the uniform, the players tended to quit earlier from exhaustion. But the helmet and shoulder pads per se had only a small effect on heat gain. They did not increase sweat rate. They did not increase rectal temperature at the end of exercise. Their only effect was an increase in the rate of rise of rectal temperature during treadmill exercise. Football players in the field have cooling breaks, drink fluids, and often remove helmets when not in action. All considered, the Armstrong et al study suggests that the helmet and shoulder pads are not a substantial risk for EHS.

Johnson et al[7] gauged responses of the exercisers in the Armstrong et al study to see if perceptual ratings can help keep athletes safe in the heat. Evaluated were scales for perceived exertion, thermal perception, thirst, and muscle pain, along with a modified Environmental Symptoms Questionnaire (ESQ). The main finding was that helmet and shoulder pads per se accounted for no difference in the mean scores on any of the 4 scales and no helpful difference in the ESQ. The authors suggest that, in future research on monitoring athlete safety in the heat, some scales may need to be refined, combined, or expanded.

Just as the Mississippi River is a confluence of streams, EHS in football is a confluence of risk factors. Climate counts, of course, but so do many other factors.[8] Players unacclimatized to the heat are at greater risk for EHS early in summer football camp. Fatness and unfitness, as shown in Marine Corps recruits, are 2 risk factors for EHS.[9] Football is a ''warrior culture'' and, as shown in real warriors, Israeli soldiers, overmotivation is a risk factor for EHS.[10] Along these lines, stimulants can also be risk factors for EHS in athletes.[11] Hydration matters, but intensity can matter more. For example, in unpublished data, we monitored core temperature via an ingested temperature sensor in 8 collegiate football players during an intense 95-minute conditioning drill on a warm, humid day in June. Even though the players drank fluids and wore no football gear, core temperature rose to a mean of nearly 103°F (39.4°C), with most of the rise in the first 20 minutes of the drill and a final spike during the closing sprinting. In short, huge guys are heat bombs. But we and others[12] have found that the stop-and-go nature of summer ''2-a-days'' can be a saving grace, in that players who may heat up during intense drills tend to cool down between drills and during rest breaks. The pros and cons of precooling are still debated,[13] but recent researchers have noted that cold drink ingestion improves exercise endurance capacity in the

heat[14] and that exercise capacity in the heat is greater in the morning than the evening,[15] likely because baseline core temperature is lower in the morning, thus increasing the margin of safety against EHS.

The 4 articles in this issue of the *Journal of Athletic Training* help in our fight against EHS by increasing our understanding of heat and hydration issues in football players. As with all good research, they answer some questions and raise more questions. We need more research like this—and more education—to end the preventable tragedy of fatal EHS in football players.

REFERENCES

1. Mueller FO, Colgate B. Annual survey of football injury research, 1931–2008. http://www.unc.edu/depts/nccsi. Accessed September 24, 2009.
2. Yeargin SW, Casa DJ, Judelson DA, et al. Thermoregulatory responses and hydration practices in heat-acclimatized adolescents during preseason high school football. *J Athl Train*. 2010;45(2):136–146.
3. Yeargin SW, Casa DJ, Armstrong LE, et al. Heat acclimatization and hydration status of American football players during initial summer workouts. *J Strength Cond Res*. 2006;20(3):463–470.
4. Fowkes Godek S, Bartolozzi AR, Peduzzi C, et al. Fluid consumption and sweating in National Football League and collegiate football players with different access to fluids during practice. *J Athl Train*. 2010;45(2):128–135.
5. Fowkes Godek S, Bartolozzi AR, Burkholder R, Sugarman E, Peduzzi C. Sweat rates and fluid turnover in professional football players: a comparison of National Football League linemen and backs. *J Athl Train*. 2008;43(2):184–189.
6. Armstrong LE, Johnson EC, Casa DJ, et al. The American football uniform: uncompensable heat stress and hyperthermic exhaustion. *J Athl Train*. 2010;45(2):117–127.
7. Johnson EC, Ganio MS, Lee EC, et al. Perceptual responses while wearing an American football uniform in the heat. *J Athl Train*. 2010;45(2):107–116.
8. Eichner ER. Heat stroke in sports: causes, prevention, and treatment. *Gatorade Sports Sci Inst Sports Sci Exch*. 2002;15(3):1–6.
9. Gardner JW, Kark JA, Karnei K, et al. Risk factors predicting exertional heat illness in male Marine Corps recruits. *Med Sci Sports Exerc*. 1996;28(8):939–944.
10. Epstein Y, Moran DS, Shapiro Y, Sohar E, Shemer J. Exertional heat stroke: a case series. *Med Sci Sports Exerc*. 1999;31(2):224–228.
11. Eichner ER. Stimulants in sports. *Curr Sports Med Rep*. 2008;7(5):244–245.
12. Fowkes Godek S, Godek JJ, Bartolozzi AR. Thermal responses in football and cross-country athletes during their respective practices in a hot environment. *J Athl Train*. 2004;39(3):235–240.
13. Duffield R, Steinbacher G, Fairchild TJ. The use of mixed-method, part-body pre-cooling procedures for team-sport athletes training in the heat. *J Strength Cond Res*. 2009;23(9):2524–2532.
14. Lee JKW, Shirreffs SM, Maughan RJ. Cold drink ingestion improves exercise endurance capacity in the heat. *Med Sci Sports Exerc*. 2008;40(9):1637–1644.
15. Hobson RM, Clapp EL, Watson P, Maughan RJ. Exercise capacity in the heat is greater in the morning than in the evening in man. *Med Sci Sports Exerc*. 2009;41(1):174–180.

Editor's note: E. Randy Eichner, MD, FACSM, is Professor Emeritus of Medicine, University of Oklahoma Health Sciences Center, and was Team Internist, University of Oklahoma football, from 1996 through 2009.