

Assessment of Evidence-Based Health and Safety Policies on Sudden Death and Concussion Management in Secondary School Athletics: A Benchmark Study

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Context: Implementation of best-practice health and safety policies has been shown to be effective at reducing the risk of sudden death in sport; however, little is known about the extent to which these policies are required within secondary school athletics.

Objective: To examine best-practice health and safety policies pertaining to the leading causes of sudden death and to concussion management in sport mandated at the state level for secondary school athletics.

Design: Descriptive observational study.

Setting: State high school athletic associations (SHSAs), state departments of education, and enacted legislation.

Patients or Other Participants: United States (including the District of Columbia) SHSAs.

Main Outcome Measure(s): A review of SHSAA health and safety policies for the 2016–2017 academic year, state department of education policies, and enacted legislation was undertaken to assess the policies related to the leading causes of sudden death and concussion management in sport. Current best-practice recommendations used to assess health and safety policies were specific to emergency action plans,

automated external defibrillators, heat acclimatization, environmental monitoring and modification, and concussion management. The total number of best-practice recommendations required for each SHSAA's member schools for the aforementioned areas was quantified and presented as total number and percentage of recommendations required.

Results: Four of 51 SHSAA member schools were required to follow best practices for emergency action plans, 7 of 51 for access to automated external defibrillators, 8 of 51 for heat acclimatization, and 3 of 51 for management of concussion.

Conclusions: At the time of this study, SHSAA member schools were not required to follow all best-practice recommendations for preventing the leading causes of sudden death and for concussion management in sport. Continued advocacy for the development and implementation of best practices at the state level to be required of all secondary schools is needed to appropriately serve the health and well-being of our young student-athletes.

Key Words: emergency action plan, heat acclimatization, automated external defibrillators, concussion

Key Points

- Health and safety policies meeting best-practice recommendations to address the leading causes of sudden death in sport should be commonplace at all levels of sport.
- Few states, including the District of Columbia, require public secondary school athletics programs to follow all best-practice recommendations related to emergency preparedness (8% of states), sudden cardiac arrest (14% of states), exertional heat stroke (16% of states), or head injuries (6% of states).
- Of the 50 states and the District of Columbia, only 7 require public secondary schools to implement comprehensive automated external defibrillator policies for managing sudden cardiac arrest, the leading cause of death in sport and physical activity.

Student-athlete participation in high school sports across the United States has nearly doubled within the past 40 years, and with this comes an unfortunate rise in the number of injuries these athletes sustain.^{1–6} More striking, and most regrettable, are the untimely and often preventable sport-related deaths or catastrophic injuries of young student-athletes. For example, from July through December 2015, 14 high school football athletes died during sport participation.⁷ Of these deaths, 50% were from indirect causes such as exertional heat stroke, sudden cardiac arrest, and exertional sickling, which, with

appropriate recognition, treatment, and care, are often survivable conditions.

Although sudden death during sport is an unfortunate risk of participating in such physical activity, the development and implementation of best-practice recommendations enhances the care provided to athletes at all levels. Fortunately, through research and clinical application, we are able to prevent, recognize, and treat many of these injuries using proper policies and procedures. The effectiveness of policies related to improving the outcomes of patients who experience a potentially catastrophic injury has been previously documented within the scientific

Table 1. Evidence-Based Best Practices for Emergency Planning Policies in Secondary School Athletics^{15,20}

No.	Recommendation	No. (%) of States Meeting Recommendation
1E	Every school or organization that sponsors athletics should develop an AEAP specifically for managing serious and/or potentially life-threatening sport-related injuries.	24 (47)
2E	The AEAP should be developed and coordinated with local emergency medical services, school public safety officials, on-site medical personnel or school medical staff, and school administrators.	9 (18)
3E	Every school should distribute the AEAP to all athletics staff members.	10 (20)
4E	The AEAP should be specific to each venue (including maps, directions, etc).	14 (27)
5E	On-site emergency equipment that may be needed in an emergency situation should be listed.	9 (18)
6E	The AEAP should identify personnel and their responsibilities to carry out the plan of action with a designated chain of command.	10 (20)
7E	Appropriate contact information for emergency medical services.	11 (22)
8E	Plan should specify documentation actions that need to be taken postemergency.	4 (8)
9E	The AEAP should be reviewed and rehearsed annually by all parties involved.	18 (35)
10E	Health care professionals who will provide medical coverage during games, practices, or other events should be included.	10 (20)

Abbreviation: AEAP, athletics emergency action plan.

literature.^{8–11} Immediate access to an automated external defibrillator (AED) has been shown to maximize survival from sudden cardiac arrest.⁹ In addition, heat acclimatization during preseason practices has drastically reduced the incidence of exertional heat-stroke-related deaths in both the collegiate and secondary school settings.^{11,12} Although evidence supports the efficacy of health and safety best practices for reducing risk, recent evidence suggests that states score poorly when assessed for mandating these potentially life-saving strategies.¹³

Although current best-practice recommendations for preventing sudden death at the secondary school level exist, few authors have addressed the adoption of these policies at the state level. Organizations such as the National Athletic Trainers' Association, the American College of Sports Medicine, and the American Medical Society of Sports Medicine have published position statements, consensus statements, and interassociation task force documents to provide best-practice recommendations related to the various causes of sudden death and catastrophic injury during sport and physical activity.^{14–21} The purpose of these documents is to provide best-practice recommendations to prevent, recognize, and treat potentially life-threatening sport-related injuries. Therefore, the purpose of our study was to describe the extent to which

state high school athletics associations (SHSAAs) and state regulations require their respective member secondary schools to develop and implement the following policies: emergency action plans (EAPs), AEDs, heat acclimatization, environment-based activity modifications, and concussion management.

METHODS

We used an observational descriptive design to assess the presence of health and safety policies to address the leading causes of sudden death during sport and physical activity at the secondary school level. This design was chosen to provide an objective assessment of health and safety policies, as no previous researchers have comprehensively examined this topic at the state level. Current best-practice recommendations for EAPs^{15,20} (Table 1), access to AEDs^{15,21} (Table 2), heat acclimatization^{14,15} (Table 3), environment-based activity modifications^{15,19} (Table 4), and concussion management^{15,17,18} (Table 5) were used to quantify the status of each state's athletic health and safety policies at the secondary school level. To maintain objectivity in assessing each of the aforementioned policies, all best-practice recommendations were taken in their entirety from the relevant position statements,

Table 2. Evidence-Based Best Practices for Automated External Defibrillator (AED) Policies in Secondary School Athletics^{15,21}

No.	Recommendation	No. (%) of States Meeting Recommendation
1A	AEDs are to be used under the advice and consent of a physician by individuals with proper training and certification.	37 (73)
2A	AEDs should be stored in a safe place.	10 (20)
3A	All athletic trainers, coaches, administrators, school nurses, and physical education teachers should have access to an AED on school property.	25 (49)
4A	Institutions sponsoring athletic events/activities should have an AED on site or access to one at each athletic venue for practices, games, or other athletic events.	14 (27)
5A	Individuals (all personnel involved with sponsored athletic events/activities) should be provided annual training and certification in cardiopulmonary resuscitation and AED use.	43 (84)
6A	Location of AED should be well marked, publicized, accessible, and known among trained staff.	15 (29)
7A	The AED should be used only after enacting the emergency medical services.	32 (63)
8A	AEDs should be inspected frequently to ensure proper working order. This includes making sure batteries are charged and wires and electrodes are in good condition.	37 (73)

Table 3. Evidence-Based Best Practices for Heat Acclimatization Policies in Secondary School Athletics^{14,15}

No.	Recommendation	No. (%) of States Meeting Recommendations
1H	Days 1–5 are the first formal practices. No more than 1 practice occurs per day.	18 (35)
2H	On days 1–5, total practice time should not exceed 3 hours in any 1 day.	22 (43)
3H	On days 1–5, 1-hour maximum walk-through is permitted; however, there must be a 3-hour minimum between practice and walk-through (or vice versa).	18 (35)
4H	During days 1–2 of first formal practices, a helmet (if applicable) should be the only protective equipment permitted. 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% live contact drills should begin no earlier than day 6.	21 (41)
5H	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.	17 (33)
6H	On a double-practice day, neither practice day should exceed 3 hours in duration, with 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.	28 (55)
7H	On a double-practice day, the 2 practices should be separated by at least 3 continuous hours in a cool environment.	14 (27)
8H	Because the risk of exertional heat illnesses during the preseason heat-acclimatization period is high, we strongly recommend that an athletic trainer be on site before, during, and after all practices.	20 (39)

interassociation task force documents, and consensus statements.

Each state received credit for each best-practice recommendation when it required member schools to abide by all identified recommendations. A state was not given credit if it required only a subset of the best-practice recommendations identified in this study. The review of each state's policies was limited to those that were (1) publicly accessible via SHSAA handbooks or accompanying information, department of education policies and procedures, and enacted legislation and (2) required or mandated for all SHSAA member schools, as this provides the expectation that all member schools must follow current best practices. Any SHSAA that recommended, suggested, or encouraged its member schools to follow best-practice recommendations did not receive credit, as the wording of such statements allows each individual school or school district to decide which health and safety policies to follow.

Data Collection

Data collection occurred in 2 parts: (1) an initial review that consisted of obtaining each SHSAA's handbook, constitution, and bylaws and any relevant state legislation and an extensive search of other publicly accessible policies

or procedures specific to each state and (2) a secondary review completed by expert reviewers.

Initial Review. Three researchers obtained the handbooks, constitutions, and bylaws for the 2016–2017 academic year for each SHSAA. Additionally, any relevant enacted legislation or department of education policies that were in place before the 2016–2017 academic year were collated. The 3 researchers independently reviewed these documents to identify policies involving the best-practice recommendations outlined in Tables 1 through 5. The results of their findings were compiled into a database for a secondary review. Any discrepancies from the initial review were highlighted for further investigation during the secondary review process.

Secondary Review. Two researchers (W.M.A., S.E.S.) with expert knowledge of health and safety policies pertaining to the prevention of sudden death and management of concussion in sport and physical activity performed the secondary review. Each researcher independently duplicated the search methods of the initial review and extensively searched each state's SHSAA handbook, constitution, bylaws, and Web site; each state's department of education policies and procedures; and relevant legislative documents to obtain all relevant health and

Table 4. Evidence-Based Best Practices for Environment-Based Activity Modification Policies in Secondary School Athletics^{15,19}

No.	Recommendation	No. (%) of States Meeting Recommendations
1W	State requires all schools to have a heat modification policy.	27 (53)
2W	The recommended heat policy is based on wet-bulb globe temperature (optimal method of measure) or heat index (adequate method of measure).	25 (49)
3W	The environmental conditions guidelines are based on epidemiologic data specific to that state/region (for bigger states, a more comprehensive analysis may be needed).	8 (16)
4W	The heat policy has at minimum 4 levels of modification, including the modification of practice time.	19 (37)
5W	Policy includes modification of equipment (if applicable to the sport).	20 (39)
6W	Policy includes modification of work: rest ratios, including unrestricted access to fluids.	19 (37)
7W	Policy mentions the use of a shaded area for rest breaks.	6 (12)

Table 5. Evidence-Based Best Practices for Concussion Management Policies in Secondary School Athletics^{15,17,18}

No.	Recommendation	No. (%) of States Meeting Recommendations
1C	Schools should develop a referral plan for concussions.	51 (100)
2C	Use certified helmets/equipment.	51 (100)
3C	The preparticipation physical examination should include concussion-specific questions.	38 (75)
4C	Preseason education for personnel, coaches, athletes, and parents (should be tailored to the group being taught) on the basics of concussion (ie, that helmets do not prevent cerebral concussions, signs and symptoms, treatment, testing options, return to play).	50 (98)
5C	High school athletes suspected of sustaining a concussion are not permitted to return to a practice, game, or activity involving exertional activity on the same day.	51 (100)
6C	Athletes suspected of a concussion are not permitted to return to participation until written release is obtained from a qualified licensed health care professional (ie, physician, athletic trainer, advanced practice registered nurse, physician assistant).	51 (100)
7C	No child or adolescent should return to sport or activity unless he or she has managed to return to school.	19 (37)
8C	Implementation of a graduated return-to-participation protocol following the Zurich guidelines with at least 5 steps.	29 (57)
9C	Comprehensive medical-management plan for acute care of a potential head or cervical spine injury.	7 (14)

safety policies specific to the participation of secondary school student-athletes.

After the secondary search, each researcher independently updated the database from the initial review. They corrected any discrepancies in the initial review during the secondary review. After this step, the researchers corroborated their findings and interpretations of the health and safety policies for each state and any disagreements in the data were thoroughly discussed until a consensus was reached. If a consensus could not be reached, a third expert researcher (D.J.C.) was consulted for a final decision. The reviews of each state's policies were for the 2016–2017 academic year and were made accurate as of June 2017.

Statistical Analyses

Data were analyzed to assess the frequencies and percentages of states that met the individual recommendations within each health and safety policy as well as the health and safety policy as a whole. All data are presented as a representative sample of the 50 states and the District of Columbia. All statistical analyses were performed using Excel (Excel for Mac 2011 version 14.7.3; Microsoft Corp, Redmond, WA).

RESULTS

State high school athletics association member schools required to follow best-practice recommendations for EAPs, access to AEDs, heat acclimatization, environment-based activity modifications, and concussion are presented in Tables 6 through 10. The percentage of each individual health and safety policy and an overall percentage of all health and safety policies combined that were required of each SHSAA's member school are depicted in Table 11.

When we examined states that required each SHSAA member school to follow best-practice recommendations for preventing the leading causes of sudden death in sport, we found that few states met the minimum best practices for any one policy. Four of 51 SHSAA member schools were required to follow best practices for EAPs, 7 of 51 for access to AEDs, 8 of 51 for heat acclimatization, 2 of 51 for

environment-based activity modifications, and 3 of 51 for management of concussion.

DISCUSSION

The purpose of our study was to describe the extent of SHSAAs' and other state regulations that required their respective member secondary schools to develop and implement health and safety policies for the prevention of the leading causes of death and for concussion management in sport. To our knowledge, we are the first to examine health and safety policies specific to the leading causes of death in sport (sudden cardiac arrest, exertional heat stroke, and head injuries) at the secondary school level. Although every state required its SHSAA member schools to abide by various policies pertaining to the health and safety of its student-athletes, no state required its member schools to abide by all best-practice recommendations specific to EAPs, AEDs, heat acclimatization, environment-based activity modifications, and concussion management.

Previous investigators²² examining state requirements for the placement of AEDs in schools in the United States found that 17 states (34% of the United States) had some form of enacted legislation that required AEDs in schools. Three states required that AEDs be placed in both public and private secondary schools and 13 states had requirements for AEDs in public secondary schools.²² However, this study did not examine other aspects of an effective AED policy within a secondary school athletics program, such as appropriate training for all personnel, access within 3 minutes from every location on the school's campus, and regular maintenance of the device(s) to ensure proper working order.²² When examining the implementation of a comprehensive AED policy for secondary school athletics, we determined that of the 50 states and the District of Columbia, only 7 had comprehensive policies for AEDs in public secondary schools. Given that use of an AED within 1 minute of a person's collapse from sudden cardiac arrest allows for survival rates up to 90%,⁹ requiring a comprehensive AED policy for all secondary schools hosting athletics should be commonplace, as sudden cardiac arrest is the leading cause of death during sport and physical activity.^{15,16}

Table 6. State Requirements for Emergency Action Plan Policies in State High School Athletic Association Member Schools

State	Recommendation										Frequency (%)
	1E	2E	3E	4E	5E	6E	7E	8E	9E	10E	
Alabama	✓		✓	✓					✓		4 (40)
Alaska	✓			✓					✓		3 (30)
Arizona											0
Arkansas	✓			✓					✓		3 (30)
California											0
Colorado											0
Connecticut											0
Delaware	✓	✓		✓	✓	✓	✓			✓	7 (70)
District of Columbia	✓										1 (10)
Florida											0
Georgia	✓	✓									2 (20)
Hawaii											0
Idaho											0
Illinois	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10 (100)
Indiana											0
Iowa											0
Kansas											0
Kentucky	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10 (100)
Louisiana											0
Maine	✓								✓		2 (20)
Maryland											0
Massachusetts	✓	✓		✓	✓	✓	✓		✓	✓	8 (80)
Michigan	✓								✓		2 (20)
Minnesota	✓			✓							2 (20)
Mississippi											0
Missouri	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10 (100)
Montana											0
Nebraska											0
Nevada											0
New Hampshire											0
New Jersey	✓	✓	✓	✓	✓	✓			✓	✓	8 (80)
New Mexico	✓			✓	✓		✓				4 (40)
New York											0
North Carolina	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10 (100)
North Dakota											0
Ohio											0
Oklahoma											0
Oregon	✓										1 (10)
Pennsylvania											0
Rhode Island	✓								✓		2 (20)
South Carolina											0
South Dakota	✓		✓	✓					✓		4 (40)
Tennessee	✓								✓		2 (20)
Texas	✓		✓			✓	✓		✓	✓	6 (60)
Utah											0
Vermont											0
Virginia	✓		✓	✓	✓	✓	✓		✓	✓	8 (80)
Washington	✓	✓					✓		✓	✓	5 (50)
West Virginia											0
Wisconsin	✓		✓			✓	✓		✓		5 (50)
Wyoming											0

Access to appropriate health care, such as that provided by an athletic trainer (AT) or other sports medicine-trained professional, is an essential component for any institution sponsoring an athletics program because these individuals are properly trained in the care of sport-related injuries and emergencies.^{23,24} Recent work by Johnson et al²⁵ identified schools with access to an AT as more likely to adopt emergency-preparedness policies than those without an AT. These findings support the need for ATs in all secondary schools to enhance emergency preparedness. Unfortunately, only 37% of public schools and 28%

of private schools had access to a full-time AT.^{26,27} Thus, in many instances, medical decisions were placed in the hands of the supervising coach(es), who lacked specific knowledge and were unprepared to make appropriate medical decisions.^{28–31} An AT is more likely to implement evidence-based health and safety policies pertaining to the leading causes of sudden death in sport, so schools without access to an AT may be at a disadvantage, especially when state-level policies are insufficient to meet current best practices. Requiring the implementation of best practices for preventing sudden death by all member schools would

Table 7. State Requirements for Automated External Defibrillator Policies in State High School Athletic Association Member Schools

State	Recommendation								Frequency (%)
	1A	2A	3A	4A	5A	6A	7A	8A	
Alabama	✓		✓		✓		✓	✓	5 (63)
Alaska					✓		✓	✓	3 (38)
Arizona	✓				✓		✓	✓	4 (50)
Arkansas	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
California	✓				✓	✓	✓	✓	5 (63)
Colorado	✓				✓	✓	✓	✓	5 (63)
Connecticut			✓	✓	✓				3 (38)
Delaware									0
District of Columbia	✓				✓		✓	✓	4 (50)
Florida	✓		✓		✓		✓		4 (50)
Georgia	✓		✓		✓		✓		4 (50)
Hawaii		✓		✓		✓		✓	4 (50)
Idaho									0
Illinois	✓		✓		✓		✓		4 (50)
Indiana	✓		✓		✓		✓		4 (50)
Iowa									0
Kansas									0
Kentucky	✓		✓		✓		✓		4 (50)
Louisiana	✓		✓		✓		✓		4 (50)
Maine	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
Maryland	✓		✓		✓		✓	✓	5 (63)
Massachusetts	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
Michigan	✓			✓	✓			✓	3 (38)
Minnesota								✓	1 (13)
Mississippi	✓		✓		✓		✓	✓	5 (63)
Missouri	✓				✓		✓	✓	4 (50)
Montana	✓				✓		✓	✓	4 (50)
Nebraska	✓				✓			✓	3 (38)
Nevada			✓		✓			✓	3 (38)
New Hampshire					✓				1 (13)
New Jersey	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
New Mexico	✓				✓		✓	✓	4 (50)
New York	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
North Carolina	✓			✓	✓			✓	4 (50)
North Dakota	✓		✓		✓		✓	✓	5 (63)
Ohio					✓			✓	2 (25)
Oklahoma	✓		✓	✓	✓			✓	5 (63)
Oregon	✓	✓	✓		✓	✓	✓	✓	7 (88)
Pennsylvania	✓	✓			✓	✓	✓	✓	6 (75)
Rhode Island			✓	✓	✓	✓			4 (50)
South Carolina	✓		✓		✓		✓	✓	5 (63)
South Dakota	✓				✓		✓	✓	4 (50)
Tennessee	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
Texas	✓		✓	✓	✓		✓	✓	6 (75)
Utah									0
Vermont								✓	1 (13)
Virginia	✓		✓		✓			✓	4 (50)
Washington	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
West Virginia	✓			✓	✓		✓	✓	5 (63)
Wisconsin	✓				✓	✓	✓	✓	5 (63)
Wyoming	✓				✓	✓		✓	4 (50)

ensure that the health and safety of secondary school student-athletes are optimized.

Coupled with the lack of appropriate health care services in secondary school athletics is the lack of preparedness of secondary schools for managing players with potentially life-threatening injuries. At the local level, assessments of emergency preparedness in Oregon²⁵ and West Virginia³² secondary schools showed that that only 28% to 33% of coaches had any training or certification in cardiopulmonary resuscitation and first aid and only 24% to 52% of secondary schools reported having a written, venue-specific

EAP, independent of whether the secondary school employed an AT. Nationally, independent research studies^{33–38} have identified that up to 70% of schools have adopted an athletics-specific EAP. We assessed the presence of health and safety policies pertaining to preventing the leading causes of sudden death in sport and found that less than 15% of the 50 states and the District of Columbia required their member schools to follow best-practice recommendations on any topic related to emergency preparedness, sudden cardiac arrest, exertional heat stroke, or head injuries. Furthermore, only 4

Table 8. State Requirements for Heat-Acclimatization Policies in State High School Athletic Association Member Schools

State	Recommendation								Frequency (%)
	1H	2H	3H	4H	5H	6H	7H	8H	
Alabama			✓		✓				2 (25)
Alaska									0
Arizona	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
Arkansas	✓	✓		✓	✓	✓			5 (63)
California									0
Colorado									0
Connecticut	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
Delaware		✓							1 (13)
District of Columbia	✓	✓	✓	✓	✓	✓		✓	7 (88)
Florida	✓	✓		✓		✓			4 (50)
Georgia	✓	✓		✓	✓	✓			5 (63)
Hawaii	✓	✓	✓	✓	✓	✓		✓	7 (88)
Idaho									0
Illinois	✓	✓		✓		✓		✓	5 (63)
Indiana		✓	✓		✓	✓		✓	5 (63)
Iowa	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
Kansas									0
Kentucky	✓	✓	✓	✓		✓	✓		6 (75)
Louisiana								✓	1 (13)
Maine									0
Maryland									0
Massachusetts	✓	✓	✓	✓		✓		✓	6 (75)
Michigan									0
Minnesota						✓			1 (13)
Mississippi	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
Missouri	✓	✓		✓		✓		✓	5 (63)
Montana									0
Nebraska	✓	✓	✓		✓	✓	✓	✓	7 (88)
Nevada			✓	✓		✓	✓	✓	5 (63)
New Hampshire								✓	1 (13)
New Jersey	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
New Mexico									0
New York		✓		✓	✓	✓	✓		5 (63)
North Carolina	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
North Dakota									0
Ohio									0
Oklahoma									0
Oregon			✓			✓			2 (25)
Pennsylvania									0
Rhode Island	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
South Carolina		✓				✓			2 (25)
South Dakota									0
Tennessee						✓	✓	✓	3 (38)
Texas									0
Utah	✓	✓	✓	✓	✓	✓	✓	✓	8 (100)
Vermont									0
Virginia				✓		✓		✓	3 (38)
Washington									0
West Virginia			✓	✓	✓	✓	✓		5 (63)
Wisconsin									0
Wyoming						✓			1 (13)

SHSAAs required their member schools to meet best-practice recommendations in 2 or more of the health and safety policies reviewed as part of this study.

With the documented successes of increased survival and risk reduction for potentially life-threatening injuries,^{9,11,12} the implementation of health and safety policies that meet best-practice recommendations¹⁵ should be common at all levels of sport, including secondary school athletics. Anecdotally, cost has been cited as a primary barrier preventing the implementation of health and safety policies aimed at reducing the risk of sudden death during

participation in secondary school athletics. Of the 5 policies examined in our study, 3 (EAP, heat acclimatization, and concussion management) require minimal expense to implement. Future research is needed to fully understand the barriers surrounding the development and implementation of these policies at the state level.

All states required that recommendations 1C, 2C, 5C, and 6C for concussion management be followed. Ensuring the proper training of personnel on cardiopulmonary resuscitation and the use of an AED was required in only 84% of the states, which was a surprising finding given that sudden

Table 9. State Requirements for Environment-Based Activity Modification Policies in State High School Athletic Association Member Schools

State	Recommendation							Frequency (%)
	1W	2W	3W	4W	5W	6W	7W	
Alabama								0
Alaska								0
Arizona								0
Arkansas	✓							1 (14)
California								0
Colorado								0
Connecticut								0
Delaware	✓	✓		✓	✓	✓		5 (71)
District of Columbia	✓	✓		✓	✓	✓	✓	6 (86)
Florida		✓					✓	2 (29)
Georgia	✓	✓	✓	✓	✓	✓	✓	7 (100)
Hawaii	✓	✓		✓	✓	✓		5 (71)
Idaho								0
Illinois	✓	✓	✓	✓	✓	✓	✓	7 (100)
Indiana								0
Iowa								0
Kansas	✓	✓		✓	✓	✓	✓	6 (86)
Kentucky	✓	✓		✓	✓	✓		5 (71)
Louisiana								0
Maryland	✓							1 (14)
Maine	✓	✓	✓		✓			4 (57)
Massachusetts								0
Michigan	✓	✓		✓	✓	✓		5 (71)
Minnesota	✓	✓	✓	✓	✓	✓		6 (86)
Mississippi	✓	✓						2 (29)
Missouri								0
Montana	✓	✓						2 (29)
Nebraska	✓	✓		✓	✓	✓		5 (71)
Nevada								0
New Hampshire								0
New Jersey	✓							1 (14)
New Mexico	✓	✓		✓				3 (43)
New York	✓	✓	✓	✓	✓	✓		6 (86)
North Carolina	✓	✓	✓	✓	✓	✓		6 (86)
North Dakota								0
Ohio	✓	✓		✓	✓	✓		5 (71)
Oklahoma	✓	✓			✓	✓		4 (57)
Oregon	✓	✓		✓	✓	✓		5 (71)
Pennsylvania								0
Rhode Island	✓	✓		✓	✓	✓		5 (71)
South Carolina								0
South Dakota	✓	✓	✓					3 (43)
Tennessee	✓	✓		✓	✓	✓		5 (71)
Texas								0
Utah								0
Vermont	✓	✓	✓	✓	✓	✓	✓	7 (100)
Virginia								0
Washington								0
West Virginia	✓	✓		✓	✓	✓		5 (71)
Wisconsin								0
Wyoming								0

cardiac arrest is the leading cause of death in sport and physical activity, whereas acute sport-related concussion has not been shown to cause sudden death. These results may be due to the heightened sensitivity surrounding sport-related concussion of the local and national media and recent court settlements on the long-term effects of concussion involving a US professional sports league.³⁹

Although we have provided a benchmark for the implementation of best-practice recommendations to prevent the leading causes of sudden death and concussion

management at the state level of secondary school athletics, credit must be given to those states that have made progress in enhancing health and safety policies. This progress has taken multiple forms; in some states, policies have been established at the SHSAA level, whereas other states have pursued legislative action to implement policies. An additional factor in the implementation of health and safety policies in secondary school athletics has been either the proactive or reactive response to implementation. Unfortunately, the reactive response to policy implementation

Table 10. State Requirements for Concussion-Management Policies in State High School Athletic Association Member Schools

State	Recommendation									Frequency (%)
	1C	2C	3C	4C	5C	6C	7C	8C	9C	
Alabama	✓	✓	✓	✓	✓	✓				6 (67)
Alaska	✓	✓	✓	✓	✓	✓	✓	✓		8 (89)
Arizona	✓	✓	✓	✓	✓	✓				6 (67)
Arkansas	✓	✓		✓	✓	✓	✓	✓		7 (78)
California	✓	✓		✓	✓	✓	✓	✓	✓	8 (89)
Colorado	✓	✓			✓	✓	✓	✓		6 (67)
Connecticut	✓	✓		✓	✓	✓		✓		6 (67)
Delaware	✓	✓	✓	✓	✓	✓				6 (67)
District of Columbia	✓	✓		✓	✓	✓		✓		6 (67)
Florida	✓	✓	✓	✓	✓	✓	✓	✓		8 (89)
Georgia	✓	✓	✓	✓	✓	✓				6 (67)
Hawaii	✓	✓	✓	✓	✓	✓	✓	✓		8 (89)
Idaho	✓	✓	✓	✓	✓	✓	✓	✓		8 (89)
Illinois	✓	✓		✓	✓	✓	✓	✓		7 (78)
Indiana	✓	✓	✓	✓	✓	✓		✓		7 (78)
Iowa	✓	✓	✓	✓	✓	✓				6 (67)
Kansas	✓	✓	✓	✓	✓	✓	✓	✓		8 (89)
Kentucky	✓	✓	✓	✓	✓	✓		✓	✓	8 (89)
Louisiana	✓	✓	✓	✓	✓	✓	✓	✓		8 (89)
Maine	✓	✓		✓	✓	✓				5 (56)
Maryland	✓	✓	✓	✓	✓	✓		✓		7 (78)
Massachusetts	✓	✓	✓	✓	✓	✓	✓	✓	✓	9 (100)
Michigan	✓	✓	✓	✓	✓	✓				6 (67)
Minnesota	✓	✓	✓	✓	✓	✓		✓		7 (78)
Mississippi	✓	✓	✓	✓	✓	✓	✓	✓		8 (89)
Missouri	✓	✓	✓	✓	✓	✓	✓	✓	✓	9 (100)
Montana	✓	✓	✓	✓	✓	✓				6 (67)
Nebraska	✓	✓		✓	✓	✓	✓	✓		7 (78)
Nevada	✓	✓	✓	✓	✓	✓				6 (67)
New Hampshire	✓	✓		✓	✓	✓		✓		6 (67)
New Jersey	✓	✓	✓	✓	✓	✓			✓	7 (78)
New Mexico	✓	✓		✓	✓	✓				5 (56)
New York	✓	✓		✓	✓	✓	✓	✓		7 (78)
North Carolina	✓	✓	✓	✓	✓	✓	✓	✓		8 (89)
North Dakota	✓	✓		✓	✓	✓				6 (67)
Ohio	✓	✓	✓	✓	✓	✓				6 (67)
Oklahoma	✓	✓	✓	✓	✓	✓				6 (67)
Oregon	✓	✓	✓	✓	✓	✓				6 (67)
Pennsylvania	✓	✓	✓	✓	✓	✓				6 (67)
Rhode Island	✓	✓		✓	✓	✓				5 (56)
South Carolina	✓	✓	✓	✓	✓	✓				6 (67)
South Dakota	✓	✓	✓	✓	✓	✓				6 (67)
Tennessee	✓	✓	✓	✓	✓	✓		✓		7 (78)
Texas	✓	✓	✓	✓	✓	✓		✓	✓	8 (89)
Utah	✓	✓	✓	✓	✓	✓	✓	✓		8 (89)
Vermont	✓	✓		✓	✓	✓				5 (56)
Virginia	✓	✓	✓	✓	✓	✓	✓	✓		8 (89)
Washington	✓	✓	✓	✓	✓	✓				6 (67)
West Virginia	✓	✓	✓	✓	✓	✓	✓	✓	✓	9 (100)
Wisconsin	✓	✓	✓	✓	✓	✓		✓		7 (78)
Wyoming	✓	✓	✓	✓	✓	✓				6 (67)

follows a catastrophic or fatal event of a secondary-school student athlete that might have been avoided had the appropriate policies been in place.

Our review of health and safety policies was extensive and included SHSAA policies, department of education policies, and enacted legislation, but it was limited by our access to only publicly available information. The inability to also access information housed only within the SHSAAs and their member schools limited our ability to fully assess their health and safety policies and may have resulted in an underestimation of each state's true policy requirements.

Although this is a limitation, failing to make these policies publicly available may hinder their dissemination and thus their implementation. Furthermore, we examined only policies required of SHSAA member schools, which did not include the private, charter, and boarding schools not governed by each SHSAA. Therefore, our results may be relevant only to public secondary schools governed by SHSAAs and not to all secondary schools.

In addition, for states requiring their member schools to implement best practices pertaining to the leading causes of sudden death in sport, we did not evaluate the regulation of

Table 11. Percentage of Best-Practice Recommendations Required for State High School Athletics Association Member Schools

State	Best-Practice Health Recommendations, %					Overall
	Venue-Specific Emergency Action Plans	Access to Automated External Defibrillator	Heat Acclimatization	Environment-Based Activity Modifications	Concussion Management	
Alabama	40	63	25	0	67	40
Alaska	30	38	0	0	89	33
Arizona	0	50	100	0	67	43
Arkansas	30	100	63	14	78	57
California	0	63	0	0	89	31
Colorado	0	63	0	0	67	26
Connecticut	0	38	100	0	67	40
Delaware	70	0	13	71	67	45
District of Columbia	10	50	88	86	67	57
Florida	0	50	50	29	89	43
Georgia	20	50	63	100	67	57
Hawaii	0	50	88	71	89	57
Iowa	0	0	100	0	67	33
Idaho	0	0	0	0	89	19
Illinois	100	50	63	100	78	79
Indiana	0	50	63	0	78	38
Kansas	0	0	0	86	89	33
Kentucky	100	50	75	71	89	79
Louisiana	0	50	13	0	89	31
Maine	20	100	0	57	56	45
Maryland	0	63	0	14	78	31
Massachusetts	80	100	75	0	100	74
Michigan	20	38	0	71	67	38
Minnesota	20	13	13	86	78	40
Mississippi	0	63	100	29	89	55
Missouri	100	50	63	0	100	67
Montana	0	50	0	29	67	29
North Carolina	100	50	100	86	89	86
North Dakota	0	63	0	0	67	26
Nebraska	0	38	88	71	78	52
New Hampshire	0	13	13	0	67	19
New Jersey	80	100	100	14	78	76
New Mexico	40	50	0	43	56	38
New York	0	100	63	86	78	62
Nevada	0	38	63	0	67	33
Ohio	0	25	0	71	67	31
Oklahoma	0	63	0	57	67	36
Oregon	10	88	25	71	67	50
Pennsylvania	0	75	0	0	67	29
Rhode Island	20	50	100	71	56	57
South Carolina	0	63	25	0	67	31
South Dakota	40	50	0	43	67	40
Tennessee	20	100	38	71	78	60
Texas	60	75	0	0	89	48
Utah	0	0	100	0	89	38
Vermont	0	13	0	100	56	31
Virginia	80	50	38	0	89	55
Washington	50	100	0	0	67	45
West Virginia	0	63	63	71	100	57
Wisconsin	50	63	0	0	78	40
Wyoming	0	50	13	0	67	26

policy implementation. Requiring policy implementation is essential for ensuring that steps are being taken to protect student-athletes; a lack of auditing or repercussions for not adhering to the required policies restricted our ability to truly assess compliance.

Future research is needed to examine the extent to which other high school athletics governing bodies require their member schools to follow best practices. Specifically, future investigators should address the following areas to

obtain a more complete depiction of health and safety policies within secondary school athletics: (1) the extent to which health and safety policies for preventing the leading causes of death during sport are implemented at the local level (ie, within a state, county, or school district), (2) longitudinal epidemiologic studies to determine the effectiveness of current best-practice recommendations for reducing the risk of sudden death during sport, and (3) assessment of the incidence rates of sport-related cata-

strophic injuries and fatalities and comparison of the differences between states that mandate versus recommend (ie, leave it up to individual school districts to implement appropriate policies) that best practices be followed.

CONCLUSIONS

At the SHSAA level, the development and implementation of mandated health and safety policies pertaining to the prevention of the leading causes of sudden death and concussion management in sport for member schools were lacking. Clinicians can use these data to advocate for the adoption of statewide health and safety policies to mitigate the risks of sudden death and catastrophic injury during the sport participation of secondary school athletes.

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