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Exertional Heat-Stroke Preparedness in High School Football by Region and State Mandate Presence

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Context: Exertional heat stroke (EHS) is a leading cause of sudden death in high school football players. Preparedness strategies can mitigate EHS incidence and severity.

Objective: To examine EHS preparedness among high school football programs and its association with regional and state preseason heat-acclimatization mandates.

Design: Cross-sectional study.

Setting: Preseason high school football programs, 2017.

Patients or Other Participants: A total of 910 athletic trainers (ATs) working with high school football (12.7% completion rate).

Main Outcome Measure(s): We acquired data on high school football programs' EHS preparedness strategies in the 2017 preseason via an online questionnaire, looking at (1) whether schools' state high school athletic associations mandated preseason heat-acclimatization guidelines and (2) heat safety region based on warm-season wet-bulb globe temperature, ranging from the milder region 1 to the hotter region 3. Six EHS-preparedness strategies were assessed: EHS recognition and treatment education; policy for initiating emergency medical services response; emergency response plan enactment; immersion tub filled with ice water before practice; wet-bulb globe temperature monitoring; and hydration access. Multivariable binomial regression models estimated the prevalence of reporting all 6 strategies.

Results: Overall, 27.5% of ATs described their schools as using all 6 EHS-preparedness strategies. The highest prevalence was in region 3 schools with state mandates (52.9%). The multivariable model demonstrated an interaction in which the combination of higher heat safety region and presence of a state mandate was associated with a higher prevalence of reporting all 6 strategies ($P = .05$). Controlling for AT and high school characteristics, the use of all 6 strategies was higher in region 3 schools with state mandates compared with region 1 schools without state mandates (52.9% versus 17.8%; prevalence ratio = 2.68; 95% confidence interval = 1.81, 3.95).

Conclusions: Our findings suggest a greater use of EHS-preparedness strategies in environmentally warmer regions with state-level mandates for preseason heat acclimatization. Future researchers should identify factors influencing EHS preparedness, particularly in regions 1 and 2 and in states without mandates.

Key Words: athletes, exertional heat illness, high school sports, regional variations, safety policies

Key Points

- In total, 57.1% of surveyed athletic trainers described having an immersion tub filled with ice water before the start of preseason practices for the 2017 high school football season.
- High schools located in region 3 (ie, wet-bulb globe temperature ≥32.3°C) and states mandating the National Athletic Trainers' Association Inter-Association Task Force preseason heat-acclimatization guidelines (52.9%) displayed the highest prevalence for using all 6 examined exertional heat-stroke–preparedness strategies.

Exertional heat stroke (EHS) is a severe type of exertional heat illness that can result in permanent disability or death if not properly treated.[1–3] In the United States, EHS is a leading cause of sudden death in athletes,[4] particularly football players.[5] From 1960 through 2017, a total of 61 football players died of EHS; most were less than 18 years of age.[6] Deaths from EHS are preventable with appropriate treatment,[1] justifying the need for prevention interventions to reduce their incidence and related mortality.

One integral component of injury prevention is *preparedness*, or the ability to ensure that precautionary measures are in place to mitigate the severity associated with potential catastrophic outcomes. This includes strategies that may not directly prevent EHS but rather aid efforts to ensure proper management when an adverse event does occur. As noted in the National Athletic Trainers' Association (NATA) position statement on emergency planning in athletics, "preparation for response to emergencies includes education and training, maintenance of emergency equipment and supplies, appropriate use of personnel, and the formation and implementation of an emergency plan.[7(p99)] A subsequent position statement[3] by the NATA that was specific to exertional heat illnesses outlined the best practices for preventing and managing these conditions and included a number of risk-factor–prevention and management-preparedness strategies.

The level of preparedness in a high school football sports program may vary as a result of many clinical and administrative factors. For example, it is possible the perception of EHS risk may be higher in warmer regions. However, census region-specific analyses do not provide information on regional variations of environmental conditions within states. The creation of EHS preparedness guidelines based on geographic location allows for appropriate modifications to be implemented for the population at risk.[8] For example, exercise modifications in generally cooler regions should not be the same as those in hotter regions because of different levels of passive heat acclimatization. During heat waves, high schools in relatively cooler areas may have athletes who are not acclimatized to this extreme, and the schools' policies may not offer sufficient protection. Active heat acclimatization includes gradually phasing in exercise during the heat; this and other preparedness strategies are important to help ensure appropriate responses should an adverse event occur.

Previous researchers[9,10] have examined the use of preseason heat-acclimatization strategies in high school football players. Whereas earlier authors[9] demonstrated a lack of compliance with best practices at the high school level, state-level mandates regarding heat acclimatization for their member schools were associated with better implementation. Our aim was to estimate EHS preparedness among US high school football programs during the 2017 preseason. Furthermore, we examined how EHS preparedness was associated with regional guidelines and state-level mandates for preseason heat acclimatization.

METHODS

The study was approved by the institutional review board at the University of North Carolina as part of a larger study to evaluate compliance with the NATA Inter-Association Task Force (IATF) preseason heat-acclimatization guidelines in high school football. However, we collected additional measures to further examine the prevention of exertional heat illness, including EHS-preparedness strategies. The methods were based on previous research.[9]

Study Sample and Recruitment

Data were obtained from athletic trainers (ATs) working with US high school football programs in the 2017 season. Eligible ATs (1) had a valid e-mail address, (2) were NATA affiliated, (3) elected to receive surveys via the NATA membership list, and (4) were working in the high school football setting.

Overall, 7278 ATs were invited to participate in this study. Nonrespondents received up to 8 e-mail reminders during the 4-month data-collection period (December 2017 to March 2018). Because the NATA membership list did not specifically delineate those ATs working in high school football programs, our survey inquired whether they worked with a high school football program in the 2017 season; those who did not were notified that they did not meet the inclusion criteria (n = 92). We were unable to account for whether ATs from the same high school responded to the survey. Of the remaining 7186 respondents, 1214 consented to begin the survey; 910 completed it and provided data for our main exposure, outcome, and covariates of interest (12.7% completion rate).

Survey Instrument

We designed our survey to replicate one used in a previous study[9] to address secondary schools' compliance with the NATA-IATF heat-acclimatization guidelines.[11] However, in addition to compliance with these guidelines, our main outcome of interest was the use of EHS-preparedness strategies discussed in the NATA position statement on exertional heat-illness prevention[3] and the IATF best-practice recommendations for preventing sudden death in high school athletes.[12] Participating ATs indicated whether their high school football programs implemented such EHS-preparedness strategies during the 2017 preseason. *Preseason* was defined as "the period usually 2–3 weeks before the first game of the regular football season, characterized by athletes participating in football-specific training, in which equipment is phased in, and football specific training and skills are conducted."[9] This definition excluded summer conditioning that occurred before football-specific training.

We pilot tested the survey with a convenience sample of 5 ATs who cared for high school athletes. We explained the study purpose to these ATs, emphasizing our intent of ensuring comparability between our findings and the previous investigation. The recommended changes, which focused on aiding participant comprehension, were applied to the survey.

Preparedness for EHS (Main Outcome). Responding ATs denoted whether their high schools used EHS-preparedness strategies that addressed both risk-factor prevention and management preparedness (*yes*/*no*). The 6 EHS-preparedness strategies that we examined originated from the NATA position statement on exertional heat illness[3]: (1) education for the recognition and treatment of EHS, (2) policy with instructions for initiating emergency medical services response, (3) emergency response plan enacted for school athletics, (4) immersion tub filled with ice water before the start of practice; (5) monitoring wet-bulb globe temperature (WBGT), and (6) hydration access (ie, athletes given water breaks or open access to water).

Heat-Safety Region (Main Exposure). High school zip codes, as reported by the ATs, were categorized into 3 heat-safety regions on the basis of previous research by Grundstein et al[8] (Figure 1). These regions were based on warm-season WBGTs from 1991 through 2005 and could account for multiple environmental variables across and within states, including temperature, humidity, wind, and radiant heating. Regions were grouped on the basis of extreme (90th-percentile) daily maximum WBGT. The mild region 1 (WBGTs $\leq$30°C) consisted of the Pacific Coast, New England, and the northern tier of the United States; the moderate region 2 (WBGTs 30.1°C–32.2°C) extended in an arc from the interior Northwest through Nevada and portions of the Midwest, Ohio Valley, and

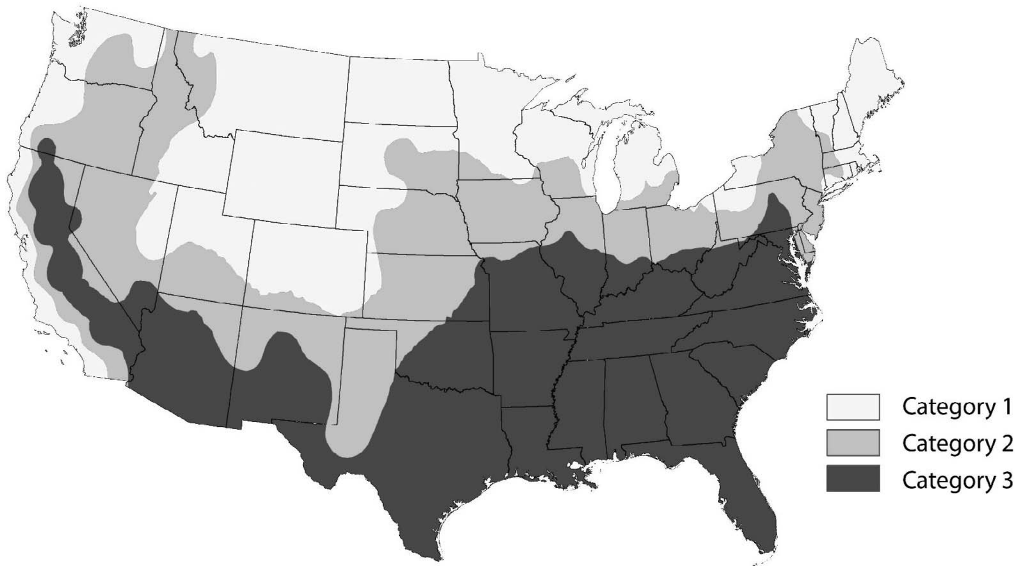

Figure 1. United States heat-safety regions (Reprinted with permission from Grundstein et al[8]).

Northeast; the hot region 3 (WBGTs $\geq$32.3°C) contained much of the southeastern quadrant of the United States, along with portions of the Southwest and the Central Valley of California.[8]

State-Level Mandates for Preseason Heat Acclimatization (Main Exposure). Earlier authors[9] found that high school football programs located in states whose athletic associations mandated guidelines for preseason football heat acclimatization were more likely to use EHS-prevention strategies. Thus, we included a variable to account for whether states mandated such guidelines. The 8 states mandating such guidelines during the 2017 high school football season were Arizona, Connecticut, Iowa, Mississippi, New Jersey, North Carolina, Rhode Island, and Utah.[13]

Covariates. Covariates of interest were also obtained from the survey. The ATs provided demographic information and years of experience as well as school-related characteristics including state, enrollment size, and number of student-athletes at their school during the 2017–2018 school year.

Statistical Analysis

Descriptive analyses were performed on AT demographics and high school characteristics. We then computed the number of EHS-preparedness strategies that were used by each high school football program (ie, range = 0–6). Next, we calculated the proportion of programs that reported using all 6 EHS-preparedness strategies as well as the proportion reporting each individual strategy.

For comparative analyses, χ^2 tests (or Fisher exact tests when the required assumptions could not be met) described distributions of the prevalence of reporting the use of all 6 EHS-preparedness strategies and each individual strategy by first, heat-safety region, and second, state-level mandate. Resulting P values $<.05$ were deemed statistically significant.

Last, we calculated multivariable binomial regression models to estimate the use of EHS-preparedness strategies by heat-safety region and state-level mandate while controlling for AT demographics and high school characteristics. Models were run first for the prevalence of reporting the use of all 6 EHS-preparedness strategies and then for each individual strategy. All binomial regression models used Poisson residuals and robust variance estimation to stabilize model fit.[14–16] For the model predicting the use of all 6 EHS-preparedness strategies, we also considered a potential interaction between heat-safety region and state-level mandate. We decided a priori to retain the interaction if the associated P value was $<.10$ (to account for the larger statistical power needed for such an analysis) and when among the 3 heat-safety regions, the percentages of reporting the use of all 6 EHS-preparedness strategies between those with and those without state-level mandates appeared different (to mitigate the potential for type II error).

All prevalence ratios (PRs) with 95% confidence intervals (CIs) not including 1.00 were considered statistically significant. An example of a PR comparing the prevalence of filling an immersion tub with ice water before practice in region 3 versus region 1 follows:

$$\mathrm{PR} = \frac{\left[\dfrac{\text{Number reporting filling an immersion tub with ice water before practice in region 3}}{\text{Number of responses in region 3}}\right]}{\left[\dfrac{\text{Number reporting filling an immersion tub with ice water before practice in region 1}}{\text{Number of responses in region 1}}\right]}$$

RESULTS

Sample Characteristics

Of the 910 respondents included in the analyses, most were women (54.1%) and less than 40 years of age (64.0%) with $\geq$10 years of AT experience (51.1%), and $\geq$5 years of experience at their current high school (50.5%; Table 1). The majority of ATs were located at high schools with 500 or more students enrolled (81.0%). Using the Grundstein et al[8] heat-safety regions, the largest proportion of ATs were from high schools in region 3 (44.4%), followed by region

Table 1. Athletic Trainers' (ATs; n = 910) and High School Characteristics, 2017 Football Preseason

Characteristic	n (%)
AT	
Sex	
Female	492 (54.1)
Male	418 (45.9)
Age, y	
20–29	329 (36.2)
30–39	253 (27.8)
40–49	176 (19.3)
≥50	152 (16.7)
Years as AT	
<5	235 (25.8)
5–9	210 (23.1)
10–19	205 (22.5)
≥20	260 (28.6)
Years at current school	
<3	277 (30.4)
3–4	173 (19.0)
5–14	166 (18.2)
≥15	294 (32.3)
High school	
Heat-safety region[a]	
1	242 (26.6)
2	264 (29.0)
3	404 (44.4)
State-level mandate?[b]	
Yes	144 (15.8)
No	766 (84.2)
Student enrollment (2017–2018 year), No.	
<500	173 (19.0)
500–999	230 (25.3)
1000–1999	321 (35.3)
≥2000	186 (20.4)
Student-athletes (2017–2018 year), No.	
<250	180 (19.8)
250–499	387 (42.5)
500–-749	199 (21.9)
≥750	144 (15.8)
Football 2017 preseason roster, No.	
<39	186 (20.4)
40–59	244 (26.8)
60–79	180 (19.8)
≥80	300 (33.0)

[a] Heat-safety regions were based on Grundstein et al.[8] The mild region 1 consisted of the Pacific Coast and northern portions of the United States; the moderate region 2 consisted of the midsection of the United States; the hot region 3 consisted of the Southern United States.

[b] During the 2017 season, the 8 states that had state-level mandates for the National Athletic Trainers' Association Inter-Association Task Force preseason heat-acclimatization guidelines were Arizona, Connecticut, Iowa, Mississippi, New Jersey, North Carolina, Rhode Island, and Utah.[12]

2 (29.0%) and region 1 (26.6%). Also, 15.8% of ATs were from high schools with state-level mandates.

Prevalence of EHS-Preparedness Strategies

More than a quarter of ATs (27.5%) noted that their high schools used all 6 EHS-preparedness strategies examined in this study (Table 2); however, the largest proportion of ATs stated their high schools used just 5 (37.1%). The most common EHS-preparedness strategy was "Hydration access" (98.7%), whereas the least common were "Immersion tub filled with ice water before start of practice" (57.1%) and "Monitor wet-bulb globe temperature" (53.0%). In fact, 18.5% indicated they used all EHS-preparedness strategies except for "Monitor wet-bulb globe temperature"; 15.0% said they used all except for "Immersion tub filled with ice water before start of practice." An additional 404 respondents (44.4%) described not using WBGT but instead checking environmental temperature and humidity. An additional 294 respondents (32.3%) commented that they did not have an immersion tub filled with ice water before the start of practice but used other cooling methods, including but not limited to ice bags/cooler (n = 248), fans (n = 81), and mist machines/water sprays (n = 67).

Variations in the Prevalence of EHS-Preparedness Strategies by Heat-Safety Regions and State-Level Mandates

When examining the prevalence of reporting the use of all 6 EHS-prevention strategies by heat-safety region, we found the highest proportion in region 3 (34.2%), followed by region 2 (25.4%) and region 1 (18.6%; Figure 2A). Differences in distributions of reporting the use of all 6 strategies occurred by heat-safety region (χ^2, $P < .001$; Table 2). Similar differences in distributions were present for specific EHS-preparedness strategies.

Distributions also varied by state-level mandates (χ^2, $P = .03$), with 34.7% of respondents reporting the use of all 6 strategies in states with mandates, compared with 26.1% in states without mandates (Figure 2B). In addition, similar differences in distributions were identified for specific EHS-preparedness strategies.

Multivariable Models Estimating the Prevalence of EHS-Preparedness Strategies

The multivariable model estimating the prevalence of reporting the use of all 6 EHS-preparedness strategies retained the interaction term between heat-safety region and state-level mandates ($P = .05$; Table 3). Compared with those high schools both located in region 1 and without state-level mandates, all other groups had larger prevalences of using all 6 EHS-preparedness strategies, although the findings were only statistically significant for high schools located in region 3, regardless of whether they had state-level mandates. Moreover, evidence indicated that both regional and state-level mandates were associated with use, but the highest prevalence occurred among high schools that were both in region 3 and in states with mandates. The prevalence of reporting the use of all 6 EHS-preparedness strategies was also higher in region 3 than in region 1 for both state-level mandate strata (without state-level mandate stratum-adjusted PR = 1.61; 95% CI = 1.17, 2.23; with state-level mandate stratum-adjusted PR = 2.21; 95% CI = 1.10, 4.49). Furthermore, the only heat-safety region stratum with significant differences in the prevalence of reporting the use of all 6 EHS-preparedness strategies was region 3 (with versus without state-level mandate-adjusted PR = 1.66; 95% CI = 1.22, 2.26).

In multivariable models estimating the prevalence of each EHS-preparedness strategy, region 3 had higher usage

Table 2. Distributions of Exertional Heat Stroke (EHS)-Preparedness Strategies Reported by Athletic Trainers at US High Schools by Heat-Safety Region, 2017 Football Preseason

Prevalence of Reporting the Use of EHS-Preparedness Strategy(ies)	n (%)							
		Heat-Safety Region[a]				State-Level Mandate?[b]		
	Total	1 (n = 242)	2 (n = 264)	3 (n = 404)	*P* Value[c]	No (n = 766)	Yes (n = 144)	*P* Value[c]
All 6 strategies	250 (27.5)	45 (18.6)	67 (25.4)	138 (34.2)	<.001[f]	200 (26.1)	50 (34.7)	.04[f]
Individual strategy								
Hydration access	898 (98.7)	239 (98.8)	257 (97.4)	402 (99.5)	.06	756 (98.7)	142 (98.6)	>.99
Emergency response plan enacted for school athletics	847 (93.1)	225 (93.0)	243 (92.1)	379 (93.8)	.68	709 (92.6)	138 (95.8)	.15
Policy with instructions for initiating emergency medical services response	833 (91.5)	225 (93.0)	235 (89.0)	373 (92.3)	.21	706 (92.2)	127 (88.2)	.12
Trained athletic training staff for recognition and treatment of EHS	750 (82.4)	189 (78.1)	213 (80.7)	348 (86.1)	.02[f]	628 (82.0)	122 (84.7)	.43
Immersion tub filled with ice water before start of practice[d]	520 (57.1)	107 (44.2)	146 (55.3)	267 (66.1)	<.001[f]	426 (55.6)	94 (65.3)	.03[f]
Monitor wet-bulb globe temperature[e]	482 (53.0)	95 (39.3)	145 (54.9)	242 (59.9)	<.001[f]	391 (51.0)	91 (63.2)	.007[f]

[a] Heat-safety regions were based on Grundstein et al.[8] The mild region 1 consisted of the Pacific Coast and northern portions of the United States; the moderate region 2 consisted of the midsection of the United States; the hot region 3 consisted of the Southern United States.
[b] During the 2017 season, the 8 states that had state-level mandates for the National Athletic Trainers' Association Inter-Association Task Force preseason heat acclimatization guidelines were Arizona, Connecticut, Iowa, Mississippi, New Jersey, North Carolina, Rhode Island, and Utah.[12]
[c] *P* value from χ^2 or Fisher exact test examining the association of risk region and presence of the prevention component.
[d] An additional 294 respondents (32.3%) stated they did not have an immersion tub filled with ice water before the start of practice, but other cooling methods were available, including but not limited to ice bags/cooler (n = 248), fans (n = 81), and mist machines/water sprays (n = 67).
[e] An additional 404 respondents (44.4%) indicated not using the wet-bulb globe temperature but instead checking environmental temperature and humidity.
[f] Indicates a significant result.

compared with the other regions for 4 of the 6 strategies (Table 4). In contrast, the only significant association with state-level mandates was greater use of "Monitor WGBT" (adjusted PR = 1.18; 95% CI = 1.02, 1.36).

DISCUSSION

Exertional heat stroke is one of the leading causes of death in athletes,[4] which highlights the critical need to implement strategies that not only prevent it but also assist sports programs in being prepared for when it occurs. Our results suggested that many EHS-preparedness strategies are being used in high school football programs. However, differences existed by geographic region and whether the high schools were located in states whose athletics association mandated the NATA-IATF preseason heat-acclimatization guidelines. Overall, our findings draw attention to the many regional variations and provide benchmark evidence for improving the use of EHS-preparedness strategies globally and in targeted regions.

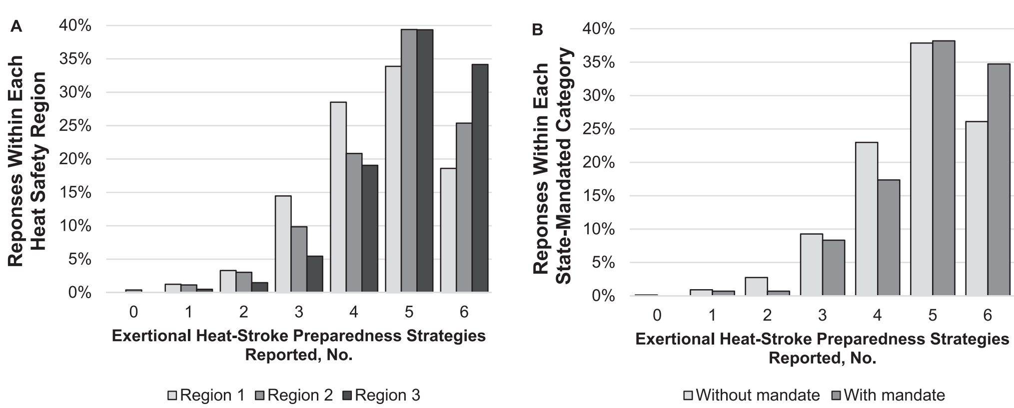

Figure 2. Distributions of the number of exertional heat-stroke (EHS)–preparedness strategies reported by athletic trainers at US high schools during the 2017 football preseason by A, heat-safety region, and B, state-level mandate.

Table 3. Adjusted Prevalence Ratios[a] (PRs) and 95% Confidence Intervals (CIs) for Interaction Between Heat-Safety Regions and State-Level Mandates (Outcome: Reported Use of All 6 Exertional Heat-Stroke–Preparedness Strategies)

	States Without Mandates		States With Mandate[c]		
Heat-Safety Region[b]	Using All 6 EHS Strategies, n (%)	PR (95% CI)	Using All 6 EHS Strategies, n (%)	PR (95% CI)	PR (95% CI) for Each Stratum of Heat-Safety Region (With Versus Without)
1	38 (17.8)	1.00	7 (24.1)	1.21 (0.60, 2.43)	1.21 (0.60, 2.43)
2	51 (25.5)	1.42 (0.99, 2.05)	16 (25.0)	1.19 (0.71, 1.98)	0.83 (0.51, 1.35)
3	111 (31.4)	1.61 (1.17, 2.23)[d]	27 (52.9)	2.68 (1.81, 3.95)[d]	1.66 (1.22, 2.26)[d]

PR (95% CI) for each stratum of state-level mandate, region(s)	States Without Mandates	States With Mandate[c]
3 versus 1	1.61 (1.17, 2.23) [d]	2.21 (1.10, 4.49)[d]
2 versus 1	1.42 (0.99, 2.05)	0.99 (0.45, 2.14)
3 versus 2	1.13 (0.85, 1.50)	2.25 (1.36, 3.73)[d]

[a] Multivariable models adjusted for characteristics of athletic trainer (sex, age, years of experience, years at high school) and high school (school enrollment, number of student-athletes, and number of athletes on preseason football roster in 2017–2018 school year).
[b] Heat-safety regions were based on Grundstein et al.[8] The mild region 1 consisted of the Pacific Coast and northern portions of the United States; the moderate region 2 consisted of the midsection of the United States; the hot region 3 consisted of the Southern United States.
[c] During the 2017 season, the 8 states that had state-level mandates for the National Athletic Trainers' Association Inter-Association Task Force preseason heat acclimatization guidelines were Arizona, Connecticut, Iowa, Mississippi, New Jersey, North Carolina, Rhode Island, and Utah.[12]
[d] Indicates a significant result.

Variations by Heat-Safety Region

The use of EHS-preparedness strategies was highest in region 3, which comprises the southern United States (both east and west). Region 3 has the highest reported warm-season WBGTs[8] and, thus, may place athletes at the greatest risk of sustaining EHS. Although the use of census-specific analyses is limited, it is important to note that the South census region has had higher incidences of exertional heat illness in both high school and collegiate athletes.[17–20] Therefore, our findings can be considered reassuring because the prevalent use of EHS-preparedness strategies may help to reduce the incidence and severity of EHS.

The lower prevalence of EHS preparedness in the cooler regions (ie, regions 1 and 2) raises concern for the safety of athletes. In fact, the heat-safety regions were developed to account for regional differences in athletes' acclimatization to the environment, understanding that individuals in hotter regions are likely partially and passively heat acclimatized and can withstand slightly higher temperatures.[8] Previous researchers[5] estimated that 25% of fatal EHS events occurred in regions 1 and 2; of these, 80% occurred in above-average WBGTs. The absolute WBGTs for those cases would not have necessarily been considered above average in region 3, emphasizing the need for a regional approach to prevention and management preparedness.[5] Sports program stakeholders in the various regions may perceive the risk of EHS differently and perceived risk may be associated with the adoption of strategies. Future authors should aim to evaluate perceived risk through health behavior models, such as the health belief model, which seeks to identify one's perceived

Table 4. Adjusted Prevalence Ratios and 95% Confidence Intervals (CIs) Estimating the Use of Exertional Heat-Stroke (EHS)–Preparedness Strategies Reported by Athletic Trainers at US High Schools, 2017 Football Preseason

	Adjusted Prevalence Ratios (95% CI)[a]			
	Heat-Safety Regions[b]			
EHS-Preparedness Strategy	3 Versus 1	2 Versus 1	3 Versus 2	With Versus Without State-Level Mandate[c]
Hydration access	1.01 (0.99, 1.03)	0.99 (0.96, 1.01)	1.02 (1.002, 1.04)[d]	1.00 (0.98, 1.02)
Emergency response plan enacted for school athletics	1.00 (0.96, 1.04)	0.98 (0.93, 1.03)	1.02 (0.97, 1.06)	1.03 (0.99, 1.07)
Policy with instructions for initiating emergency medical services response	0.98 (0.93, 1.02)	0.95 (0.90, 1.004)	1.03 (0.97, 1.08)	0.96 (0.90, 1.02)
Trained athletic training staff for recognition and treatment of EHS	1.10 (1.01, 1.19)[d]	1.02 (0.93, 1.11)	1.08 (1.002, 1.16)[d]	1.01 (0.94, 1.09)
Immersion tub filled with ice water before start of practice	1.43 (1.22, 1.68)[d]	1.24 (1.04, 1.48)[d]	1.15 (1.01, 1.31)[d]	1.14 (0.996, 1.30)
Monitor wet-bulb globe temperature	1.52 (1.27, 1.81)[d]	1.36 (1.12, 1.64)[d]	1.12 (0.97, 1.28)	1.18 (1.02, 1.36)[d]

[a] Multivariable models adjusted for characteristics of athletic trainer (sex, age, years of experience, years at high school) and high school (school enrollment, number of student-athletes, and athletes on preseason football roster in 2017–2018 school year).
[b] Heat-safety regions were based on Grundstein et al.[8] The mild region 1 consisted of the Pacific Coast and northern portions of the United States; the moderate region 2 consisted of the midsection of the United States; the hot region 3 consisted of the Southern United States.
[c] During the 2017 season, the 8 states that had state-level mandates for the National Athletic Trainers' Association Inter-Association Task Force preseason heat acclimatization guidelines were Arizona, Connecticut, Iowa, Mississippi, New Jersey, North Carolina, Rhode Island, and Utah.[12]
[d] Indicates a significant result.

susceptibility to and the severity and benefits of and barriers to a health concern (eg, EHS).[21]

The Combined Effect of Heat-Safety Region and State-Level Mandates

In multivariable models controlling for heat-safety region as well as AT and high school characteristics, significant findings were only present for monitoring WBGT. However, in the model examining the use of all 6 strategies, we observed an interaction between heat-safety region and state-level mandates. Those high school programs in region 3 and in states with mandates had the highest prevalence of reporting the use of all 6 EHS-preparedness strategies. This result may support the notion that states with mandates for preventing exertional heat illness may help their high school football programs better implement a set of comprehensive strategies to prepare for potential EHS events.[9] Yet differences between responses from states with or without mandates were found only in region 3. Furthermore, the state-level mandates considered were related to preseason heat acclimatization and not the measures of EHS preparedness examined in the current study, which may explain the mixed findings. Finally, the goal of such mandated policies is to ensure that best practices are in place to better prevent and manage injuries.[13] Nonetheless, state-level mandates do not necessarily translate to compliance with best practices, thus warranting the need for process-evaluation–based research that examines adoption practices as well as factors that facilitate or impede adoption. This should include discussions with high school sport administrators, coaches, and other stakeholders. Given the potential importance of these policies—both in region 3, where warm-season WBGTs are higher,[8] and in regions 1 and 2, where WBGTs are cooler and the perceived risk of EHS is potentially lower—future interventions should address the potential lack of adoption in all 3 regions.

Areas for Improvement Related to EHS Preparedness

Although most of the responding ATs noted that their schools complied with best practices associated with EHS preparedness, we identified areas for improvement. First, it is imperative that ATs use on-site measurements of WBGT to identify risk and implement the warranted modifications of activity time, intensity, and work-to-rest ratios.[3,5] Modifying activity on the basis of region-specific guidelines can overcome the lack of or variations in acclimatization athletes experience and may reduce the overall risk for EHS. About half of the ATs reported monitoring WBGTs during the preseason. In addition, 44% of ATs reported monitoring weather conditions without the use of a WBGT. However, we were not able to ascertain whether the ATs made practice modifications based on the WBGT or continued these practices after the preseason.

For EHS, survival rates of 100% have been reported when athletes are immersed in cold water within the first 30 minutes.[22,23] Given this statistic, it is just as important to ensure preparedness for cold-water immersion (CWI) before the athletic activity as to use CWI when needed. Having a CWI tub prepared for a potential patient, rather than filling the tub after diagnosis, allows for prompt submersion. However, our definition of CWI preparedness may be more stringent than is practical in a number of settings (eg, only adding ice to the CWI when a suspected EHS occurs). Because not all high schools may be fully prepared with CWI tubs, further examination is warranted to better elucidate the barriers to their use. Still, as with any survey research, what is self-reported as being done may differ from what is actually being done, thereby highlighting the benefits of triangulation (ie, data validation through cross-verification from multiple sources) to confirm or refute our findings.

At the same time, we believe it is important to acknowledge the high prevalence of use of the other EHS-preparedness strategies considered in this study. For example, our finding that the large majority of responding ATs noted their schools had emergency response plans for school athletics parallels previous research.[24] Although it is promising that most ATs reported that their schools emphasized the need for ATs to be trained to recognize and treat patients with EHS, we are equally concerned that approximately 1 in 5 respondents lacked this EHS-preparedness strategy. Ideally, the use of all strategies would be at 100%; less than 100% usage can be due to a number of factors, including legitimate barriers to adoption that future researchers should strive to identify and mitigate as well as the measurement error that is inherent to survey research.

Limitations

Our study's response rate may have resulted in a sample that was not generalizable to all high school football programs, particularly given that 30% of high schools lacked AT coverage.[25] Also, we were unable to account for whether multiple ATs from the same high school responded to the survey. Typical biases related to survey research, such as recall and social desirability bias, may apply to our work. Furthermore, our definitions of EHS preparedness may be more stringent than practical in a number of settings (eg, only adding ice to the CWI tub when a suspected EHS occurs, checking temperature and humidity without a WBGT). Additional investigation is necessary to examine the effectiveness of such practices. Moreover, our operationalization of EHS preparedness (*yes*/*no*) cannot account for how well each strategy was implemented overall and within each program during the 2017 preseason. Thus, future authors should identify barriers to the implementation of best practices.

CONCLUSIONS

A number of EHS-preparedness strategies were reported as being used during the high school football preseason. The use of these strategies was highest in region 3 (ie, highest reported warm-season WBGTs) and in states whose high school athletics association mandated the NATA-IATF preseason heat-acclimatization guidelines. Clinicians should consider the importance of these strategies and work with high school sports administrators to ensure the resources needed for proper adoption. Such efforts are particularly important in regions 1 and 2, where the perceived risk of EHS may be lower and, consequently, EHS-preparedness strategies may not be used.

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