

Factors Affecting Incidence Rate of Exertional Heat Illnesses

Analysis of 6 Years of High School Football Practices in North Central Florida

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Background: Although experts have advocated for regionally specific heat safety guidelines for decades, guidelines have not been universally adopted.

Purpose: To describe the rate and risk factors associated with exertional heat illness (EHI).

Study Design: Descriptive epidemiology study.

Methods: For a 3-month period (August-October) over 6 years (2013-2018), athletic trainers at 13 high schools in North Central Florida recorded varsity football practice time and length, wet-bulb globe temperature (WBGT), and incidences of EHI, including heat stroke, heat exhaustion, and heat syncope.

Results: Athletes sustained 54 total EHIs during 163,254 athlete-exposures (AEs) for the 3-month data collection periods over 6 years (incidence rate [IR], 3.31 /10,000 AEs). Heat exhaustion accounted for 59.3% (32/54), heat syncope 38.9% (21/54), and heat stroke 1.9% (1/54) of all EHIs recorded. Of the EHIs, 94.4% (51/54) were experienced within the first 19 practices. The first 19 practices had an IR of 7.48 of 10,000 AEs, and the remaining 44 practices had an IR of 0.32 of 10,000 AEs, demonstrating that the risk of EHI for practices 1 to 19 was 23.7 times that of the remaining practices. When comparing morning to afternoon practices, 35.2% (19/54) EHI incidents occurred during morning practices. The risk of EHI during practices with WBGT >82°F (27.8°C) was 3.5 times that of practices with WBGT <82°F.

Conclusion: In the current study, the risk of EHI was greatest in the first 19 practices of the season and during practices with WBGT >82°F. As modifiable risk factors for EHI, increased vigilance and empowerment to adhere to acclimatization guidelines can mitigate EHI risk. Health care providers must continue to advocate for implementation of regulations and the authority to make decisions to ensure patient safety.

Keywords: football (American); athlete-exposure; risk; wet-bulb globe temperature

INTRODUCTION

Exertional heat illnesses (EHIs) affect thousands of high school athletes in the United States every year.¹¹ The most severe form of EHI, exertional heat stroke (EHS), is 1 of the top 3 causes of death in young athletes in the United States, particularly football players, and may be the leading cause of death in athletes during the summer months.^{2,19} From 1995 to 2018, a total of 64 American football players died secondary to EHS, with 47 of these being high school athletes.¹⁸ Nearly 83% of all EHI events in U.S. high school football occur during preseason practices and

scrimmages.²⁵ However, a 100% survival rate is attainable and has been documented in athletes sustaining EHS if whole-body cooling is initiated immediately and core body temperature is lowered to normal within 30 minutes of collapse.^{5,6} In addition, both extrinsic and intrinsic risk factors associated with EHI are known and described in the literature, including the most recent National Athletic Trainers' Association (NATA) position statement on EHIs.^{5,23} Extrinsic risk factors include hot and humid environmental conditions, excessive clothing/protective equipment, and inordinate pressure from peers/coaches/organizations to perform.^{1,5,23} Intrinsic risk factors for the development of EHI include inadequate heat acclimatization, poor physical fitness, elevated body mass index, high exercise intensity, concurrent illnesses, stimulant drugs/medications, lack of sleep, and excessive motivation to

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perform.^{1,5,23} Sports medicine team members, including team physicians and athletic trainers (ATs), should be aware of these risk factors and make activity modifications when possible to decrease the risk of EHI.²³

Heat acclimatization is a physiologic process that causes adaptations to the human body that progressively allow it to more effectively tolerate thermal stress.⁵ In 2009, the NATA Inter-Association Task Force (NATA-IATF) published preseason heat acclimatization guidelines for American football to be used by U.S. secondary schools in an attempt to reduce the risk of EHIs in this population.⁴ These guidelines recommend gradual acclimatization to the heat/humidity over the first 2 weeks of preseason practices to allow enough time for appropriate physiologic changes to occur.^{4,14}

Heat-acclimatization guidelines should be made based on the use of wet-bulb globe temperature (WBGT), which is a measure of environmental heat stress that provides a weighted average of relative humidity (wet bulb [WB]), radiant heat (globe temperature [GT]), and ambient air temperature (dry bulb [DB]) with the following formula: $WBGT = 0.7(WB) + 0.2(GT) + 0.1(DB)$.^{5,22} The use of WBGT guidelines allow activity modifications to occur with regard to work-to-rest ratios, activity levels, protective equipment worn, length of practice, and length and frequency of hydration breaks.^{5,22} These current activity modification guidelines (AMGs) for high school preseason football practice require at least 5 days of single sessions limited to 3 hours each under equipment restriction.⁴ During the second week of practice, 2 practices per day may be held but not on back-to-back days; a minimum of 3-hour rest periods are required between consecutive practices; practice times are limited to a total of 5 hours per day; and equipment and work/rest ratios are modified when environmental conditions warrant it.^{14,23}

Not every state high school athletic association mandates compliance with these guidelines; however, certain states began requiring mandatory heat acclimatization guidelines in 2011.¹ Compliance to these heat acclimatization guidelines in high school football programs improved in 2017 compared with 2011, due to the continued advocacy to improve the awareness of EHI; however, significant work on widespread change or adoption is still necessary.¹⁴ In addition, recent research suggests that state high school athletic associations that require adherence to the NATA-IATF heat acclimatization guidelines have seen rates of EHI in American football players fall by 55%.¹⁵ Proactive state associations are clearly making progress on policy implementation for safety in high school athletics but

continue to face barriers, including the lack of perceived value and understanding in addition to the cost affiliated with mandating health and safety policy recommendations.²⁰

Although sports medicine experts have been advocating for the need for regionally specific heat safety guidelines for decades, these guidelines have not been universally adopted. Activity modifications in cooler regions should not be the same as those in hotter regions given the difference in passive heat acclimatization levels in athletes in different geographic regions.¹⁶ In an effort to make regionally specific heat acclimatization recommendations possible, previous research has divided the country into 3 regions based on differences in WBGT: (1) mild region (Pacific Coast, New England, and the northern tier of the United States), (2) moderate region (Interior Northwest through Nevada and portions of the Midwest, Ohio Valley, and Northeast), and (3) hot region (Southeastern United States and areas of the Southwest and Central Valley of California).^{12,16} We have previously described the incidence rate (IR) of EHI in Florida high school football players in hot region 3 to be 1.92 per 1000 athlete-exposures (AEs) in football programs that followed the Georgia High School Association (GHSAA) Practice Policy for Heat and Humidity, as the Florida High School Athletic Association's (FHSAA) heat policy did not go into effect until June 23, 2020.^{10,23} Recommendations, including those from the NATA, have continued to evolve, noting the importance of regionally based AMGs for heat safety, yet they have not been universally adopted by all sports medicine organizations.

The purpose of the current study was to contribute to the literature regarding the rate and risk factors associated with IR of EHI as well as to continue to advance the importance of regionally based AMGs. While a few recent studies have provided EHI IR data for high school football athletes in the region, we aimed to contribute to the paucity of reports measuring WBGT on site, separating cramps from EHS, heat exhaustion, and heat syncope in this population.^{8,23} We addressed the following research questions:

1. What is the IR of EHI in high school football players in Florida during practices from August to October?
2. What factors are associated with incidence of EHI in high school football players in Florida during practices from August to October?

To address our primary research question, we calculated IR, clinical incidence, IR by practice number, and IR by WBGT. To address our second research question, we analyzed the effect of the interaction of WBGT and practice

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length on EHI IR as well as the relationship between activity modification policy implementation and EHI cases. The results from the current study add to a recent report on Georgia high school football practices that studied the effect of WBGT on EHI IR and reported EHI cases by practice number.⁸

METHODS

ATs serving 13 high schools in North Central Florida participated in this study. ATs provided on-site medical care for and collected data at all varsity football practices from August 1 through October 31, over 6 years (2013-2018). At each practice, data recorded included the date, time and length of practice, WBGT (in °F) at the beginning and end of practice, the number of athletes participating, and the number and type of any EHIs sustained. Before data collection began each fall, the primary researcher (B.L.T.) held a meeting to train all ATs on the data-collection methods, use of equipment, and data-recording forms. Each AT provided recorded data to the researchers on a weekly basis. The study protocol received institutional review board approval.

Definition of Illness

Researchers trained all 13 ATs on the standard EHI definitions using the NATA position statement,³ diagnostic criteria, and treatment procedures at the meeting before data collection began. ATs recorded cases of (1) EHS, (2) heat exhaustion, and (3) heat syncope (Table 1). Diagnoses recorded were based on AT assessments or emergency department notes for cases in which emergency transportation was necessary.

Instrumentation

Each AT used a digital handheld heat-stress monitor with a 4-cm globe (model WBGT8758; General Tools & Instruments) to measure WBGT. The portable monitors measure ambient temperature, relative humidity, radiant heat, and wind speed to calculate WBGT. To equilibrate the globe before each measure, each AT exposed the WBGT device to the sun for at least 5 minutes while standing on their football practice field. Each team practiced on grass fields. To record conditions at both the beginning and end of each practice, WBGT devices were held 0.91 to 1.2 m off the ground to estimate the heat stress at the torso level of athletes.²¹ Researchers had all WBGT devices calibrated twice each year: before data collection began and once again during data collection.

Activity Modification Guidelines

All schools adopted the FHSAA acclimatization policies as well as those dictating the number of practices per day as well as preseason equipment restrictions. Because FHSAA did not provide WBGT-based AMGs at the time of this research, all 13 high schools agreed to follow a standard policy based on the GHSA Practice Policy for Heat and

TABLE 1
Definitions of Exertional Heat Illnesses³

Heat syncope

Definition: Orthostatic dizziness associated with peripheral vasodilation, postural blood pooling, diminished venous return, decreased cardiac output, and cerebral ischemia

Signs and symptoms:

- Occurs during periods of acclimatization (before plasma volume expansion)
- May also be associated with cardiac conditions or the use of diuretics
- Presents immediately after stopping activity and standing (ie, breaking immediately after a sprint)
- Patient is usually hypohydrated and fatigued and has a diminished pulse
- Patient will complain of tunnel vision or lightheadedness or will faint/collapse with immediate response

Exercise (heat) exhaustion

Signs and symptoms:

- Usually occurs in hot, humid conditions when a patient experiences heavy sweating, hypohydration, sodium losses, and energy losses
- Difficult to differentiate with exertional heat stroke without assessing rectal temperature, in that the patient may be evaluated with early onset of altered mental status
- Athlete may have weakness, fainting, dizziness, headache, hyperventilation, nausea, diarrhea, intestinal cramping or persistent muscle cramping, decreased urine output, and mild hyperthermia, as measured via rectal thermometry (range, 36°C-40°C [97°F-104°F])

Exertional heat stroke

Signs and symptoms:

- Usually occurs in hot, humid conditions and presents with elevated core body temperature, as measured via rectal thermometry (usually >40°C [104°F]) and altered mental status
- Results from excessive heat production or inhibited heat loss
- Athlete may have tachycardia, hypohydration, hypotension, sweating, hyperventilation, vomiting, diarrhea, dizziness, drowsiness, irrational behavior, confusion, irritability, emotional instability, hysteria, apathy, aggressiveness, delirium, disorientation, staggering, seizures, loss of consciousness, and coma
- Results in organ system failure when immediate whole-body cooling is not used to return core temperature to near-normal temperatures

Humidity (Table 2).¹⁰ We chose these guidelines because of the similarity of environmental conditions and lack of published evidence-based guidelines for our region. Researchers did not standardize or modify hydration plans beyond those described in the policy in Table 2. ATs ensured that cold water and immersion tubs were readily accessible during all practices. Electrolyte supplements were accessible but seldom used during practices.

Data Analysis

Data for the 13 high schools over the 6-year time span (2013-2018) were compiled in a Microsoft Excel spreadsheet, cleaned, and coded for the month/day and environmental conditions (temperature, WBGT, and humidity),

TABLE 2
Activity Modification Guidelines Based on WBGT^{5,10a}

WBGT	Activity Guidelines and Rest Break Guidelines
<82.0°F (<27.8°C)	Normal activities; provide at least 3 separate rest breaks each hour of a minimum duration of 3 min each during workout
82.0°F-86.9°F (27.8°C-30.5°C)	Use discretion for intense or prolonged exercise; watch at-risk players carefully; provide at least 3 separate rest breaks each hour of a minimum duration of 4 min each
87.0°F-89.9°F (30.6°C-32.17°C)	<ul style="list-style-type: none"> · Maximum practice time is 2 h · For football: players restricted to helmet, shoulder pads, and shorts during practice; all protective equipment must be removed for conditioning activities · For all sports: provide at least 4 separate rest breaks each hour of a minimum duration of 4 min each
90.0°F-92.0°F (32.2°C-33.3°C)	Maximum length of practice is 1 h; no protective equipment may be worn during practice and there may be no conditioning activities; there must be 20 min of rest breaks provided during the hour of practice
>92.0°F (>33.3°C)	<ul style="list-style-type: none"> · No outdoor workouts · Cancel exercise; delay practice until a cooler WBGT reading occurs.

^aWBGT, wet-bulb globe temperature.

with the recorded WBGT measure at the start of the practice. The length of practice was converted from the start and end times to length in minutes, and any incomplete data points for each analysis were removed separately. The rate of EHI was quantified by calculating illness frequency by type and year. Next, we calculated the IR per 10,000 AEs,¹⁷ in which an AE was defined as 1 athlete participating in 1 session in which the athlete was exposed to the possibility of sustaining an athletic injury.⁸ We calculated IR by practice number and by WBGT AMG categories.

The estimated clinical incidence was calculated to identify the proportion of athletes who had at least 1 case of EHI during the fixed period (ie, fall sports season). Clinical incidence was defined as the occurrence of EHI cases per athlete, which is an indicator of resource utilization of expected frequency of EHI given a certain number of athletes.¹⁷ To calculate the estimated clinical incidence, we divided the number of total EHI cases in a season by the number of athletes at risk at the start of the season for the 78 time points (by year and by school). The average clinical incidence was then computed for the 6-year data collection period.¹⁷

Regression analyses were performed to determine predictors of EHI, including WBGT risk category and practice length. All statistical analyses were performed using SPSS Version 26 (IBM) with the significance set at $P < .05$ a priori.

RESULTS

Over the course of 6 years, regardless of EHI cases, the typical practice length exceeded 2 hours (mean, 151 ± 50 minutes) and would have been classified as normal for outdoor participation (mean WBGT, $79.5^\circ \pm 5.0^\circ$). From a total of 163,254 AEs, we identified 54 cases of EHI (IR per 10,000 AEs, 3.31 [95% CI, 2.43-4.19]). Many of the EHIs were heat exhaustion ($n = 32$, 59.3%; IR per 10,000 AEs, 1.96 [95% CI, 1.28-2.64]), while there were 21 incidents of heat syncope (38.9%; IR per 10,000 AEs, 1.29 [95% CI, 0.74-1.84]) and only 1 incident of EHS (1.9%; IR per 10,000 AEs, 0.06 [95% CI, -0.06 to 0.18]). We saw the greatest incidence of EHI in 2013 ($n = 17$, 31.5%) and in 2017 ($n = 14$, 25.9%).

The overall mean clinical incidence was 54 EHI cases per 4439 total athletes, for an overall mean of 0.01216. When individually analyzing the average clinical incidence over the data collection period, we identified a slight increase to 0.01579 or 1.579%, with the highest clinical incidence in 2017 at 1 high school that had 5 EHI cases with 30 athletes for a clinical incidence of 0.1667 or 16.67%.

Practice Number

We identified that 94.4% (51/54) of the EHI cases occurred during the first 19 practices beginning between August and October. For the first 19 practices, the IR was 7.48 per 10,000 AEs (95% CI, 5.43-9.53). For the remaining 44 practices (practices 20-63), the IR was 0.32 per 10,000 AEs (95% CI, -0.04 to 0.67), suggesting that practices 1 to 19 had 23.7 times the risk compared with those that followed. When analyzing this period further, we were able to discern that 74.1% ($n = 40$) of the total cases occurred between days 1 and 11, which dropped to 61.1% ($n = 33$) for days 1 to 8. However, the first 6 days of practice accounted for 48.1% ($n = 26$) of EHI cases. Nineteen of the 54 incidents (35.2%) occurred during a morning practice, all of which took place in the first 8 practices, annually. The overall frequency of EHI cases and IR per 10,000 AEs by practice number is displayed in Figure 1.

Wet-Bulb Globe Temperature

We compared EHI IR during practices with an average WBGT falling within each category for activity modifications (Table 3). Practices with WBGT $>82^\circ\text{F}$ had 3.5 times the risk (6.25/10,000 AEs [95% CI, 4.18-8.32]) compared with practices with WBGT $<82^\circ\text{F}$ (1.77/10,000 AEs [95% CI, 0.98-2.57]). Our regression analysis identified that WBGT at the start of practice was not a predictor of EHI incidence ($R^2 = 0.013$, $P = .848$); however, we did identify that the average WBGT during practice was a weak but significant predictor of EHI ($R^2 = 0.001$, $P = .038$).

Policy Factors (Risk Category and Practice Length)

When we categorized WBGT data using the AMG categories (Table 3), we did not identify a significant influence of WBGT at the start of practice on cases of EHI ($P = .135$).

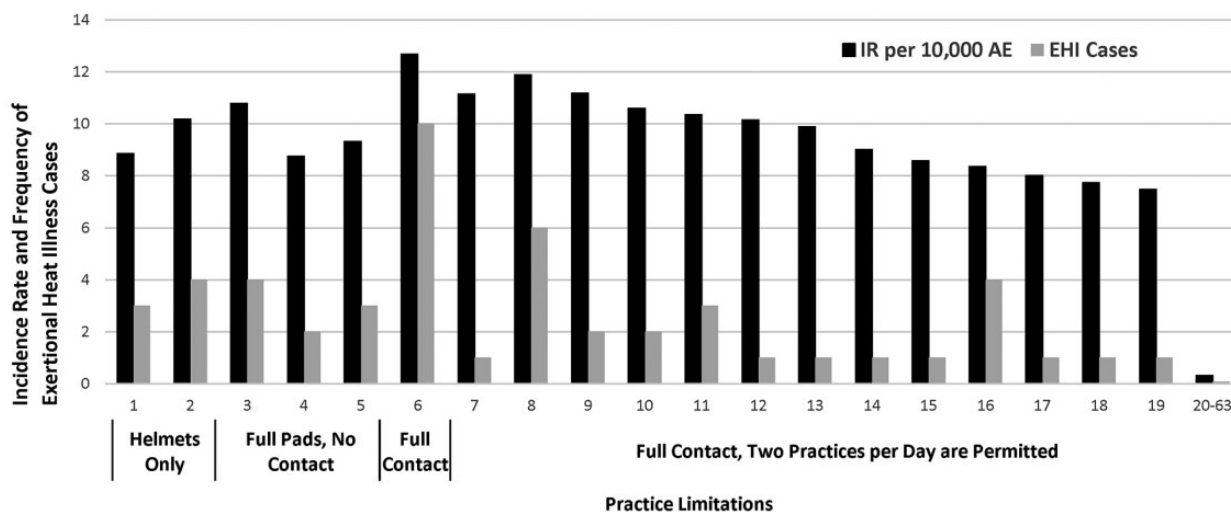


Figure 1. Exertional heat illness (EHI) cases and incidence rate (IR) per 10,000 athlete-exposures (AEs) by practice number in relation to heat acclimatization policy.

TABLE 3

Football Practice Length, EHI Cases, and IRs for Each Risk Category Based on Average WBGT Measured On Site^a

WBGT	Risk Category	No. of Valid Practices Recorded (%)	Mean Length of Practice, min	EHI Cases	IR per 10,000 AE
<82.0°F (27.8°C)	Normal athletic activity	2084 (65.5)	153 ± 50	19	1.77
82.0°F-86.9°F (27.8°C-30.5°C)	Use discretion	974 (30.6)	150 ± 50	30	6.04
87.0°F-89.9°F (30.6°C-32.17°C)	Max 120 min of athletic activity	114 (3.6)	144 ± 62	5	8.83
90.0°F-92.0°F (32.2°C-33.3°C)	Max 60 min of athletic activity	11 (0.3)	94 ± 42	0	0
>92.0°F (>33.3°C)	No outdoor activities	0 (0.0)	N/A	0	0

^aAE, athlete-exposure; EHI, exertional heat illness; IR, incidence rate; N/A, not applicable; WBGT, wet-bulb globe temperature.

However, the start of practice WBGT may not be the best or only indicator as the AMG categories discuss WBGT and length of practice. To further the combination of policy factors, we identified 3193 valid data points with a categorized WBGT measured at the start of practice in combination with practice length (in minutes). Of the identified practices that fell into modified risk categories (maximum of 2 h, maximum of 1 h, no outdoor practice), most did not adhere to the policy guidelines designed to prevent EHIs.

In a follow-up descriptive analysis for data points that had length of practice (n = 2622), the risk-categorized WBGT at the start of practice, and EHI incidence, we identified 330 practices that were categorized as requiring a modification (WBGT, >87). Of these 330 practices, 205 (62.1%) had a practice length that exceeded the AMGs, which suggests policy nonadherence. However, the analysis revealed that only 13% (7/54) of the EHI cases occurred during practices that were violating the policy, suggesting that the vast majority of EHI cases occurred during “normal” athletic activity or “use discretion” risk categories (WBGT, <86.9). The length of practice during which an athlete suffered an EHI was 177 ± 61 minutes (95% CI, 157-198 minutes), while practices without EHI cases lasted 151 ± 49 minutes (95% CI, 149-152 minutes). Our

regression identified that practice length combined with WBGT at the start of practice was a weak but significant predictor of EHI cases ($R^2 = 0.005$, $P < .001$), suggesting that EHI prevention is multifactorial.

DISCUSSION

Out of 163,254 AEs recorded over the 6-year study period, there were 54 cases of EHI, leading to an IR of 3.31 per 10,000 AEs. Numerous studies have evaluated the IR of EHI in athletes, although differences exist in region/climate, specific athletic population (collegiate vs secondary school), reporting methods, and inclusion of types of EHI studied. We recorded only heat syncope, heat exhaustion, and heat stroke and did not include dehydration, heat cramps, or hyponatremia. Tripp et al²³ reported an IR of 11.92 per 10,000 AEs (1.92/1000 AEs) EHIs (including heat cramps, heat exhaustion, and heat syncope) in high school football athletes in North Central Florida in a 3-month period (August-October). Cooper et al⁷ calculated an IR of 11.52 per 10,000 AEs (1.52/1000 AEs) over 4 football seasons in 60 colleges and universities representing 5 geographic regions of the United States. EHIs reported in the

study included heat cramps, heat syncope, and heat exhaustion.⁷ Yeargin and colleagues²⁴ evaluated the epidemiology of EHIs (dehydration, heat syncope, heat cramps, heat exhaustion, hyponatremia, and EHS) in 25 collegiate sports. In this report, football accounted for 75% of all EHI events and an IR of 1.55 per 10,000 AEs.²⁴ It should be noted that while rates of EHI are high for high school athletes participating in soccer, wrestling, basketball, and track and field, the rate of EHI in football was exceedingly higher than that for all other sports—11 times that of all other sports combined.²⁴

Previous research has suggested that the majority of EHI in both high school and collegiate football players occurs in the preseason during practice.^{13,23,24} Cooper et al⁷ reported the greatest risk of EHI within the first 14 days of practice in collegiate football players. These researchers noted an increase in EHI during the first 2 practices and then again for practice 7 (which corresponded to the start of double-session practices), and risk remained elevated through practice 15.⁷ Although our population was high school football athletes, our results are similar to those reported by Cooper et al.⁷ Of the EHIs we recorded, 94.4% (51/54) were sustained within the first 19 practices of the season. The first 19 practices had an IR of 7.48 per 10,000 AEs, compared with 0.32 per 10,000 AEs for the remaining 44 practices. The risk of EHI for practices 1 to 19 was 23.7 times the risk compared with the remaining practices ($n = 44$). Upon closer examination, 61.1% (33/54) of cases of EHI were suffered in practices 1 to 8 and 74.1% (40/54) in practices 1 to 11. These findings further support the importance of heat acclimatization and the need for adherence to NATA-IATF preseason heat acclimatization guidelines that have been shown to decrease rates of EHI by 55% if followed appropriately.^{4,15}

Although not strong predictors, average WBGT and WBGT at the start of practice by length of practice were significant predictors of EHI. As such, factors like WBGT and the length of practice under elevated WBGT must be considered when monitoring and modifying football practices. This finding, when viewed in the context of the first 19 practices yielding 94.4% (51/54) of EHIs sustained and 23.7 times the risk compared with all remaining practices, suggests that reducing maximum practice length during this period may mitigate risk. Immediate access to knowledgeable and trained medical care in the prevention, recognition, and management of EHI and specifically, access to ATs is imperative to mitigating risk, initiating an emergency action plan, and immediately treating EHIs when they occur.⁵ Recent research indicates that continued advocacy by state high school athletic associations and sports medicine advisory committees for the implementation of health and safety policies is necessary to enhance the overall health and safety of secondary school athletes.²⁰

The NATA and American College of Sports Medicine have published position statements recommending environmental heat stress monitoring with WBGT to make regional AMGs to help mitigate the risk of EHI.^{5,7,22} In college football players, Cooper et al⁷ reported that the rate of EHI was higher when the WBGT was $>82^{\circ}\text{F}$.⁷ While,

unlike Cooper et al,⁷ we recorded EHI during high school football practices and measured WBGT on site, our results were similar. We observed 3.5 times the risk of EHI during practices with WBGT $>82^{\circ}\text{F}$ compared to those with WBGT $<82^{\circ}\text{F}$. In addition, we also identified that the average WBGT during practice is a significant predictor of EHI. As resources allow, we suggest strong consideration for monitoring of WBGT throughout practice sessions in an effort to reduce the incidence of EHI. These findings contribute to the current recommendation that best practices for high school athletic programs should use WBGT to measure environmental conditions on site and modify activity accordingly as part of their heat safety policies to prevent EHI. Our findings suggest that WBGT should be monitored throughout practice sessions to determine practice safety.

Limitations

The EHIs reported in this analysis occurred only in high school football athletes in North Central Florida, which limits comparisons to different geographical regions and populations. In addition, we relied on reporting from ATs who were on the field with the football players when injuries occurred, which could lead to reporting errors, though we personally trained all ATs on the diagnosis and definitions of EHIs using the best available literature. Another factor limiting comparisons among published reports was that we did not record heat cramps as a reportable EHI because recent literature supports that heat cramps neither predispose athletes to other more serious conditions nor typically cause loss of sports participation due to exposure to heat alone.⁹ Lastly, all outdoor football activities in our study population occurred on grass surfaces, which prevented comparison with other athletic surfaces.

Future Research

The findings in this study relative to practice length pose interesting questions about policy adherence with AMG standards for WBGT and practice length. Although only 11 practices required a time modification not to exceed 60 minutes, the mean length of practice was 90 minutes. Those practices that should have been restricted to 120 minutes based on AMG risk categorization lasted on average 25 minutes longer than recommended. The ATs were trained in the GHSA guidelines, yet practices often exceeded the recommended length, which suggests an implementation and adherence failure. Although our data did not identify that practice length alone was a strong predictor of EHI, we know that high school athletic associations that require adherence to the NATA-IATF heat acclimatization guidelines have seen rates of EHI in American football players fall by 55%.¹⁵ Future research should evaluate the implementation challenges at the AT level for adhering to acclimatization and AMGs as well as evaluate programs that have been effective at decreasing EHI risk by implementing and adopting best practices.

CONCLUSION

In this study, we identified lower IRs as compared with previous research, but this is likely due to the exclusion of heat cramps from our analyses, which, as we know from contemporary literature, are not influenced by environmental heat. We were able to discern an alarming 23.7 times increased risk associated with the first 19 practices and a 3.5 times increased risk associated with practices with WBGT >82°F. We also identified that the average length of practice when an EHI occurred lasted almost 3 hours. These factors are modifiable and within the scope of acclimatization guidelines, which, when implemented, are effective at mitigating the risk of EHI. However, barriers still exist for the adoption, implementation, and adherence of these guidelines. Continued efforts are needed to ensure patient safety when the risk of EHI is high; specifically, sports medicine professionals should be readily accessible and empowered to make decisions to mitigate EHI risk for high school athletes.

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