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Special Report from the CDC

Heat illness among high school athletes — United States, 2005–2009

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ABSTRACT

Introduction: Heat illness is a leading cause of death and disability among U.S. high school athletes. *Methods:* To examine the incidence and characteristics of heat illness among high school athletes, CDC analyzed data from the National High School Sports-Related Injury Surveillance Study for the period 2005–2009. *Results:* During 2005–2009, the 100 schools sampled reported a total of 118 heat illnesses among high school athletes resulting in ≥1 day of time lost from athletic activity, a rate of 1.6 per 100,000 athlete-exposures, and an average of 29.5 time-loss heat illnesses per school year. The average corresponds to a weighted average annual estimate of 9,237 illnesses nationwide. The highest rate of time-loss heat illness was among football players, 4.5 per 100,000 athlete-exposures, a rate 10 times higher than the average rate (0.4) for the eight other sports. Time-loss heat illnesses occurred most frequently during August (66.3%) and while practicing or playing football (70.7%). No deaths were reported. *Conclusions:* Consistent with guidelines from the National Athletic Trainers' Association, to reduce the risk for heat illness, high school athletic programs should implement heat-acclimatization guidelines (e.g., set limits on summer practice duration and intensity). All athletes, coaches, athletic trainers, and parents/guardians should be aware of the risk factors for heat illness, follow recommended strategies, and be prepared to respond quickly to symptoms of illness. Coaches also should continue to stress to their athletes the importance of maintaining proper hydration before, during, and after sports activities. *Impact of industry:* By implementing preventive recommendations and quickly recognizing and responding to heat illness, coaches, athletic trainers, and the sporting community can prevent future deaths.

1. Introduction

Heat illness encompasses a spectrum of illness that includes muscle cramps, heat syncope, heat exhaustion, exertional heat stroke, and exertional hyponatremia (Binkley, Beckett, Casa, Kleiner, & Plummer, 2002). Symptoms can be both physical (e.g., dehydration, thirst, fatigue, dizziness, lightheadedness, weakness) as well as neurological (e.g., confusion, disorientation, loss of consciousness; Binkley et al.). Although heat illness is preventable, it is the leading cause of death and disability among U.S. high school athletes (Mueller & Cantu, 2008). In 2010, an estimated 7.5 million students participated in high school sports annually (National Federation of State High School Associations, 2010). Despite the high incidence and the large population at risk, no study has yet to investigate heat illness incidence among a nationally representative sample of U.S. high school athletes.

2. Methods

The High School Sports-Related Injury Surveillance Study (CDC, 2006), conducted by the Center for Injury Research and Policy at Nationwide Children's Hospital, has been described in detail previously (Collins, McIlvain, Yard, & Comstock, 2009). Briefly, all high schools with ≥1 National

Abbreviations: NATA, National Athletic Trainers' Association; CI, Confidence Interval; CDC, Centers for Disease Control and Prevention.

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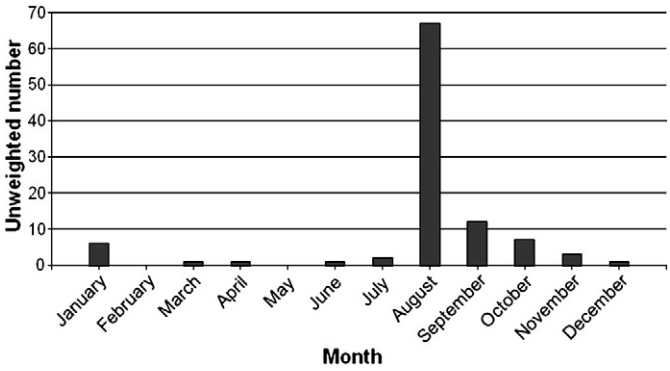

Fig. 1. Number (n = 101[a]) of time-loss heat illnesses[b] among high school athletes, by month—National High School Sports-Related Injury Surveillance Study,[c] United States, 2005–2009. [a]Excludes 17 cases with missing dates. [b]Defined as heat exhaustion/heat stroke that 1) resulted from participation in a school-sanctioned practice or competition, 2) was assessed by a medical professional (with or without treatment), and 3) resulted in ≥1 days of time loss from athletic activity. [c]Data based on reports from a 100-school sample.

Athletic Trainers' Association (NATA)–affiliated certified athletic trainer (ATCs) with a valid e-mail address are invited to participate. Willing participants are categorized into eight strata based on school population (enrollment ≤1000 or >1000) and U.S. Census geographic location (Northeast, Midwest, South, and West). From these eight strata, 100 high schools are randomly chosen to participate. During the school year, participating ATCs enter their school's injury and exposure data weekly into an online surveillance system. Data are collected on nine sports: football, wrestling, soccer, baseball, and basketball (for boys); and volleyball, soccer, basketball, and softball (for girls).

Time-loss heat illness was defined as dehydration or heat exhaustion/heat stroke that: (a) resulted from participation in a school-sanctioned practice or competition; (b) was assessed by a medical professional; and (c) resulted in ≥1 day of time loss from athletic activity. If an athlete sustained a heat illness and returned or was cleared to return to practice or competition the next day, the heat illness was not reportable. Exposures to sports activities were measured by "athlete-exposures." One athlete-exposure was defined as one athlete participating in one practice or one competition. Rates per 100,000 athlete-exposures were calculated based on the actual number of time-loss heat illnesses reported by the schools.

Each case of time-loss heat illness was assigned a sample weight on the basis of the inverse of the school selection probability. These weights were summed to provide national estimates of time-loss heat illness, from which average annual estimates were calculated. Confidence intervals were calculated by use of a direct variance estimation procedure that accounted for the sample weights and the complex sample design. Finally, although heat illness might have a geographic distribution, this study was designed to provide national estimates only.

3. Results

During 2005–2009, a total of 118 time-loss heat illnesses (an average of 29.5 per school year) were reported by the 100 participating schools in the nine sports studied. These data correspond to an estimated average annual number of 9,237 (95% confidence interval [CI] = 8,357–10,116) time-loss heat illnesses nationwide. The majority of time-loss heat illnesses occurred among high school football players (70.7%), who sustained an estimated average annual 6,529 (CI = 5,794–7,264) time-loss heat illnesses. Time-loss heat illness among high school athletes occurred most frequently in August (66.3%; Fig. 1), the month when most schools begin preseason sports training.

The highest rate of time-loss heat illness was among football players, 4.5 per 100,000 athlete-exposures (Table 1), a rate 10 times higher than the average rate (0.4) for the eight other sports. Football time-loss heat illness rates were similar in practice (4.4) and competition (4.7) (Table 1); 76.7% occurred during preseason. Although football practice and competition had similar rates, because more time (including preseason) is spent practicing, 83.6% of all football time-loss heat illnesses occurred during practice. Football time-loss heat illnesses during practice usually occurred 1–2 hours (46.6%) or >2 hours (37.2%) after practice had begun. The majority of illnesses (58.2%) occurred among varsity football players and among juniors (35.6%) or seniors (28.3%). Affected football players commonly had a body mass index[1] categorized as overweight (37.1%) or obese (27.6%). Although the majority of football players (63.1%) returned to play 1–2 days after illness onset, 18.4% missed 3-6 days, 9.7% missed 7-21 days, and 3.0% discontinued their season.

4. Discussion

This analysis is the first to report national estimates for time-loss heat illness among high school athletes. The findings in this report indicate that time-loss heat illness occurred most frequently among football players (4.5 time-loss heat illnesses per 100,000 athlete-exposures) and during August (66.3%) and are consistent with previous studies reporting that football players accounted for 5.3% of all nonfatal heat-related visits to emergency departments (Sanchez, Thomas, Malilay, & Annest, 2010) and that 88% of football heat illnesses occurred in August (Cooper, Ferrara, & Broglio, 2006). This study found that 64.7% of football players sustaining a heat illness were either overweight or obese. Obesity has been shown to be a risk factor for heat illness because fat decreases heat loss; a previous study reported that 47.1% of all high school football players were overweight or obese (Choate, Forster, Almquist, Olsen, & Poth, 2007). In the absence of prompt intervention, heat illness can result in permanent morbidity (e.g., neurologic, cardiac, renal, gastrointestinal, hematologic, or muscle dysfunction) or mortality. These results support the existing NATA recommendations to continue emphasis of appropriate primary and secondary prevention strategies.

All heat illnesses in high school athletes are preventable. Since 1995, according to an annual survey of catastrophic football injuries, 31 high school football players have died from heat stroke.[2] One component of primary prevention is the implementation of acclimatization periods to

[1] Body mass index (BMI) = weight (kg) / [height (m^2)]. BMI classifications: <18.5 underweight, 18.5–24.9 normal weight, 25–29.9 overweight, ≥30 obese.
[2] http://www.unc.edu/depts/nccsi/2009AnnualFootball.pdf.