

# State-Level Implementation of Health and Safety Policies to Prevent Sudden Death and Catastrophic Injuries Within Secondary School Athletics

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**Background:** Sudden death and catastrophic injuries during sport can be attenuated with the implementation of evidence-based health and safety policies. However, the extent of the implementation of these policies within secondary school athletics is unknown.

**Purpose:** To provide an assessment of the implementation of health and safety policies pertaining to the leading causes of sudden death and catastrophic injuries in sport within secondary school athletics in the United States.

**Study Design:** Descriptive epidemiology study.

**Methods:** A rubric for evidence-based practices for preventing the leading causes of death and catastrophic injuries in sport was created. The rubric comprised 5 equally weighted sections for sudden cardiac arrest, head injuries, exertional heat stroke, appropriate medical coverage, and emergency preparedness. State high school athletic association (SHSAA) policies, enacted legislation, and Department of Education policies were extensively reviewed for all 50 states and the District of Columbia. States meeting the specific criteria in the rubric, which required policies to be mandated for all SHSAA member schools, were awarded credit; the weighted scores were tabulated to calculate an aggregate score. States were then ranked from 1 (best) to 51 (worst) based on the aggregate score achieved.

**Results:** The median score on the rubric was 47.1% (range, 23.00%-78.75%). States ranked 1 through 10 (from 78.75% to 56.98%) were North Carolina, Kentucky, Massachusetts, New Jersey, South Dakota, Missouri, Washington, Hawaii, Wisconsin, and Georgia, respectively. States ranked 11 through 20 (from 56.03% to 50.55%) were Arkansas, New York, Mississippi, West Virginia, Oregon, Illinois, Tennessee, Arizona, Texas, and District of Columbia, respectively. States ranked 21 through 30 (from 49.40% to 44.00%) were Virginia, Pennsylvania, Florida, New Mexico, Alabama, Maine, Rhode Island, Indiana, Nevada, and Utah, respectively. States ranked 31 through 40 (from 43.93% to 39.80%) were Ohio, Delaware, Alaska, Vermont, Louisiana, Maryland, Oklahoma, Connecticut, Idaho, and South Carolina, respectively. States ranked 41 through 51 (from 38.73% to 23.00%) were Michigan, North Dakota, Nebraska, New Hampshire, Kansas, Wyoming, Minnesota, Montana, Iowa, California, and Colorado, respectively.

**Conclusion:** State scores ranged from 23.00% to 78.75% for the implementation of evidence-based best practices for preventing the leading causes of sudden death and catastrophic injuries (sudden cardiac arrest, traumatic head injuries, exertional heat stroke, and exertional sickling) in sport. Continued advocacy for the development and implementation of policies at the secondary school level surrounding sudden death and catastrophic injuries is warranted to optimize the health and safety of these student athletes.

**Keywords:** sudden cardiac death; exertional heat stroke; traumatic head injuries; emergency action plans; preparticipation examination

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With over 7.8 million secondary school student-athletes participating in sanctioned sports on an annual basis in the United States, it is prudent that their health and safety

remain paramount to those overseeing secondary school athletics at all levels.<sup>28</sup> When examining the total number of secondary school athletes sustaining fatal or catastrophic injuries from 1982 to 2015, there have been 735 fatalities (185 from direct causes, 550 from indirect causes) and 626 catastrophic injuries (613 from direct causes, 13 from indirect causes), with direct causes attributed to trauma (ie, athlete-

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to-athlete or athlete-to-object contact) and indirect causes being exertion based (ie, sudden cardiac arrest, exertional heat stroke, asthma).<sup>27</sup> Furthermore, evidence shows that 90% of all sudden deaths during sport participation is accounted for by 4 conditions: sudden cardiac arrest, traumatic head injuries, exertional heat stroke, and exertional sickling.<sup>9,27</sup> While the risk of mortality and morbidity exists to those participating in secondary school athletics, various steps can be taken to mitigate this risk and optimize emergency preparedness and care in this population.

The development and implementation of evidence-based best practices specific to factors responsible for sudden death in sport and physical activity have been shown to reduce the risk of morbidity and mortality.<sup>1,2,7,17,19,22</sup> The National Collegiate Athletic Association (NCAA) has found success with the implementation of various health and safety policies, such as heat acclimatization in 2003 and the notification of sickle cell trait status in 2010.<sup>1</sup> Similarly, evidence has shown that in states with mandated heat acclimatization for secondary school athletics programs, there have been zero exertional heat stroke-related deaths since implementation, whereas before implementation, these states had 50% (22/44) of all exertional heat stroke-related deaths from 1980 to 2015.<sup>7</sup>

While the implementation of health and safety policies at the NCAA level affects member schools across the United States, policy changes at the secondary school level are left to the individual states, as the National Federation of State High School Associations (NFHS) has no governing authority over the health and safety policies for secondary school athletics. States have continued to make progress in enhancing the health and safety of their student athletes<sup>1,3,4,20,30,31</sup>; however, the extent of mandated policies on topics related to the leading causes of sudden death and catastrophic injuries in sport is unknown. Therefore, the purpose of this study was to provide a graded assessment of the implementation of health and safety policies pertaining to the leading causes of sudden death and catastrophic injuries in sport at the state level for secondary school athletics programs.

## METHODS

### Study Design

This study utilized a descriptive observational design. Health and safety policies specific to the leading causes of sudden death and catastrophic injuries in sport and emergency

preparedness were quantified for all 50 states and the District of Columbia. For the purposes of this study, only policies that were required or mandated to be followed by all state high school athletic association (SHSAA) member schools were used. Policies that were recommended or encouraged were not included, as it is implied that individual schools were left to decide whether to implement evidence-based best practices. The institutional review board at the University of Connecticut deemed that this study was exempt from approval, as human participants were not directly involved.

### Rubric Development

To provide an objective assessment as to where individual states ranked in terms of health and safety policies aimed at preventing the leading causes of sudden death and catastrophic injuries in sport, a grading rubric was created (Table 1). Utilizing current evidence-based best practices for preventing sudden death in sport within secondary school athletics<sup>11</sup> and supplementary position statements, consensus statements, and Inter-Association Task Force statements endorsed by some of the leading medical organizations within the United States (Table 2),<sup>5,8,10,12-15,18,25,26</sup> the grading rubric consisted of 5 equally weighted subsections: sudden cardiac arrest, exertional heat stroke, traumatic head injuries, appropriate health care coverage, and emergency preparedness. The weighting of the individual components within each subsection was derived from the number of components within each subsection.

Five experts in the areas of preventing sudden death and catastrophic injuries in sport independently reviewed the rubric to establish content validity. The 5 experts were board-certified athletic trainers with either a doctor of philosophy (PhD;  $n = 3$ ) or master of science (MS;  $n = 2$ ) degree in exercise science, with a combined 38 years of clinical experience and 78 published peer-reviewed articles on topics related to sudden death and catastrophic injuries in sport and physical activity and optimizing athletic performance. After a review of the rubric by the expert reviewers, all comments were tabulated, and changes in the content of the rubric were made when there was a majority consensus ( $\geq 3$  of the 5 reviewers agreeing) or if the comment was substantiated by current evidence-based best practices.

### Data Collection Procedures

Data on required health and safety policies for preventing sudden death and catastrophic injuries in sport were

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Ethical approval for this study was waived by the University of Connecticut.

TABLE 1  
State Grading Rubric for Assessing the Implementation of Evidence-Based Best Practices  
for Preventing and Managing the Leading Causes of Sudden Death Within Secondary School Athletics<sup>a</sup>

Topic	Yes/No	Weighting, %
<b>Sudden cardiac arrest</b>		
Screening (PPE questions and physician clearance) Requires 4th edition PPE forms from the AAP or equivalent	Y	4
AED on site at each venue or accessible within 1-3 minutes		<b>16</b>
1A. AEDs are to be used under the advice and consent of a physician by persons with proper training and certification	Y	2
2A. AEDs should be stored in a safe place	Y	2
3A. All ATs, coaches, administrators, school nurses, and physical education teachers should have access to an AED on school property	Y	2
4A. Institutions sponsoring athletic events/activities should have an AED on site or access to one at each venue for practices, games, or other athletic events	Y	2
5A. All personnel involved with sponsored athletic events/activities should be provided annual training and certification in CPR and AED use	Y	2
6A. The location of the AED should be well marked, publicized, accessible, and known among trained staff	Y	2
7A. The AED should be used only after enacting the EMS system	Y	2
8A. AEDs should be inspected frequently to ensure proper working order; this includes making sure that the batteries are charged and the wires and electrodes are in good condition	Y	2
Points possible		<b>20</b>
<b>Exertional heat stroke</b>		
Heat acclimatization		<b>7</b>
1H. Days 1-5 are the first formal practices; no more than 1 practice occurs per day	Y	1
2H. On days 1-5, the total practice time should not exceed 3 hours in any 1 day	Y	1
3H. On days 1-5, a 1-hour maximum walk-through is permitted; however, there must be a 3-hour minimum between the practice and walk-through (or vice versa)	Y	1
4H. During days 1-2 of first formal practices, a helmet should be the only protective equipment permitted (if applicable), and during days 3-5, only helmets and shoulder pads should be worn; beginning on day 6, all protective equipment may be worn, and full contact may begin Football only: On days 3-5, contact with blocking sleds and tackling dummies may be initiated Full-contact sports: 100% of live contact drills should begin no earlier than day 6	Y	1
5H. On days 6-14, double-practice days must be followed by a single-practice day; on single-practice days, 1 walk-through is permitted, separated from the practice by at least 3 hours of continuous rest; when a double-practice day is followed by a rest day, another double-practice day is permitted after the rest day	Y	1
6H. On a double-practice day, neither practice should exceed 3 hours in duration and no more than 5 total hours of practice in the day; warm-up, stretching, cool-down, walk-through, conditioning, and weight-room activities are included as part of the practice time	Y	1
7H. On a double-practice day, the 2 practices should be separated by at least 3 continuous hours in a cool environment	Y	1
Environmental-based activity modifications		<b>5</b>
1W. The state requires all schools to have a heat modification policy	Y	0.625
2W. The heat policy is based on the WBGT (optimal measurement)	Y	0.625
3W. The recommended heat policy is based on the heat index (adequate alternative if the WBGT is unavailable)	Y	0.625
4W. The environmental condition guidelines are based on epidemiological data specific to that state/region (for bigger states, a more comprehensive analysis may be needed)	Y	0.625
5W. The heat policy has a minimum 4 levels of modification, including the modification of practice time	Y	0.625
6W. The policy includes the modification of equipment (if applicable to the sport)	Y	0.625
7W. The policy includes the modification of work:rest ratios, including unrestricted access to fluids	Y	0.625
8W. The policy mentions the use of a shaded area for rest breaks	Y	0.625
Cold-water immersion tubs for on-site cooling for all warm weather practices	Y	<b>3</b>
If exertional heat stroke suspected, on-site cooling using cold-water immersion before transport to the hospital	Y	<b>3</b>
Screening questions on the PPE (ie, history, other predisposing factors) Requires 4th edition PPE forms from the AAP or equivalent	Y	<b>2</b>
Points possible		<b>20</b>

(continued)

TABLE 1 (continued)

Topic	Yes/No	Weighting, %
<b>Traumatic head injuries</b>		
Comprehensive training and education for coaches (ie, Heads Up Football or equivalent)		<b>10</b>
Football coaches	Y	8
All coaches	Y	2
Athletes are not permitted to return to activity on the same day if a concussion is suspected	Y	<b>2</b>
Athletes are not permitted to return to activity until cleared by an appropriate health care professional (MD, AT, DO, PA, APRN)	Y	<b>2</b>
Athletes are not permitted to start return to play until they fully return to school	Y	<b>2</b>
A minimum of a 5-step graduated return-to-play protocol is required before full return to activity	Y	<b>2</b>
No more than 2 phases in any 1 day		
If symptoms return during any 1 step, the athlete must regress to the previous step		
Concussion-related PPE questions	Y	<b>2</b>
Requires 4th edition PPE forms from the AAP or equivalent		
Points possible		<b>20</b>
<b>Appropriate health care coverage</b>		
AT regulation		<b>10</b>
Licensure	Y	10
Some form (ie, registered)		0
No regulation		0
Appropriate health care professional (eg, AT) be on site at collision/contact practices		<b>10</b>
Required at all collision/contact practices and competitions	Y	10
Recommended at all collision/contact practices and competitions		0
Points possible		<b>20</b>
<b>Emergency preparedness</b>		
EAPs		<b>8</b>
1E. Every school or organization that sponsors athletics should develop an EAP specifically for managing serious and/or potentially life-threatening sport-related injuries (athletic EAP)	Y	0.8
2E. The athletic EAP should be developed and coordinated with local EMS, school public safety officials, on-site medical personnel or school medical staff, and school administrators	Y	0.8
3E. Every school should distribute the athletic EAP to all athletic staff members	Y	0.8
4E. The athletic EAP should be specific to each venue (including maps, directions, etc)	Y	0.8
5E. On-site emergency equipment that may be needed in an emergency situation should be listed	Y	0.8
6E. The athletic EAP should identify personnel and their responsibilities to carry out the plan of action with a designated chain of command	Y	0.8
7E. Appropriate contact information for EMS	Y	0.8
8E. The athletic EAP should specify documentation actions that need to be taken after an emergency	Y	0.8
9E. The athletic EAP should be reviewed and rehearsed annually by all parties involved	Y	0.8
10E. Health care professionals who will provide medical coverage during games, practices, or other events should be included	Y	0.8
Coaching education is required as part of the coaching certification on topics related to preventing sudden death in sport	Y	<b>4</b>
CPR/AED and first aid training are required for all coaches		<b>4</b>
All coaches	Y	4
Only head coaches		0
Sickle cell trait status		<b>2</b>
Requires 4th edition PPE forms from the AAP or equivalent	Y	2
Regulation of strength and conditioning sessions		<b>2</b>
1S. Conditioning periods should be phased in gradually and progressively to minimize the risk of injuries during transitional periods; also introduce new conditioning activities gradually, especially during the early stages of a conditioning program	Y	0.667
2S. Exercise and conditioning activities are not permitted to be used as punishment	Y	0.667
3S. Requires appropriate supervision (ie, a coach certified in CPR/first aid with education on the prevention of sudden death in sport or an AT on site)	Y	0.667
Points possible		<b>20</b>
<b>Total score</b>		<b>100</b>

<sup>a</sup>Bolded values indicate the total points available for each policy. AAP, American Academy of Pediatrics; AED, automated external defibrillator; APRN, advanced practice nurse practitioner; AT, athletic trainer; CPR, cardiopulmonary resuscitation; DO, doctor of osteopathic medicine; EAP, emergency action plan; EMS, emergency medical services; MD, physician; PA, physician assistant; PPE, preparticipation examination; WBGT, wet-bulb globe temperature.

TABLE 2  
 Medical and Sport Organizations Endorsing Evidence-Based Best Practice Recommendations  
 on Topics for Preventing and Managing the Leading Causes of Sudden Death in Sport<sup>a</sup>

Inter-Association Task Force Documents				Consensus Statements		Position Statements			
Secondary School Athletics <sup>8</sup>	Sudden Cardiac Arrest <sup>14</sup>	Conditioning Sessions <sup>9</sup>	Heat Acclimatization <sup>10</sup>	Preparticipation Examination <sup>5</sup>	Concussion <sup>19</sup>	Preventing Sudden Death in Sport <sup>12</sup>	Concussion <sup>7</sup>	Exertional Heat Illness <sup>11</sup>	Emergency Action Plan <sup>3</sup>
NFHS	NFHS	ACEP	AAP	AOASM	BJSM <sup>b</sup>	NATA <sup>b</sup>	NATA <sup>b</sup>	NATA <sup>b</sup>	NATA <sup>b</sup>
AMSSM	AAP	ACSM	AMSSM	AOSSM					
AOSSM	ACEP	AMSSM	NATA	AMSSM					
AOASM	ACSM	AOSSM	ACSM	ACSM					
CATA	AHA	CATA	CATA	GSSI					
GSSI	AMSSM	CSCCA	NSCA	AAFP					
KSI	AOSSM	GSSI	AOSSM						
NATA	AOASM	KSI							
NCCSIR	APTA	NASM							
NCSF	NAEMSP	NATA							
ACSM	NAEMT	NSCA							
NIAAA	NATA								
NSCA	NCAA								
GFELLAR	AAEM								
	SCAA								

<sup>a</sup>AAEM, American Academy of Emergency Medicine; AAFP, American Academy of Family Physicians; AAP, American Academy of Pediatrics; ACEP, American College of Emergency Physicians; ACSM, American College of Sports Medicine; AHA, American Heart Association; AMSSM, American Medical Society for Sports Medicine; AOASM, American Osteopathic Academy of Sports Medicine; AOSSM, American Orthopaedic Society for Sports Medicine; APTA, American Physical Therapy Association (Sports Physical Therapy Section); BJSM, *British Journal of Sports Medicine*; CATA, Canadian Athletic Therapists Association; CSCCA, Collegiate Strength and Conditioning Coaches Association; GFELLAR, Matthew Gfeller Sport-Related Traumatic Brain Injury Research Center; GSSI, Gatorade Sports Science Institute; KSI, Korey Stringer Institute; NAEMSP, National Association of Emergency Medical Service Physicians; NAEMT, National Association of Emergency Medical Technicians; NASM, National Academy of Sports Medicine; NATA, National Athletic Trainers' Association; NCAA, National Collegiate Athletic Association; NCCSIR, National Center for Catastrophic Sport Injury Research; NCSF, National Council on Strength and Fitness; NFHS, National Federation of State High School Associations; NIAAA, National Interscholastic Athletic Administrators Association; NSCA, National Strength and Conditioning Association; SCAA, Sudden Cardiac Arrest Association.

<sup>b</sup>Organization that published the statement.

collected from state entities empowered to make statewide regulations for SHSAA member schools. SHSAA handbooks, bylaws, and constitutions for the 2016-2017 academic year were obtained in addition to any policies and procedures available via publicly accessible sources (ie, the SHSAA website). Relevant enacted legislation signed by the respective state's governor as well as policies and procedures instilled by each state's Department of Education policies were also obtained. For the purposes of this study, only publicly accessible data were obtained and reviewed from the aforementioned entities.

Two researchers (W.M.A. and S.E.S.) with a collective 8 years' experience researching health and safety policies at the secondary school level, 14 years' clinical experience as board-certified athletic trainers, and 27 peer-reviewed publications on topics related to preventing sudden death and catastrophic injuries in sport and physical activity and optimizing athletic performance independently reviewed the extent of policy implementation for each state based on the materials that were acquired from the aforementioned entities. States were given credit for each rubric-specific criterion met, and the associated weighted value for each criterion was summed to provide an overall score. After the independent review and grading, the 2 researchers met to

compare their scores for each state. Any discrepancies within the grading of individual components of the rubric were discussed between the 2 researchers until a consensus was made. In the event the researchers were unable to arrive at a consensus, a third researcher (D.J.C.), who is a board-certified athletic trainer with 24 years of clinical experience and 205 peer-reviewed publications on the topics related to preventing sudden death and catastrophic injuries in sport and physical activity and optimizing athletic performance, was brought in to make a final decision.

After the final determination of each state's individual score from the rubric, a round of quality assurance was completed. Each state's rubric was sent to the executive director of that respective state's SHSAA. In addition, the rubric was sent to the attendees of the 2017 Collaborative Solutions for Safety in Sport meeting, which consisted of representatives from each SHSAA and sports medicine advisory committee, as they were made aware of this project during the meeting held in March 2017 in Kansas City, Missouri. Persons receiving the rubric were given 30 calendar days to review and provide the researchers with any discrepancies from their perspective. If discrepancies existed, the reviewers were requested to provide a copy of the publicly available policy in question for assessment by

the researchers. If the researchers confirmed that discrepancies existed, the rubric was updated to reflect the changes in the data provided by the representatives from the SHSAA. Fifteen states responded to emails within the 30-day period, with 8 states identifying discrepancies with the rubric scores. The 8 states that indicated discrepancies provided appropriate documentation as to where the policy was located for their state, which the researchers reviewed using the aforementioned steps; changes to the rubric were then made if warranted. For the states that did not respond within the 30-day period, it was assumed that the information listed was correct, and no further changes were made.

### Data Analysis

The scores for each state's rubric were tabulated to obtain an aggregate score, which was based on a total score of 100. The scores were then transformed to a percentage, and each state was ranked from 1 (state with the greatest number of health and safety policies required of their member schools) to 51 (state with the lowest number of health and safety policies required of their member schools). The rubric scores are also presented as medians and percentiles.

## RESULTS

Table 3 depicts the rank of all 50 states and the District of Columbia pertaining to the implementation of evidence-based best practices for preventing the leading causes of death and catastrophic injuries in sport. Of the 50 states and the District of Columbia, the median score on the rubric was 47.1%. States scoring in the top 10%, with a score of  $\geq 60.46\%$  on the rubric, were North Carolina, Kentucky, Massachusetts, New Jersey, and South Dakota. Conversely, states scoring in the bottom 10%, with a score of  $\leq 33.68\%$  on the rubric, were Minnesota, Montana, Iowa, California, and Colorado. Individual state scoring is depicted in the Appendix (available at <http://journals.sagepub.com/doi/suppl/10.1177/2325967117727262>).

## DISCUSSION

The purpose of this study was to objectively grade each of the 50 states and the District of Columbia on the implementation of evidence-based best practice policies for preventing the leading causes of sudden death and catastrophic injuries in sport at the secondary school level. To our knowledge, this is the first time that an objective assessment and ranking of each state's implementation of health and safety policies specific to the leading causes of sudden death and catastrophic injuries in sport has been calculated. We found that the scores that states received ranged from 23.00% to 78.75%, with a median score of 47.1%. In addition, we found that the state with the greatest number of evidence-based best practice health and safety policies on this topic was North Carolina, compared to Colorado, which had the least number of policies required of its SHSAA member schools.

After a review of each state's policies, a large degree of variability was observed, which was reflected in the subsequent

TABLE 3  
Ranking of States Regarding the Implementation of Evidence-Based Best Practices for Preventing and Managing the Leading Causes of Sudden Death and Catastrophic Injuries Within Secondary School Athletics

Rank	State	Score, %	Rank	State	Score, %
1	North Carolina	78.75	26	Maine	47.10
2	Kentucky	71.13	27	Rhode Island	46.73
3	Massachusetts	67.40	28	Indiana	46.00
4	New Jersey	67.03	29	Nevada	45.00
5	South Dakota	60.58	30	Utah	44.00
6	Missouri	60.00	31	Ohio	43.93
6	Washington	60.00	32	Delaware	43.73
8	Hawaii	59.13	33	Alaska	43.40
8	Wisconsin	59.13	34	Vermont	42.38
10	Georgia	56.98	35	Louisiana	41.00
11	Arkansas	56.03	36	Maryland	40.63
12	New York	55.75	37	Oklahoma	40.50
13	Mississippi	55.25	38	Connecticut	40.00
14	West Virginia	54.33	38	Idaho	40.00
15	Oregon	53.59	40	South Carolina	39.80
16	Illinois	53.38	41	Michigan	38.73
17	Tennessee	52.73	42	North Dakota	38.00
18	Arizona	52.00	43	Nebraska	37.75
19	Texas	50.80	44	New Hampshire	36.00
20	District of Columbia	50.55	45	Kansas	35.75
			46	Wyoming	35.00
21	Virginia	49.00	47	Minnesota	33.35
22	Pennsylvania	48.25	48	Montana	33.25
23	Florida	48.08	49	Iowa	33.00
24	New Mexico	47.20	50	California	26.00
25	Alabama		51	Colorado	23.00

scores and ranking for each state. States that tended to score higher on the rubric had policies in place that covered evidence-based best practices in all 5 subsections of the rubric. Conversely, states that tended to score lower on the rubric were lacking policies in 1 or more subsection altogether.

Examining the evidence-based best practices that all states required of their SHSAA member schools to implement focused on the management of a suspected concussion; if a concussion is suspected, the athlete is removed from play and not permitted to return until cleared by a health care professional. Collectively, the only evidence-based best practices that were not readily met across the United States pertained to the regulation of off-season strength and conditioning sessions. This is alarming, as secondary school student athletes have continued to die during strength and conditioning sessions, and data from the collegiate level have shown that off-season strength and conditioning sessions were responsible for the greatest number of NCAA Division I football athlete deaths from 2000 to 2016.<sup>6</sup>

The large variability in policy implementation at the state level can be attributed to the differences between each state's procedures for developing and implementing health and safety policies at the secondary school level. Within secondary school athletics, each state has the autonomy to develop and implement health and safety policies, which is

voted on by each state's high school athletic association after receiving recommendations from its sports medicine advisory committee or enacted through state legislation. While each state's sports medicine advisory committee, composed of licensed health care professionals, may put forth proposed health and safety policies, the final decision on the adoption and implementation of such proposed policies is typically the responsibility of the SHSAA executive committee, which often does not have any medical expertise. Likewise, at the legislative level, unless there is engagement from all stakeholders involved (ie, sports medicine professionals, secondary school administrators, and legislators), health and safety policies for secondary school athletics may lack essential components of evidence-based best practices.

Notwithstanding, most SHSAAs maintain positive professional relationships with their sports medicine advisory committees (A.M. Pike et al, unpublished data, 2017) and have made continued progress in developing programs and policies to better protect their student athletes. Ultimately, to optimize the health and safety of secondary school student athletes in the United States, policies and procedures to minimize the risk of sudden death and catastrophic injuries need to be created, implemented, evaluated, and refined by the sports medicine advisory committee in each state and not the high school athletic association. This would ensure that those with the most knowledge of serious potential medical consequences are the decision makers for the implementation of best practices of these issues.

From a national level, the NFHS oversees the rules of 16 secondary school sports, which cover an estimated 7.8 million student athletes.<sup>29</sup> Rules passed down to each state from the NFHS focus on maintaining fair play and sportsmanship, minimizing risk, preserving the traditions of the sport, and providing an even balance between offense and defense.<sup>29</sup> These rules are specific to each individual sport and involve topics such as playing field, sport-specific equipment, and personal protective equipment. While sport-specific rules for minimizing the risk of injuries exist, such as wearing helmets, mouth guards, and ear and eye protection to help prevent traumatic face, skull, brain, and neck injuries,<sup>16,21,23,32,33</sup> the NFHS does not currently have any rules pertaining to indirect causes of sudden death such as sudden cardiac arrest or exertional heat stroke.

Identifying strategies to prevent sudden death in sport and physical activity has led to the development of evidence-based best practices to guide patient care on topics such as sudden cardiac arrest, exertional heat stroke, traumatic brain injuries, and overall emergency preparedness. The implementation of policies related to the prevention and management of the leading causes of sudden death in sport has proven successful in reducing the number of fatalities previously observed at both the collegiate and secondary school level.<sup>1,2,7,19</sup> Aside from reducing the number of fatalities associated with the leading causes of sudden death during sport, the implementation of heat acclimatization and environmental-based activity modification policies has been shown to significantly reduce the incidence of exertional heat illness as a whole (E.R. Cooper et al, unpublished data, 2017). Despite supporting evidence showing the effectiveness of the aforementioned policies, many states have yet to fully adopt

and implement these life-saving policies within secondary school athletics, as observed from our findings.

### Limitations and Future Research

While the purpose of the current study was to evaluate policy implementation at the state level, we did not capture policy implementation for all secondary schools within the United States. Private and/or boarding secondary schools are often regulated by independent league organizations and therefore are only obligated to abide by legislative mandates rather than policies in place by each SHSAA. The current study also only examined policies required and/or mandated within the 2016-2017 academic year, which may not reflect the positive changes that states have made leading up to the academic year in which data were collected. While data suggest that most SHSAAs maintain positive professional relationships with their sports medicine advisory committees in driving policy changes, these data are currently unpublished. Given prior literature investigating the effectiveness of mandated versus recommended policies from a broader public health issue,<sup>24</sup> future research is needed to investigate the effectiveness of mandated versus recommended policies within secondary school athletics on reducing the incidence of sudden death in this setting. The current study only examined the implementation of mandated policies, as they require all SHSAA member schools to follow the written policies, versus a recommended policy in which individual schools/school districts are at the discretion of deciding what policies to put in place for their school. Additionally, while this study identified the current policy requirements for secondary schools across the United States, future research should investigate the local implementation of these policies in secondary schools.

### CONCLUSION

When assessing health and safety policies pertaining to the leading causes of sudden death at the state level for secondary school athletics, states only met 23.00% to 78.75% of evidence-based best practice recommendations. Continued efforts by all entities (NFHS, SHSAAs, state sports medicine advisory committees, state departments of education, state legislatures, etc) overseeing secondary athletics within the United States are warranted to better enhance the health and safety of our young student athletes.

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