Heat Injury Prevention Practices in High School Football

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Objective: To survey high school American football programs regarding current prevention measures for reducing heat injuries during the football season.

Design: Web-based survey of 27 questions based on consensus statement guidelines by the American College of Sports Medicine on reducing heat injury risk in youth football.

Setting: National (United States) and community-based.

Participants: High school programs receiving survey distribution from their state athletic association and the National Federation of State High School Associations.

Main Outcome Measures: Responses (percentage and incidence) to questions on preseason acclimatization procedures, practice modification protocols, preparticipation risk factors, hydration management strategies, rest period strategies, heat injury education and policies, and preparation for heat-related emergency care.

Results: A total of 540 high school football programs from 26 states completed the survey. The reported number of preseason heat injuries per program (1.38 $\pm$ 2.08) was greater ($P < 0.001$) compared to during the regular season (0.98 $\pm$ 1.84). Programs modified equipment configurations during preseason (no helmets or pads, 31.3%; just helmets, 57.0%; helmets and shoulder pads only, 33.5%) or altered the practice schedule when there was excessive heat. Hydration management, education, and preparation for dealing with an acute heat injury varied among programs.

Conclusions: Greater implementation of effective prevention measures to reduce the incidence of heat-related injury and death in high school American football is needed. Strategies should focus on modifying practices appropriately on a day-to-day basis to minimize heat strain and optimize hydration, identifying and educating at-risk individuals during the preparticipation period, and developing an emergency action plan for effectively managing heat injuries.

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INTRODUCTION

Heat-related injury and even death are no strangers to high school football in the United States. The National Center for Catastrophic Sport Injury reported that 21 young football players died from heat stroke,[1] usually during the preseason, from 1995 through 2001. Unfortunately, the annual incidence of preventable injury and death during football practice and play in the heat seemingly has not changed. At least 5 high school football heat-related fatalities occurred during the summer of 2006, despite ongoing efforts at the national and local levels to educate coaches, players, and medical support staff on effective strategies to lessen the risk of fatal and nonfatal heat stroke on the field.

Multiple risk factors for potential heat stroke are particularly evident in young football players, including reduced heat tolerance,[2–7] insufficient fluid intake,[8] additional heat production and retention due to the football equipment,[9,10] and inadequate preseason acclimatization.[3,5] Studies show that football protective equipment and uniform components increase energy expenditure due to the added weight and act as barriers for heat loss,[11] resulting in even greater heat production and retention during activity[9,10] and heat retention at rest, with increased risk of heat injury in hot weather.[12] Players also need a period of time to acclimatize to the uniform and to the intensity and duration of practice. Therefore, high school football players may be at particularly greater risk during the early preseason, when the environment is often hotter and more humid and the uniform configuration and workload may be inappropriate for the level of fitness and acclimatization of individual players.

The American College of Sports Medicine (ACSM),[12,13] National Athletic Trainers' Association (NATA),[14] American Academy of Pediatrics,[7] and others have previously provided guidelines regarding exercise in the heat. A recent consensus statement from an ACSM roundtable specific to heat stress and injury risk in youth football[15] has been gaining attention at the local level through widespread media emphasis[16] and support by the National Federation of State High School Associations (NFHS). These particular recommendations include strategies for (1) preseason acclimatization, (2) practice modification, (3) identification of risk factors during the preparticipation physical exam, (4) proper fluid and rest management, and (5) monitoring the athletes on the field with properly educated staff. However,

a better appreciation of existing heat injury prevention practices, particularly in high school football, is essential to develop effective intervention strategies. By identifying common strengths and weaknesses of current practices sampled from football programs across the nation, coaches, medical support staff, administrators, high school sports programs, and sports medicine organizations can focus their efforts on specific areas to more effectively reduce the risk, lessen the incidence, and improve the outcomes of serious heat injury.

METHODS

Survey Instrument

We used a 27-question web-based survey that primarily focused on preseason practice parameters and considerations highlighted in the ACSM youth football consensus statement on heat stress and injury risk.[15] A pilot survey was previously performed with a convenience sample of 59 high school football programs from around the country. A revised survey was subsequently distributed by the NFHS directly to all state high school associations, who in turn forwarded the internet link and password to access the survey to their respective individual programs. The sampling frame included all high school programs registered at the time of the survey in 2005 with the state high school associations. Each end-user survey recipient was asked to have 1 experienced individual directly involved in the care of their football players complete the survey (eg, a coach, athletic trainer, athletic director, or team physician). A request to complete the survey was sent via e-mail to all programs in May 2005 and again in September 2005.

The survey instrument included questions regarding geographic and climate information, preseason acclimatization procedures, practice modification protocols based on environment considerations, methods for identifying individuals during the preparticipation physical exam who may be at greater risk for incurring heat injury, hydration management strategies and rest period procedures, heat injury education and policies, and preparations for heat-related emergency care.

Data Handling and Analysis

Confidentiality was maintained through a secure server, and all responses were compiled into a coded database. No identifying or protected health information was collected from any person completing the survey or their respective football program. Missing data were not substituted, and 4 completed surveys with insufficient data were eliminated. Data analysis included standard frequencies and comparisons (chi-square and *t* tests) using SPSS for Windows (Version 14.0; SPSS, Chicago, IL). The study was approved by the Committee for Human Research at the University of California, San Francisco.

RESULTS

Survey Population

Five hundred forty high school football programs from 26 states completed and submitted surveys. Of the respondents, 60.9% (330) were coaches, 19.7% (107) were certified athletic trainers, 16.1% (87) were athletic directors, and 3.3% (16) were others. Table 1 shows the participating states, the respective number of responding programs, and the average number of heat injuries reported during the 2004 football season.

Heat Injury Incidence

The reported number of heat injuries per program for the preseason (1.38 ± 2.08) was greater ($P < 0.001$) compared to those reported for the regular season (0.98 ± 1.84). Thirty-two percent of programs reported 2 or more heat injuries throughout the 2004 preseason and regular season. Programs with at least 2 heat injuries during the preseason were more likely ($P < 0.001$) to have reported at least 2 additional heat injuries during the rest of the season.

Environmental Conditions and Guidelines

Only 138 programs (26%) reported having typical high temperatures equal to or greater than 32.2°C (90°F) during preseason. Interestingly, 1 program replied that the average daily temperature is generally higher during their regular season compared to the summer preseason. Specific prepared guidelines regarding participation in the heat were used by 45.4% of the responding programs. These guidelines were either from their own state association or from organizations such as the National Collegiate Athletic Association (NCAA), NFHS, NATA, or the Gatorade Sports Science Institute.

TABLE 1. Distribution of Participated Programs and Reported Number of Heat Injuries (per Program) by State for the 2004 Football Season

State	Programs That Submitted a Completed Survey	Heat Injuries During First 2 Weeks of Preseason, Mean (SD)	Heat Injuries Reported Per Program, Mean (SD)
Michigan	93	0.99 (1.61)	1.41 (1.92)
South Dakota	54	0.47 (0.83)	0.47 (0.83)
Kansas	53	1.06 (1.449)	1.80 (2.54)
Missouri	50	1.02 (1.33)	1.84 (2.38)
Washington	47	0.79 (1.63)	1.33 (2.48)
Illinois	42	2.84 (2.55)	4.75 (3.70)
Nebraska	36	1.35 (1.43)	2.21 (2.31)
Florida	30	1.55 (2.20)	3.48 (5.91)
Idaho	29	1.59 (3.07)	2.40 (4.41)
New Jersey	27	2.46 (3.11)	4.27 (4.97)
Tennessee	17	3.13 (2.99)	6.40 (5.03)
California	16	0.80 (1.01)	1.80 (2.54)
New Mexico	10	0.40 (0.70)	0.50 (0.71)
Oregon	10	3.10 (2.28)	5.30 (4.55)
Rhode Island	6	1.50 (1.73)	2.25 (2.63)
Virginia	5	4.60 (2.79)	9.00 (5.52)
Colorado and Minnesota	3 each	DNC	DNC
Wyoming	2	DNC	DNC
Arizona, Delaware, Iowa, Kentucky, New Hampshire, Utah and Wyoming	1 each	DNC	DNC

DNC, Did not calculate due to low sample size.

TABLE 2. Summary of Key Findings

What programs are doing well
A standardized preparticipation physical exam (PPE) is required for most high school football programs
The preseason is at least 2 weeks long in most programs, which allows adequate time to achieve safe, progressive, and effective acclimatization to the environment, the uniform and protective equipment, and the daily practice session workload for the vast majority of players while still meeting appropriate individual and team training objectives
A common method of assessing environmental heat risk is often adopted, especially when it is mandated by a state high school athletic association
Most programs recognize the importance of sufficient hydration and generally provide at least 3 rest/rehydration breaks per hour during on-field training sessions
Many high school football programs provide some education for players on heat injury recognition and prevention
What programs need to improve
High school football programs need to make appropriate adjustments to high heat and humidity by altering the equipment configurations and the practice intensity and duration for the safety of the athletes. These adjustments can include:
Using less equipment early during preseason (eg, helmets only or no pads or partial pads)
Reducing duration and intensity of practice drills and sessions
Eliminating 2-a-day practices during the first week of preseason and 2-a-day practices on successive days during the second week of preseason
Scheduling practice at cooler times of the day or indoors
Football programs need to use regular on-site measurements of environmental temperature and humidity before and during practice, and follow preplanned strategies for practice modification to reduce heat injury incidence on the football field
Programs should utilize planned hydration strategies that encourage optimal hydration for various environmental conditions. Water should be readily available at the sideline in bottles or in a cooler with cups rather than relying on an on-site water fountain alone. Sport drink beverages can be utilized, but they are not essential to heat safety
The daily assessment of player hydration status with pre-practice to post-practice weights to assess both acute and day-to-day fluid loss should be implemented to assist fluid recovery for individual players; although, coaches should appreciate that improved hydration alone will not completely eliminate excessive heat strain or the risk of heat injury
Football staff should develop an emergency action plan to prepare for heat illness evaluation and care. The appropriate equipment to begin cooling an affected player immediately while awaiting the emergency response team for transport to an emergency facility should be available on-site, and the staff should be trained to use it
A national standardized PPE history form should include a description of previous heat injuries and identify potential medical conditions that put an athlete at additional risk for heat illnesses
Medical conditions identified during the PPE or after a change in medical status that predispose an athlete to heat illness should be communicated to the coaching staff so appropriate modifications in practice parameters (eg, drill intensity and duration, uniform configuration, etc.) can be implemented and at risk players can be monitored for signs of heat illness
Education for high school football players and coaches regarding the prevention and recognition of heat injuries should be augmented to include preseason training for coaches, team staff, and medical professionals using recommendations with scientific basis
State high school football associations should provide up-to-date specific recommendations on heat injury prevention and management to all programs in their jurisdiction

Humidity was considered when estimating environmental heat stress by 71.3% of respondents. To determine ambient heat stress, 30.7% of the programs reported calculating heat index (using the local temperature and relative humidity), whereas 24.6% rely only on the local weather report. Others reported using a sling psychrometer (6.5%) or an electronic environmental monitoring device (3.3%) for on-site measurements; 7.0% (38) of the programs use a wet-bulb globe thermometer for monitoring on-field heat stress.

Preseason Acclimatization

Almost all programs (94.8%; 493 of 520) reported having at least 2 weeks for preseason training, with a preseason average duration of 2.5 $\pm$ 0.9 weeks. Programs with a preseason less than 2 weeks long did not report more heat injuries than programs with a longer preseason. Moreover, length of the preseason was not statistically associated with the reported average high temperature during the preseason ($r = 0.08$). Programs using 2-a-day practices during the preseason (74.6%) reported greater total daily active practice and conditioning time (4.2 $\pm$ 2.1 h versus 3.1 $\pm$ 1.2 h) compared to programs practicing only once daily ($P < 0.001$).

Practice Modifications

In response to excessive heat stress, 31.3% of programs modified the equipment configuration by eliminating the helmets and all pads, 57.0% practiced in just helmets and no other pads, and 33.5% reduced the uniform to helmets and shoulder pads only. The coaching staff eliminated supplemental running and other conditioning drills in 25% of the reporting programs when there was excessive heat stress. Other heat-related practice modifications included increasing number of water breaks (14.3%), changing practice location to indoors (3.9%), changing scheduled practice time to morning or evening (8%), and shortening practice duration (2.8%). Notably, 19 programs (3.5%) reported that they do not make any changes in response to the heat and go through full practice as planned regardless of the temperature. These programs were distributed among 11 states and were not concentrated in cooler areas.

Fluid Intake and Hydration Assessment

Only 45.7% of the respondents indicated that they have a planned routine for managing player hydration during practice and 6.7% indicated that they do not have any scheduled water breaks. The number of water breaks (3.2 ± 1.4) ranged from 1 to 8 breaks per hour. One third of the programs use body weight in some way to assess hydration. Specifically, 7% perform prepractice weighing only, 1.3% perform postpractice weighing only, and 11.3% of the programs perform both to assess fluid requirements.

Fluids were commonly made available during practice using water fountains (66.9%; 361), cooler(s) and cups (39.8%; 215), group water bottles (38.3%; 207), individual water bottles (31.7%; 171), vending machines (8.5%; 46), and other means (10.4%; 56). Only 32.4% of programs reported that the staff supplied practice-session fluids, while 9.8% of respondents answered that the players were responsible for their own fluids. Extra salt intake for players during the first week of practice was recommended by 24.3% (396) of the respondents. Sport drinks were reported to be used by the players in 92.2% of the programs. In addition, 45.2% of the respondents indicated that their athletes use "energy" drinks.

Secondary Prevention of Heat Injuries

Of the high school football programs, 62.4% indicated that they provided players with education on the recognition and prevention of heat injuries, 18.0% of the programs reported that their coaches participated in education sessions on heat injuries, and 17.4% indicated that their team physicians received such training.

The equipment available for assessing and managing heat injury during team practice or play included the following: oral thermometer (27.6%; 149), rectal thermometer (2.2%; 12), ice bags/cooler (92.2%; 498), intravenous (IV) fluids (0.7%; 4), fans (23.7%; 128), mist machine/water spray (14.8%; 80), and tubs for immersion cooling (22.0%; 119).

Preparticipation Physical Exam

Ninety-three percent of programs reported that a preparticipation physical exam (PPE) was required before starting team practice or playing, including the try-out sessions. However, 4.4% indicated that a PPE was not required. A standardized preparticipation physical exam form recommended by their state high school association is used by 74.1% of programs. Only 33.0% of programs reported that their state had a high school sports medicine advisory committee, and 74.8% of programs indicated that the coaches reviewed the athletes' medical conditions after the PPE. For PPE questions that identify "at risk" conditions for heat injury, responding individuals recognized the following specific questions from their forms: previous heat related illness, 51.7%; cardiac disease, 75.6%; syncope/fainting episodes, 55.0%; medications, 78.5%; supplements, 23.1%; sickle cell trait/disease, 22.6%; kidney disease, 45.0%.

DISCUSSION

This survey assessment is the first attempt to profile high school football procedures related to heat stress. With less than half of the surveyed programs reportedly using available prepared guidelines regarding participation in the heat, more effective dissemination of heat-related educational information is clearly needed to help high school football programs take advantage of current best practices recommended by their state associations and national governing bodies.

Although some regions of the country (eg, Ohio, as indicated by our pilot survey) report widespread use of sling psychrometers, the heat index (reported by the local weather station) appears to be the most popular method for estimating the degree of environmental heat stress. However, a practical and effective method for more precisely determining on-field heat stress would be valuable for programs to assess the environmental challenge and adjust the practice parameters and uniform configuration for player safety. For those who do not have the equipment to measure on-field wet-bulb globe temperature (WBGT), Coyle has developed a formula for converting dry-bulb temperature and relative humidity to a WBGT[17] utilizing a readily available program (Heat Stress Advisor, http://www.zunis.org/sports_p.htm).

It is remarkable how few high school football programs respond to environmental heat stress with proven modifications such as adjustments to equipment use or practice activities during any part of their schedule, including preseason. Only slightly more than half the programs reported using a "helmets-only" and "no-pads" protocol in excessive heat, which suggests that many coaches and athletic directors may not appreciate the heat injury risk associated with heat trapped by the football uniform. Kulka and Kenney demonstrated how exercise in different football uniform configurations combined with an increase in environmental temperature and humidity can readily lead to critical heat balance limits, uncompensable heat strain, and increasing risk of heat stroke.[11] Adding more uniform and equipment creates an increasing heat transfer barrier and lowers the environmental threshold for uncompensable heat stress. A small number of programs reported that they make no adjustment of their practices on the basis of the environment, which does not reflect the commonly held notion of "best practice" for player safety. Potential heat strain and clinical risk may be underappreciated by these programs or player safety simply remains secondary to planned practice objectives. These programs were distributed among 11 different states with no particular concentration in cooler areas of the country.

We acknowledge the inherent challenges associated with modifying practice schedules for many schools and football programs. For example, the athletes or facilities may not be available during cooler times of the day. Moreover, some regions of the country have inherently demanding weather conditions throughout the day during the preseason and the competitive season; in effect, the risk is high no matter what time of day the players are on the field. The opportunities to reduce player risk also depend on resources available to each team. Not all programs have facilities to reschedule their practices easily or to hold practice indoors. In addition, the fact that reported average high temperature was not associated with the length of the preseason suggests that the duration of preseason is most likely determined more by other administrative scheduling factors, even though a longer preseason

could potentially provide a greater opportunity for more progressive and safe acclimatization.

Overall, these high school football program staff members seem to recognize the value of sufficient hydration, as increasing the number of water breaks, having mandatory water breaks, and allowing fluid intake at any time were common responses to prevent heat injuries. These programs are also playing a primary role in recommending and implementing appropriate hydration protocols with players; however, how and how often fluid is provided varies.

Body weight change from prepractice to postpractice and from practice to practice is a relatively easy and practical way to estimate degree of individual dehydration incurred during a training session and over a series of practices. Prepractice return to initial baseline weight helps prevent fluid deficits that can be cumulative over several days.[8,18] Athletes practicing daily and not monitored with weight checks to assure return to baseline weight are especially at risk for cumulative dehydration. Notably, only one third of the programs use body weight to assess hydration, with much fewer (~11%) performing both presession and postsession body weight measurements.

The widespread lack of sufficient equipment for assessing and managing heat injuries is critical. Few high school football programs had a thermometer to measure a player's rectal (core) temperature or are prepared to immerse a hyperthermic athlete in an ice water tub for immediate on-site cooling. Managing the complications of exertional heat stroke typically requires advanced life support facilities; therefore, transfer of affected athletes is essential. However, cooling should not be delayed while awaiting transfer or interrupted if the athlete is stable.[14,19] The programs without appropriate equipment to rapidly cool an athlete with heat stroke need to appreciate that the rapid reduction of core temperature in a hyperthermic athlete is critical to reducing both morbidity and mortality for the player.[20]

The effectiveness of the PPE to reduce heat injury remains controversial.[21–23] Use of improved standardized forms may make the information collected by an examining physician more uniform and would assist in more consistent and prompt identification of individual risk factors. For example, history of heat injuries may increase a player's risk for incurring heat illness and exertional collapse on the field, and a history of sickle cell trait may increase a player's risk of exertion-related sickling that seems more prominent in hot conditions. These potential risks should be pointed out to coaches in the player clearance, so any suggested limitations or practice modifications for an athlete can be implemented and at-risk players can be monitored more closely. The small number of high school programs (4.4%) indicating that a PPE was not required may reflect either a lack of knowledge about the prerequisite for a PPE or that some programs allow athletes to try out and play before obtaining their PPE clearance.

Limitations

We recognize that the results are limited by reporting and recall biases. The term "heat injury" was not specifically defined, and this may have resulted in variable interpretation by programs answering the questions and may have caused a disparity in the responses. From the authors' clinical experiences working with football players and coaches, heat injuries are more likely to be underreported than overreported. Also, the group sampled here represented a relatively small subset of coaches, athletic trainers, team physicians, and others, given the large number of programs across the country. However, respondents were from programs and leagues representing 26 states with a broad spectrum of rules, policies, routines, and climates, providing novel insight into existing heat injury prevention practices in high school football. The majority of respondents were from Northern states, which may have skewed the data. Notably, there were no survey responses from Texas or many other Southern belt states with some of the largest number of high school football programs and greatest degree of heat stress.

CONCLUSIONS

As expected, numerous high school football programs are aware of certain factors that increase or reduce heat strain and heat injury risk on the field, and many are making some accommodations to improve player safety. However, the survey results provide strong evidence that much more needs to be done to reduce the incidence of heat-related injury and death in high school football. A summary of our key findings presented as "What programs are doing well" and "What programs need to improve" to reduce the risk for heat injuries in high school football is outlined in Table 2. Many of the recommendations presented here are based on the ACSM consensus statement on youth football and heat stress and injury risk.[15] The insight and shortcomings identified from this survey help to focus education efforts and recommendations that address accepted practices and improvements for football player safety.

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