Original Research

Heat Stress and Injury Prevention Practices During Summer High School Football Training in South Texas

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ABSTRACT

Int J Exerc Sci 3(2) : 55-63, 2010. The purpose was to describe practice conditions influencing the risk of heat stress to athletes in summer football training in South Texas high schools, and to compare these conditions to ACSM recommendations for heat stress/injury risk reduction in this population. Thirty (*N*=30) high school summer football practices were observed. Wet bulb globe temperature (WBGT) was measured before/after practices and practices were observed for: duration/ structure; athlete clothing; and rest break frequency/duration/content. Practices averaged 125±31 min and WBGT (pre- to post-practice) was 29.7±2.1°C to 31.2±2.2°C for morning, and 31.2±1.6°C to 28.9±1.2°C for evening practices. Most practices included contact (93%), and a majority were full-contact (53%). Most athletes wore full pads (83%) and medium/dark colored clothing (73%). Outside of scheduled breaks athletes removed helmets (63%), sat/knelt (63%), and had access to fluid (90%). Athletic trainers were present at 93% of the practices. A typical practice had 3 rest breaks, each lasting approximately 5 min. During breaks, athletes were provided fluid (93%), removed helmets (89%), and sat/knelt (76%), but were rarely provided shade (2%). While none of the practice sessions were conducted in conditions warranting the cancellation of outside activity (WBGT>33.1°C), the environmental data confirms that this region presents athletes with a very high risk of heat stress/injury. While a majority of the schools were taking many of the precautionary measures recommended by ACSM, many of the guidelines were not being followed. Governing bodies of high school athletics need to encourage compliance with recommendations for the reduction of heat stress/injury in this population.

KEY WORDS: Athletes, heat exhaustion, heat stroke, sports injury prevention, risk management, sports medicine

INTRODUCTION

The increased thermal challenge presented to the body when wearing a football uniform and the negative effect this ensemble has on the body's ability to dissipate heat have been well established (9-11,13,14). In 2005, the American College of Sports Medicine (ACSM) published a consensus statement detailing recommendations for youth football practice modifications to reduce the risk of heat exhaustion and exertional heat stroke risk in these athletes, particularly in pre-season (i.e., summer) practices (4). Two years after the publication of this roundtable consensus statement, Luke and his colleagues surveyed over 500 high school football programs in the U.S. concerning their practices and procedures

for conducting pre-season practice sessions (12). The investigators noted that practices to reduce the risk of heat stress and injury varied among programs, and that there was a need for programs to pay closer attention to the modification of practice session structure to reduce the risk of heat-related injury and death among participants (12). Unfortunately, the investigators reported that a limited number of the respondents in this study were from the Southern United States (12) where the climate tends to present athletes with greater heat stress during the summer months compared to many other regions of the nation (6). Additionally, there were no respondents from the Texas surveyed programs despite the large number of high school programs in that state (12).

The South Texas climate presents a significantly greater risk of heat injury to outdoor athletes than many other regions of the country, particularly in the month of August when pre-season high school football practices are held statewide. While adherence to precautionary recommendations from exercise science and sports medicine organizations such as ACSM (1,4) for the reduction of heat stress and injury risk are critical in all regions of the nation, it is even more so in regions such as South Texas. High school football programs in Texas must comply with rules established by the University Interscholastic League (UIL), the governing body of high school athletics in Texas, when scheduling practice sessions, including summer pre-season practices (5). The only UIL restrictions of relevance to the reduction of heat stress/injury with which the programs are expected to be in compliance deals with practice session duration. The UIL rules state that after the fourth day of summer pre-season, program participants may practice 3 hr · day^{-1} on days where only one practice is scheduled, and 5 hr · day^{-1} on days where two or more practice are scheduled. On multiple-practice days, no single practice can last more than 3 hr and there has to be a rest/recovery period between practices of at least 1 hr. Other than compliance with these regulations, the programs are free for the most part to determine practice session scheduling and structure. With the exception of the rest/recovery period between multiple practice sessions on a single day (ACSM recommends a 3 hr break between sessions), these regulations are in agreement with the ACSM recommendations for practice duration (4). However, the ACSM consensus statement also recommends that multiple-practice days should not be conducted on consecutive days, and that the practice duration and structure should be modified or cancelled based on the environmental conditions [i.e., wet bulb globe temperature (WBGT)]. Additionally, the consensus statement details other practice session structure modifications and recommendations to reduce the risk of heat stress and injury in the athlete. The UIL rules do not make reference to any of these environmental and practice session structure/scheduling factors.

The purpose of this investigation was to: 1.) describe practices and conditions influencing the risk of heat stress/injury to athletes participating in summer football training in a sample of South Texas high schools, and 2.) to compare these practices and conditions to ACSM recommendations for the reduction of heat exhaustion and exertional heat stroke risk in this population.

METHODS

Participants

Thirty high schools (N = 30) in South Texas were identified using information obtained from the UIL. Specifically, the UIL district alignment rosters were obtained via the internet (i.e., through public domain) (17). The high schools selected for participation were from the three largest classifications (5A, 4A, 3A) from UIL Region IV (South Texas) based on their proximity to Corpus Christi, TX.

Procedures

Data were collected over approximately two weeks in early August. During this time, participating high schools were in pre-season summer football training and had control over practice session scheduling and structure within UIL guidelines (i.e., schools had flexibility with regard to the times of day that they conduct practice sessions, the attire worn by players during practice sessions, practice session content, etc.) (5). Each high school was assigned to one of three investigators and each investigator was responsible for observing a single practice session at each of the schools he/she was assigned. Observation days were randomly assigned across the schools for each investigator. In most cases, the schools' web sites were used to determine practice session schedules for each school on a given observation day. If this information was not available on-line, the schools' were contacted directly to determine practice session schedules. These inquiries were made approximately one week prior to each school's scheduled observation. All practice sessions were open to the public, resulting in the data collection being classified as the observation of public behavior. Therefore, the participants (i.e., the schools being observed) were not required to provide informed consent according to the Texas A&M University-Kingsville Institutional Review Board (Human Subjects).

Measurements/Observations

Approval from the Texas A&M University-Kingsville Institutional Review Board (Human Subjects) was secured prior to data collection. In an attempt to improve measurement reliability, each investigator was provided with operational definitions for all required observations. The following observations/measurements were made at each individual practice session for each of the 30 high schools:

Environmental Information: Wet bulb globe temperature (WBGT) and its derivatives were measured using a commercially available field measurement device (Kyoto Electronics, Kyoto, JAPAN). Measurements were made after device stabilization (approximately 2 min) in duplicate at the beginning and end of each practice session.

Practice Session Duration: The time-of-day for the beginning and end of each practice session observed was recorded, from which practice duration (min) was derived. Practice duration was defined as the total amount of time a majority of members of the team was on the practice field and engaged in a structured practice session (i.e., including warm-up, instruction, scheduled rest breaks, etc.).

Practice Session Structure: The investigators recorded the degree of contact involved [Full (majority of active practice time involving live scrimmage and/or drills requiring full-speed contact) or Limited/None]; if helmets were removed by participants outside of scheduled breaks (Yes/No); if participants were allowed to sit/kneel outside of scheduled breaks

(Yes/No); fluid availability outside of scheduled breaks (Yes/No); on-field ice tub availability (Yes/No); and on-field athletic training staff availability (Yes/No). For each of these variables, investigators assigned a single "score" to each of the 30 sessions that best reflected the observed practices over a majority of each session.

Athlete Clothing: Investigators recorded whether or not athletes wore full-pads (defined as helmet, shoulder pads, and pants/leg pads)(Yes/No), and the type of primary clothing color worn by the majority of participants (Dark/Medium or Light). For each of these variables, investigators assigned a single "score" to each of the 30 sessions that best reflected the observed practices over a majority of each session.

Scheduled Rest Break Information: Investigators recorded the frequency (breaks per practice) and duration (min) of scheduled rest breaks. During these breaks, it was also recorded whether or not fluid was available to the participants (Yes/No); if participants removed their helmets (Yes/No); if they had the opportunity to sit/kneel (Yes/No); and if shade was available to them (Yes/No). For each of these variables, investigators assigned a single "score" to each scheduled rest break in each of the 30 sessions (total = 84 scheduled rest breaks) that best reflected the observed practices over a majority of each scheduled rest break.

Data Presentation/Statistical Analyses

For the environmental and practice duration variables, the sample was separated into those engaging in morning practices (AM) (n=12) and those practicing in the afternoon/evening (PM) (n=18). All the means are reported with ± standard deviation (SD). Differences between the groups for practice session duration were analyzed using an unpaired t-test, and within each group for WBGT differences between the start and end of the practice sessions using paired t-tests (SPSS, Chicago, IL). The level of significance for all statistical analyses was set at $p \leq 0.05$.

For descriptive purposes, practice session structure and athlete clothing data are presented as the percentage of the 30 sessions in which each practice was observed. Similarly, the scheduled rest break data is presented as the percentage of the 84 scheduled rest breaks observed in which each practice was noted. Where applicable, the means are reported with ± SD.

RESULTS

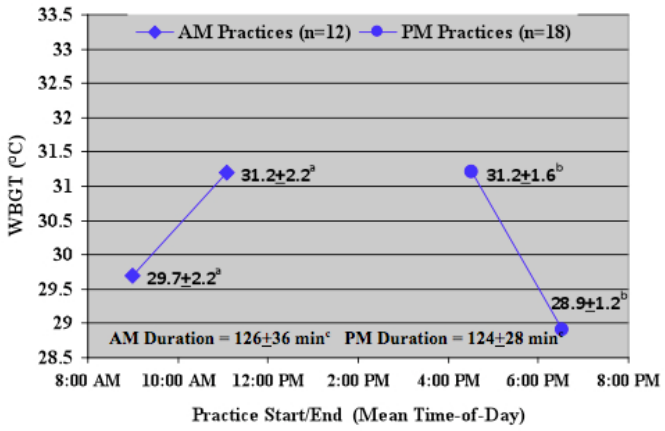

Figure 1. Wet bulb globe temperature (WBGT) progression over morning and afternoon football practice sessions. [a]practice start/end WBGT within AM practices (p=0.0621); [b] practice start/end WBGT within PM practices(p=0.0001); [c]AM and PM practice durations (p=0.8973).

Environmental Information / Practice Session Duration

As depicted in figure 1, the average practice session duration for the two groups were similar (p=0.8973). Additionally, the decrease in WBGT over the course of the

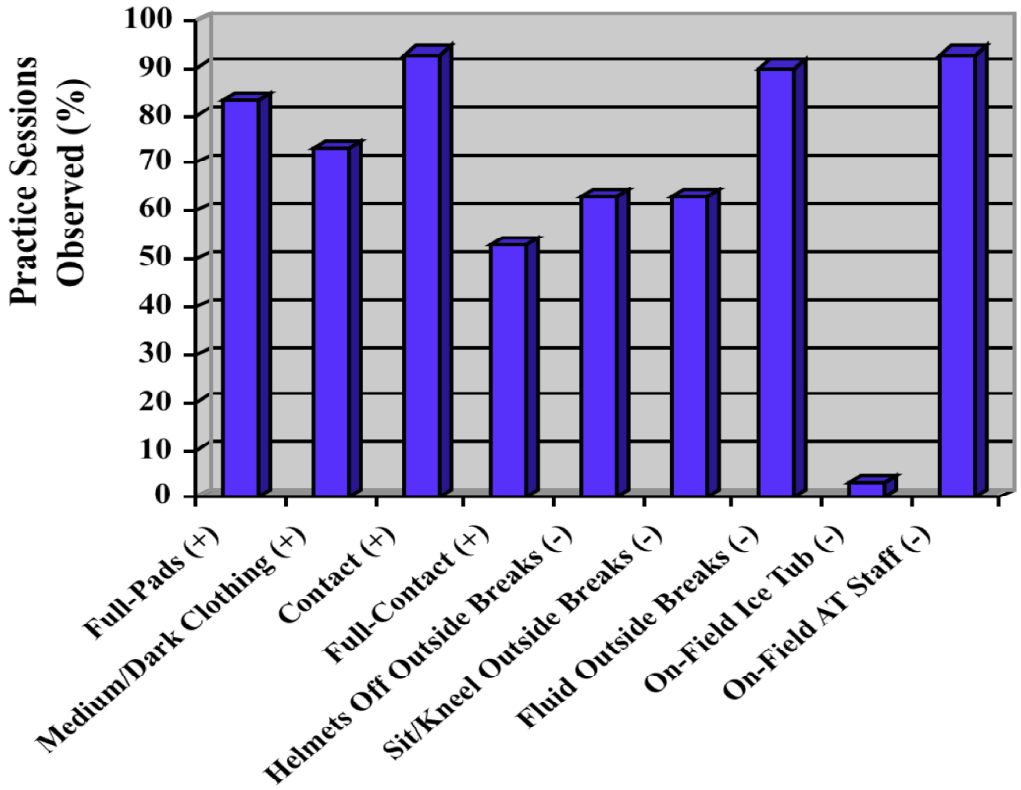

Figure 2. Athlete clothing and practice structure variables influencing heat stress and injury risk. + = positive risk factor for heat stress/injury; - = negative risk factor for heat stress/injury. Percentages derived from a sample of 30 practice sessions.

PM practice sessions depicted in figure 1 was statistically significant (p=0.0001) and the increase as depicted for the AM group was close to being statistically significant (p=0.0621).

Practice Session Structure/Athlete Clothing

As shown in figure 2, in a majority of the practice sessions observed there were a number of practice session structure-/athletic clothing-related practices that could help to reduce the risk of heat stress and injury among the participants. However, other practices were observed that could increase the risk of heat stress/injury (e.g., full contact, full pads, medium/dark colored clothing, no on-field ice tub availability) in most of the practice sessions.

Scheduled Rest Break Information

The average practice session included 2.8 $\pm$ 1.6 scheduled rest breaks lasting 5.3 $\pm$ 2.9 min. The recommended precautions to reduce the risk of heat stress/injury were being taken during a majority of the 84 scheduled rest breaks observed (e.g., fluid availability, helmet removal, sit/kneel), as shown in figure 3. The exception however is the fact that shade was made available to participants during very few of the scheduled rest breaks observed.

DISCUSSION

All of the practice session durations observed were within UIL rules and ACSM scheduling recommendations, and all were conducted in either the morning or late afternoon/evening as recommended by ACSM. While multiple observations were

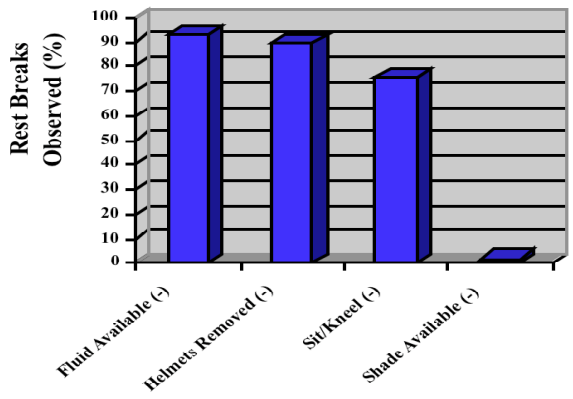

Figure 3. Scheduled rest break variables influencing heat stress and injury risk. - = negative risk factor for heat stress/injury. Percentages derived from a sample of 84 scheduled rest breaks.

not made on the schools, a delimitation of this study, we did have access to the summer practice schedules for most of the schools. None of the schools engaging in two-a-day practice schedule refrained from using this practice format on consecutive days. As mentioned previously, this was not in conflict with UIL rules, but goes against ACSM recommendations for practice structure/scheduling. While the investigators did not observe any single practice session being conducted in conditions warranting cancellation according to ACSM guidelines (WBGT>33.1°C) (8, 11), the environmental data support the fact that this region does in fact present athletes with a very high risk of heat stress and injury (3). This was despite the fact that the environmental conditions in the South Texas region for the year in which the data were collected were milder than normal compared to the same month in recent years (7). While the range of WBGT experienced throughout the practices was similar between the AM and PM groups, the WBGT was increasing throughout the duration of the AM practices and decreasing throughout the PM practices. This exposed the athletes in the AM group to greater environmental stress towards the end of their practice session when they would naturally be at greater risk of dehydration from excessive sweating (16), heat stress and injury due to fatigue and increased heat storage related to exposure time (15).

While athletes in a majority of the practice sessions were observed sitting/kneeling and/or removing their helmets outside of scheduled rest break, this recommended practice was not observed in nearly 40% of the sessions which is far from desirable. It was also observed that in nearly all of the practice sessions that fluid was made available to the participants outside of the scheduled rest breaks, and adequate athletic training staff were on-field. In most cases, fluid was available at individual practice stations allowing for greater access by the athletes. A similar attention to hydration was also noted in the sample of programs surveyed by Luke et al. in 2007 (12). However, it is of great concern that both of these ACSM recommended practices were not observed in 100% of the practice sessions.

The athletes wore full-pads (83%) and dark/medium colored clothing (73%) in a large majority of the practices, both of which are discouraged for the reduction of heat stress/injury (11, 13, 14). It was also noted that the primary practice uniform colors were usually aligned with each individual schools primary color, which tended to be a dark/medium color and not a light color. Additionally, the practice uniforms appeared to be old game uniforms. It is possible that the color of the practice jerseys worn was determined by financial reasons and not necessarily based

on what was optimal for the reduction of heat stress and injury risk. Despite the fact that most practices were conducted in full-pads, and the fact that almost all of the practices included contact, only approximately half of the practices were deemed to be full-contact. While it is possible that the practices that were deemed not to be full-contact were modified due to the environmental conditions, it was not possible for the investigators to assess this.

The presence of on-field ice (water) tubs was observed at only one of the 30 schools. While this does not necessarily mean that these tubs were not available to the athletic training staff at some other location on campus (e.g., the training room), it does at the very least mean that their proximity to the practice field was less than optimal. This concern is given to the importance of this mode of cooling in the emergency care of athletes suspected of exertional heat stroke (2).

It is recommended by ACSM that rest breaks be scheduled at least every 30-45 min during the practice sessions, and should include adequate time for the athletes to rest, cool, and replace their body fluids. This includes providing the athletes shade if possible. The average practice observed was in compliance with these guidelines with regard to scheduled rest break frequency, fluid availability, and the opportunity for the athletes to remove their helmets and sit/kneel. However, the average rest break length was only 5 min in duration (range = 1-10 min). It is unlikely that this rest break duration is adequate for rest, cooling, and fluid replacement. This is especially true given the fact that virtually none of the schools provided shade for these athletes during the scheduled rest breaks to help reduce the radiant heat stress on these athletes and improve their ability to dissipate heat.

While none of the schools that were observed were in violation of any of the practice structure/ scheduling regulations set forth by their state's governing body of high school athletics, these regulations are limited with regard to their recommendations for reducing the risk of heat stress/injury in high school football players when compared to the recommendations set forth in ACSM's 2005 consensus statement. However, it is apparent that most of the programs observed are taking many of the precautionary measures detailed in this publication in order to reduce heat stress and injury risk in this population, especially with regards to attention to fluid replacement in these athletes. Unfortunately, there were many recommendations that were not being followed including recommendations concerning practice structure and rest break duration/structure.

It is imperative that the governing bodies of high school athletics across the nation expand their guidelines for conducting football practices, particularly summer (pre-season) practices to include recommendations from exercise science and sports medicine organizations such as ACSM in order to reduce the risk of heat stress and injury among participants. This would include the monitoring of on-field WBGT as an index of heat stress, and the modification of practice structure based on these observations. Likewise, in programs where it is logistically possible, it is recommended that practices be held in the

late afternoon/evening hours where the environmental stress is typically decreasing throughout the practice sessions. Not only should this practice schedule reduce the risk of excessive sweating, heat stress and injury risk, but from an acclimatization standpoint it should also be effective as these athletes are training to practice and perform in the late afternoons/evenings as soon as the fall semester and football season begins.

As stated previously, a delimitation of this descriptive study was the fact that each school was only observed once. The resulting assumption being that the practice session observed at each school was reflective of each school's normal practice session structure, schedule, etc. It is recommended for future research of this nature that multiple observations be made at each school, and it would be preferable if each school's entire summer practice program was observed. Increasing the sample sizes (N=50+) of similar studies would also be preferable. Additionally, the study design did not allow for post-observation interviews with school athletic staff (e.g., coaches, athletic trainers) which would have enabled greater insight into the schools' rationales and decision making processes regarding practice session structure, scheduling, etc. These issues should be taken into consideration in future investigations in this area.

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