

Optimizing Athlete Safety: Advanced Strategies for Preventing Exertional Heat Stroke in Collegiate Football Through Strength and Conditioning Interventions

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Abstract

Judge, LW, Moore, M, and Bellar, D. Optimizing athlete safety: Advanced strategies for preventing exertional heat stroke in collegiate football through strength and conditioning interventions. *J Strength Cond Res* 39(6): 711–719, 2025—Ensuring the safety of National Collegiate Athletic Association football players is paramount, particularly because these athletes contend with the rigorous physical demands and high-impact collisions inherent to the sport. In recent years, the increasing body mass of collegiate football linemen has significantly heightened their risk for exertional heat stroke (EHS), a potentially fatal condition. This article critically examines the correlation between the larger body sizes of these athletes and the increased incidence of EHS. Although the health risks associated with oversized athletes are well-recognized, the practical challenges of addressing these risks remain complex. This article emphasizes the critical role of strength and conditioning (S&C) coaches in bridging the gap between awareness and actionable solutions. By exploring evidence-based strategies, including enhanced training protocols, heat acclimatization practices, comprehensive health screenings, wearable technology, and tailored emergency response plans, this article offers a rigorous, science-driven approach to creating safer athletic environments. Ultimately, the article aimed to advance the well-being of collegiate football linemen by equipping S&C coaches with the tools and knowledge necessary to effectively manage the unique challenges posed by the physical demands of their athletes.

Key Words: evidence-based training, linemen, environmental health and safety, injury prevention, and athlete well-being

Introduction

The health, safety, and mental well-being of collegiate athletes are paramount concerns within the domains of sports science and sports medicine. The National Collegiate Athletic Association (NCAA) has been instrumental in advancing athlete welfare through a multifaceted approach that encompasses legislative measures, educational initiatives, and targeted mental health support systems (46–48). These initiatives are exemplified by the implementation of stringent drug testing protocols, comprehensive educational programs for athletes and coaches, and the development of specialized mental health resources designed to address the unique psychological and social challenges faced by athletes. The NCAA's integration of mental health support with physical wellness initiatives underscores its commitment to a holistic approach to athlete well-being, acknowledging the interdependence of physical and psychological health (2,37).

The inception of the NCAA in the early 20th century was motivated by a critical need to enhance athlete safety, particularly in response to the dangerous “flying wedge” formation in early football, which resulted in numerous injuries and fatalities (41). Over the decades, the NCAA has continually evolved its policies, placing a pronounced emphasis on athlete health through initiatives such as mandatory health screenings, advancements in the

sports equipment technology, and the provision of comprehensive mental health resources. However, the severe and often debilitating consequences of repetitive head trauma, such as chronic traumatic encephalopathy (CTE), and the life-threatening risks posed by exertional heat stroke (EHS), underscore the ongoing necessity for stringent safety protocols aimed at preventing fatalities.

Concussions have rightfully occupied a central focus in sports medicine because of their profound long-term effects on cognitive and neurological health (18). This recognition has catalyzed significant policy reforms and the implementation of robust safety measures to mitigate associated risks (9,42,50,58). However, despite the high stakes, EHS has not garnered equivalent attention, although it remains a potentially fatal condition that disproportionately affects athletes, particularly those in football (3).

The NCAA's lack of comprehensive directives on EHS prevention represents a glaring oversight in its safety protocols, particularly when compared with mandatory standards already implemented at the high school level in the Southeastern United States. Despite the NCAA Sport Science Institute providing general recommendations for sport-related illness and injury prevention, the guidance on EHS is fragmented and inadequate, often overshadowed by more established protocols for other conditions such as concussions (29). This deficiency is especially alarming for football linemen, whose larger body mass and high-intensity physical demands substantially increase their vulnerability to EHS (12,15,39,48). Research has demonstrated

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that linemen are disproportionately affected by exertional heat illnesses due to higher metabolic heat production and reduced heat dissipation capacity, underscoring the urgent need for sport-specific interventions (12,15).

Although high school programs in the Southeast mandate life-saving measures such as environmental monitoring, work-to-rest ratio adjustments, and immediate access to cold-water immersion for EHS treatment, the NCAA has been unacceptably slow in adopting similar standards (3,29). This inertia reflects a broader systemic issue within collegiate sports governance, wherein the implementation of evidence-based health and safety protocols lags despite clear scientific consensus (3). Effective prevention strategies should include mandatory heat acclimatization protocols beyond early August training periods, ongoing coaching education on EHS risks, and the integration of wearable technologies to monitor physiological markers of heat stress (3,25). Furthermore, robust emergency action plans, including immediate access to cold-water immersion and standardized cooling protocols, must be institutionalized across NCAA programs.

This article advocates for the NCAA to take a leadership role by developing and enforcing evidence-based policies that prioritize athlete safety in all competitive and training environments. Coordinated efforts involving sport managers, strength and conditioning (S&C) coaches, athletic trainers, and sports medicine professionals are critical to addressing this preventable cause of fatality. Such measures not only align with ethical imperatives but also fulfill the NCAA's mandate to safeguard the health and well-being of its student-athletes. The objectives of this article are threefold.

- **Analyze Current Strategies:** Conduct a thorough examination of existing prevention and response strategies for EHS in NCAA collegiate football, with a specific focus on the role of S&C programs in preparing athletes for heat stress.
- **Evaluate Effectiveness:** Critically assess the effectiveness of current protocols and interventions, particularly within S&C training environments, in mitigating the risks associated with EHS.
- **Propose Proactive Measures:** Advocate for a paradigm shift toward proactive prevention measures, emphasizing the integration of S&C best practices to prioritize athlete health and safety.

By synthesizing recent scientific research, this article promotes the adoption of a far-reaching, thorough, extensive preventive framework for NCAA athletic programs. This framework emphasizes stakeholder education, policy revisions, and the deployment of advanced monitoring systems, all aimed at enhancing player safety and reducing the incidence of EHS (14,15,17,19,38). The persistent occurrence of EHS-related fatalities in football underscores the urgent need for comprehensive, evidence-based safety strategies. Collaboration among the NCAA, educational institutions, and athletic programs is essential to ensure the immediate and long-term health and safety of collegiate athletes.

Overview of Exertional Heat Stroke Risks and Prevalence

Exertional heat stroke is a critical and potentially fatal condition, distinguished by severe hyperthermia with core body temperatures exceeding 40.5 degrees C (104 °F), coupled with central nervous system dysfunctions, including delirium, seizures, and coma (12). The prevalence of EHS is particularly concerning in high-intensity sports such as football, where the confluence of

physical exertion, environmental stressors, and protective equipment substantially elevates the risk (1). Football players, especially linemen, are disproportionately affected due to several contributing factors, including the heavy, nonbreathable gear that exacerbates heat retention; the intense physical demands of the sport; and the oppressive heat and humidity often present during training and competition (3,23).

The trend toward increasing body mass among football linemen, many of whom now exceed 300 pounds, further complicates heat dissipation, thereby intensifying thermal strain and susceptibility to EHS (35). The large body mass of linemen inherently generates more heat during physical exertion. As body mass increases, the surface area-to-mass ratio diminishes, reducing the efficiency of heat transfer to the environment, which is critical for thermoregulation (3). The positions of offensive and defensive linemen, which require sustained, high-intensity effort with minimal recovery time, impose significant physiological stress. The heavy protective gear, including helmets and pads, exacerbates this issue by trapping heat and impeding sweat evaporation, which is a primary cooling mechanism (4,15,33).

Addressing the risks associated with EHS necessitates a comprehensive and multifaceted approach encompassing education, prevention, and immediate response strategies. Sports coaches, S&C professionals, and medical personnel must be adequately trained to recognize the early signs of EHS and implement rapid cooling techniques. The integration of advanced technology, such as wearable temperature sensors and environmental monitoring tools, provides real-time data that are crucial for preemptively managing thermal stress. Standardizing acclimatization protocols is essential, allowing athletes to gradually adjust to the physiological demands of intense physical activity in hot conditions, thereby reducing the incidence of EHS (1,8,22).

Educating athletes about the importance of regular breaks and the early recognition of heat stress symptoms is critical to safeguarding their health and optimizing performance. Furthermore, it is imperative for sports managers and S&C coaches to adjust practice schedules to avoid peak heat periods, typically between 10 AM and 4 PM, when the risk of heat-related illnesses is highest (3). During periods of extreme heat, using indoor facilities equipped with adequate ventilation and air conditioning can significantly mitigate the risk of EHS. Ensuring access to hydration stations and promoting regular fluid intake are fundamental to maintaining optimal hydration levels and preventing dehydration, a key factor in EHS (36). The implementation of a buddy system, where athletes monitor each other for symptoms of heat stress, such as dizziness, confusion, or excessive sweating, can further enhance safety. Training for football and S&C coaches should include first aid and emergency response procedures specifically tailored for heat-related illnesses to ensure prompt and effective treatment when needed. Regularly reviewing and incorporating these safety protocols into training regimens will help create a safer and more effective environment for athletes. In addition, the development and implementation of a comprehensive emergency action plan (44), which includes immediate response strategies for potential EHS incidents, are critical to ensuring preparedness and swift action in life-threatening situations.

Current Prevention and Management Strategies for Exertional Heat Stroke in Collegiate Football

In collegiate football, current prevention and management strategies for EHS are multifaceted, encompassing preseason

acclimatization programs, hydration practices, environmental monitoring, athlete and staff education, and the availability of on-field cooling resources (14). However, despite these interventions, EHS continues to pose a significant threat, underscoring the need for more robust, evidence-based prevention programs (34). The NCAA Sports Medicine Handbook provides a comprehensive set of protocols for the prevention, recognition, and treatment of EHS, emphasizing the importance of rapid cooling and immediate medical intervention (29). Recognizing the symptoms of EHS, such as confusion, altered mental state, and significant body temperature elevation, is crucial for initiating prompt treatment. Rapid whole-body cooling, particularly through cold-water immersion, is paramount in preventing fatal outcomes. The guidelines also advocate for the availability of cooling vests and ice towels as supplementary measures to enhance immediate cooling efforts. Continuous education and regular emergency response drills are vital to ensure that all personnel are prepared to act swiftly and effectively in the event of an EHS incident.

Despite the existence of these guidelines, several critical gaps persist.

1. **Awareness and Education:** Although educational initiatives targeting both athletes and staff are essential, inconsistent knowledge retention and application often contribute to preventable cases of EHS. To address this, structured and ongoing educational programs must be developed, integrating updated curricula and hands-on training exercises that emphasize the multifactorial nature of EHS prevention. These programs should involve both medical personnel and S&C coaches, who have direct interaction with athletes during high-intensity training. Strength and conditioning coaches, in particular, should play an active role in reinforcing key concepts, including hydration, acclimatization, rest periods, and environmental monitoring, as part of a comprehensive strategy for mitigating EHS risk. Educational initiatives should also challenge common misconceptions, such as the belief that hydration alone is sufficient to prevent EHS. Incorporating simulation exercises, workshops, and real-world scenarios into regular training schedules will ensure that athletes and coaches are prepared to recognize and respond to EHS risks effectively. This detailed, multipronged approach will ensure the education is actionable, relevant, and aligned with current evidence-based practices.
2. **Hydration Strategies:** Although proper hydration practices are important, they must be integrated with other preventive measures. Hydration stations should be strategically located to ensure accessibility during practices and games. Strength and conditioning coaches should work with sports nutritionists to implement personalized hydration plans tailored to individual sweat rates and other physiological parameters. This integrated approach will provide more effective maintenance of hydration levels, reducing the risk of EHS. Strength and conditioning programs can reinforce this by monitoring hydration during training sessions and modifying workloads as needed.
3. **Environmental Monitoring:** The use of wet bulb globe temperature (WBGT) devices, including both traditional sling psychrometers and digital versions, is crucial for assessing environmental conditions. However, the key to effective EHS prevention lies not just in measuring WBGT, but in using these data to adjust work-to-rest ratios during training. Inconsistent application of these tools across programs reduces their effectiveness. It is essential for institutions to establish a clear protocol for the systematic collection and application of WBGT data. Collaboration between S&C coaches and athletic trainers is critical to ensure that environmental assessments are integrated into training practices. By standardizing the monitoring process and adjusting work-to-rest ratios based on real-time WBGT data, coaches and athletic trainers can significantly enhance athlete safety and minimize the risk of heat-related illnesses.
4. **Exercise Acclimatization:** Football demands repeated high-intensity efforts, such as sprints, tackles, and explosive movements, primarily relying on the phosphagen system and anaerobic glycolysis. Exercise acclimatization programs must be tailored to build anaerobic endurance for sustained explosive efforts. Strength and conditioning coaches should design conditioning protocols that include short-duration sprints (10–20 seconds) with brief recovery periods (30–60 seconds), simulating football's stop-start nature. These protocols enhance anaerobic energy production and recovery efficiency. For linemen, conditioning should emphasize strength and power, anaerobic endurance, with additional focus on lower-body explosiveness through exercises such as squats, power cleans, and cluster sets of 5 repetitions (power exercises with 15–30 seconds recovery after each repetition). This approach ensures linemen can sustain repeated high-intensity efforts. By addressing both anaerobic endurance and positional-specific energy demands, coaches can prepare athletes for football's physical challenges and improve overall performance.
5. **Heat Acclimatization:** Heat acclimatization involves the physiological adaptation of the body to hot environments, enhancing thermoregulatory function and reducing the risk of heat-related illnesses. Heat acclimatization programs should be implemented over a period of 7–14 days, gradually increasing exposure to heat while reducing the intensity and duration of exercise initially. These programs allow the body to adjust to environmental heat through adaptations such as improved sweating efficiency, increased plasma volume, and more effective thermoregulation. Strength and conditioning coaches should work closely with athletic trainers to monitor heart rate, body temperature, and hydration status during this process, ensuring that athletes gradually adapt without compromising their health. The key is to avoid overexposure early in the process, allowing athletes to safely acclimatize to the heat before increasing the training intensity.
6. **Cooling Resources:** Ensuring the availability of immediate cooling resources, such as ice baths, cooling vests, and shaded areas, is crucial for effective EHS management. However, access to these resources is often uneven across programs. Policies mandating the availability and accessibility of cooling resources during all athletic activities must involve the input and supervision of S&C coaches, who are often the first to identify signs of heat-related distress during physical training. Their coordination with athletic training staff ensures that emergency cooling resources are used effectively when needed.
7. **Positional and Biological Considerations:** Biological factors such as body mass and position-specific physiological demands must be central to EHS prevention strategies. Linemen, who typically have higher body mass and greater muscle mass, face distinct metabolic and thermoregulatory challenges compared with skill position players, making them more susceptible to EHS. Strength and conditioning coaches should develop conditioning programs that address these differences. For linemen, conditioning should prioritize anaerobic endurance to support short, high-intensity efforts,

focusing on maximal strength, power, and anaerobic capacity. This can be achieved through low-repetition, high-load resistance training and exercises that target the phosphagen system, which supports efforts of short duration but high intensity. Skill players, while requiring aerobic capacity for sustained play, must also develop sport-specific speed and agility. Conditioning for skill players in football should prioritize a blend of moderate-intensity aerobic exercises and sport-specific drills. Improving cardiovascular capacity through aerobic conditioning enhances endurance, which is crucial for maintaining performance throughout the game. In addition, incorporating football-specific drills that focus on speed, agility, and change-of-direction ability is essential because these skills are vital for high-intensity bursts commonly required during plays. The combination of aerobic fitness and these sport-specific skills enables skill players to recover efficiently between explosive efforts, ensuring sustained performance and reducing fatigue during the game. This approach emphasizes both the endurance needed for continuous movement and the explosiveness required for dynamic actions on the field. By tailoring conditioning programs to the metabolic demands and thermoregulatory stress of each position, S&C coaches can optimize performance and reduce EHS risk, ensuring athletes are both physically prepared and safe under varying conditions.

Incorporating Theoretical Foundations into Strength and Conditioning Coaching Practices

Strength and conditioning coaches are essential for translating theoretical models such as the Health Belief Model (HBM) (57) and Self-Determination Theory (SDT) (21) into practical, on-the-ground preventive strategies. The HBM allows S&C coaches to tailor their training and heat-acclimation protocols based on athletes' perceived susceptibility to EHS. This perception is enhanced by using wearable technologies that provide real-time feedback on athletes' physiological conditions, such as core temperature and hydration levels. These technologies bridge the gap between theoretical awareness and practical behavior changes, ensuring athletes are consistently engaging in heat mitigation strategies. By doing so, S&C coaches leverage empirical evidence to optimize athletes' training regimens while promoting safety, particularly in high-risk environments such as collegiate football (3,43,49).

Moreover, S&C coaches are key players in the multidisciplinary approach necessary to mitigate EHS risks by fostering an environment of communication and collaboration between sport scientists, athletic trainers, and other coaching staff. This interdisciplinary approach is grounded in systems thinking, a concept that recognizes the importance of considering the broader athletic ecosystem, which includes individual behavior patterns, environmental factors, and institutional policies. Strength and conditioning coaches, therefore, must not only focus on improving performance but also ensure that heat-acclimation protocols and recovery strategies are tailored to athletes' unique needs and sport-specific demands (14,43).

Self-Determination Theory emphasizes fostering intrinsic motivation in athletes through a supportive and autonomy-promoting environment, which S&C coaches are particularly well-positioned to cultivate (21). By giving athletes, a sense of control over their training, such as allowing them to actively participate in decision-making related to heat-acclimation

practices, S&C coaches can foster intrinsic motivation, leading to more consistent and long-term adherence to EHS prevention strategies. Position-specific conditioning and individualized performance monitoring provide athletes with clear benchmarks for success, further reinforcing competence and relatedness within their training environments (47,55).

Strength and conditioning coaches can also tailor training programs to the unique physiological and psychological needs of athletes, further ensuring that both physical performance and mental resilience are developed. Through regular feedback sessions, S&C coaches can help athletes internalize preventive measures, such as proper hydration, scheduled recovery, and environmental monitoring. This proactive approach ensures that heat-stress risks are minimized, while athlete engagement and motivation remain high. In addition, the integration of SDT creates a feedback loop, where athletes not only perform optimally but are also invested in their long-term health and safety, making EHS prevention more sustainable across seasons (21,49).

For S&C coaches, precise terminology and conceptual clarity are essential to the successful implementation of heat-stress prevention protocols. Misunderstandings stemming from ambiguous communication between coaches, athletes, and sport management can lead to errors in the execution of preventive measures, which may increase the risk of EHS. Therefore, S&C coaches must ensure that training regimens, acclimatization protocols, and emergency action plans are communicated effectively and consistently across all levels of an athletic program (43). This ensures a unified understanding of EHS risk factors and creates a culture of safety that permeates every aspect of athlete preparation. By adhering to established theoretical frameworks such as HBM and SDT, S&C coaches are uniquely positioned to lead the charge in EHS prevention (21,57). Their role in developing athlete-centric, evidence-based preventive strategies ensures that heat-stress risks are minimized while promoting overall athlete well-being and performance longevity. Figure 1 illustrates the key principles for transformative change in EHS prevention, including proactive risk assessment, continuous improvement processes, and engagement strategies designed to enhance preventive measures and foster a culture of safety and sustainability.

The evolving landscape of collegiate football necessitates the adoption of advanced player safety protocols informed by robust theoretical frameworks such as the HBM and SDT (21,54,57). The continuous refinement of preventive measures, leveraging both theoretical insights and practical evidence, is essential to mitigate the inherent risks associated with football. This article calls for an ongoing enhancement of player safety initiatives, aiming to ensure the overall well-being and protection of athletes in their educational and athletic pursuits. Through the systematic application of these theoretical models within a comprehensive and holistic framework, collegiate athletic programs can develop and implement more effective preventive strategies against EHS. This approach will not only align with the latest scientific insights but also address the specific needs and behaviors of athletes, ultimately fostering a safer and more sustainable sports environment.

Exertional Heat Stroke Survivability in Football and the Role of Strength and Conditioning Coaches

Exertional heat stroke remains one of the most pressing safety concerns in football, with a long history of fatalities that

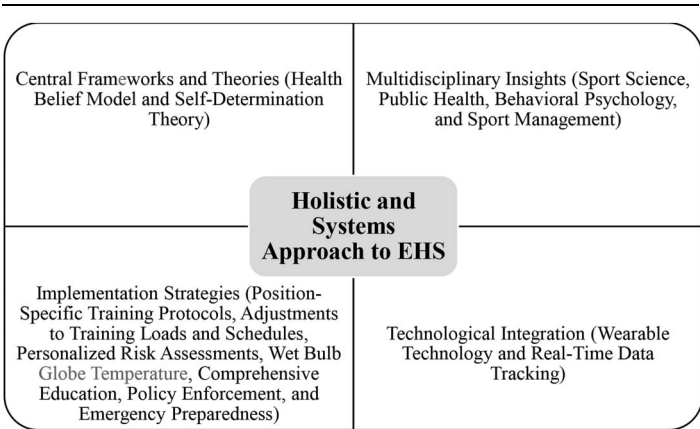


Figure 1. Foundations for transformative change in EHS prevention.

underscores the persistent challenges in prevention (3,6,7,10,11,29,33,45). Yet, EHS is 100% survivable if core body temperature is reduced to below 104 °F within 30 minutes of onset. Prompt and effective cooling interventions are critical, as EHS-related deaths have occurred across youth, high school, and collegiate football, underscoring the need for immediate action and improved response protocols (5,7,10,11,32,33).

Strength and conditioning coaches play a pivotal role in preventing EHS by integrating evidence-based strategies into training programs. The successful prevention of EHS requires a multifaceted strategy that combines scientific research with practical implementation, focusing on the customization of training programs to the physiological needs of individual athletes (3). Strength and conditioning coaches must stay abreast of the latest data on EHS prevention, incorporating updated training practices, environmental monitoring, and emergency response protocols into their routines. Continuous education and certification

are crucial for ensuring that coaches, trainers, and medical staff are fully equipped to recognize, prevent, and respond to EHS incidents.

The challenge for S&C coaches lies in balancing the competitive demands of football with the need to protect athlete health. This often requires making difficult decisions, such as modifying training schedules, enforcing mandatory rest periods, and using advanced technology to monitor athletes' physiological responses in real-time. By fostering a transparent and communicative environment, S&C coaches can build trust with athletes, ensuring that safety is prioritized without compromising the integrity of the sport. The financial implications of implementing comprehensive EHS prevention strategies, including the purchase of cooling equipment, funding for research, and upskilling of staff, can be substantial. However, S&C coaches must effectively advocate for these resources by emphasizing the long-term benefits of reducing fatalities and

Table 1
Evidence-based practices for the prevention of exertional heat stroke.

Measure	Description	References
Proper training and education	Coaches, trainers, and medical staff must be well-versed in recognizing early signs of EHS and implementing rapid cooling techniques. Athletes should be educated on the symptoms of heat stress and the importance of maintaining hydration	Casa et al., (15); NCAA, (46)
Advanced monitoring and individual assessments	Using wearable sensors that track core body temperatures in real-time can provide immediate data, allowing for prompt interventions before heat stress escalates. Personalized risk assessments can help in tailoring preventive measures to individual athletes	Casa et al., (16); DeMartini-Nolan et al., (24)
Environmental monitoring	Tools such as wet bulb globe temperature monitors are crucial for assessing environmental conditions. Adjusting practice schedules based on these readings can prevent exposure to extreme heat	Anderson et al., (1); Casa et al., (15)
Comprehensive acclimatization protocols	Gradually increasing the intensity and duration of physical activities during preseason helps athletes adapt to the heat, thereby reducing the likelihood of EHS.	Armstrong et al., (4)
Immediate on-site treatment	Quick access to cooling methods, such as ice baths and cooling vests, can be life-saving during EHS incidents. Ensuring that proper medical equipment and trained personnel are available on-site at all times is essential	McDermott et al., (40)
Hydration and cooling strategies	Personalized hydration plans and the usage of cooling equipment, such as misting fans, shade tents, and cooling vests can help maintain safe body temperatures during high-exertion activities	Casa et al., (15); Judge et al., (36)

improving athlete welfare. Data-driven arguments highlighting cost savings associated with preventing EHS incidents, such as reduced medical expenses, decreased liability risks, and improved team performance because of healthier athletes, are essential for securing necessary investments (19,22,24,28).

The evolving legal landscape further increases the scrutiny on S&C coaches to adhere to best practices. Legal consequences of EHS fatalities can be severe, including potential lawsuits, regulatory sanctions, and loss of NCAA certification or recognition of athletic programs. It is imperative that S&C coaches collaborate closely with legal and medical experts to ensure compliance with relevant laws and regulations, thereby safeguarding their programs against legal repercussions. The ongoing issue of EHS fatalities underscores the critical responsibility of S&C coaches in advocating for, implementing, and maintaining robust safety protocols. By prioritizing athlete health, S&C coaches not only prevent tragedies but also enhance the overall quality and sustainability of their programs. This proactive approach requires a relentless commitment to education, resource allocation, and adherence to scientific evidence to ensure athletes compete in the safest possible environment (16,20,26–28).

Current strategies often prioritize the immediate survival of EHS incidents, typically involving the cessation of activity, recognition of symptoms, and prompt medical intervention. However, this survival-based approach must evolve toward a more proactive prevention model (3). Effective prevention requires a paradigm shift toward evidence-based protocols that include preseason acclimatization plans, the routine monitoring of environmental conditions using tools such as WBGT monitors, and personalized hydration strategies informed by real-time data from wearable sensors. These sensors, which track core body temperatures, provide critical data that can prevent heat stress from escalating into EHS.

To further enhance proactive prevention, S&C coaches should.

1. **Implement Preseason Acclimatization Plans:** Evidence suggests that gradual acclimatization to heat over a 2-week period significantly reduces the risk of EHS (30,51). Coaches should monitor athletes' response to heat exposure during practice sessions and adjust workloads based on observed tolerance levels.
2. **Routine Environmental Monitoring:** In addition to using WBGT devices, S&C coaches should implement daily environmental assessments and track temperature, humidity, and heat index data at all practice sites. This ensures that decisions on training intensity and duration are based on real-time environmental conditions, reducing the risk of overexposure.
3. **Personalized Hydration Strategies:** Hydration strategies should be personalized, using wearable sensors to track fluid intake and body temperature. Coaches should collaborate with athletic trainers to adjust individual hydration protocols based on athletes' sweat rates and electrolyte imbalances (31,53). Real-time data can guide these adjustments during training sessions.
4. **Indoor Training Alternatives:** During extreme heat events, transitioning to indoor training environments with controlled temperatures can mitigate the risks associated with heat stress. Providing a climate-controlled alternative for conditioning, especially during peak heat periods, is essential for athlete safety.

Despite clear evidence of the biopsychosocial, fiscal, and legal impacts of EHS fatalities, resistance to adopting evidence-based

practices persists among some NCAA coaches. This resistance highlights the urgent need for comprehensive educational initiatives to overcome such barriers and fully integrate science-backed protocols into training regimens (34). Strength and conditioning coaches must foster a culture that prioritizes EHS prevention through continued education and advocacy. This may include implementing regular workshops, seminars, and certification programs that focus on heat-related illnesses and their prevention. By embracing advanced, evidence-based strategies, S&C coaches can transition from a reactive to a proactive stance on EHS prevention, safeguarding both the health and performance of their athletes.

Addressing the mental and behavioral health aspects of these tragedies is also essential. Professionals such as sport psychologists and psychiatrists play a vital role in providing psychological support, promoting mental health awareness, and developing comprehensive wellness programs that help athletes cope with the trauma and grief resulting from sudden deaths in sport. These professionals collaborate extensively with S&C coaches, medical staff, and athletic trainers to create environments that prioritize the holistic well-being of athletes. Educational sessions that focus on recognizing the signs of heat-related illnesses and emphasize the critical importance of preventive measures are crucial to ensuring athletes are well-informed and prepared to handle extreme conditions (56).

The evolution of collegiate football necessitates a corresponding advancement in player safety protocols. The ethical and institutional imperative to continuously refine and enhance preventive measures to mitigate the inherent risks of the sport is clear (3,14,26,28). As college football continues to evolve, it is essential to continuously adapt strategies for protecting player health and safety. This relentless commitment to improvement can significantly enhance the overall experience for athletes, ensuring that they can compete at their highest level in the safest possible environment.

Reevaluating Athlete Safety: A Strategic Approach to Exertional Heat Stroke Prevention in Football

The ongoing challenge of EHS in football highlights a pressing need for innovative and comprehensive prevention strategies. The persistence of EHS-related fatalities despite current safety measures underscores significant gaps in existing protocols and necessitates a paradigm shift toward a more integrative and multidimensional prevention framework (11,25). Football players, particularly linemen, are at an elevated risk for EHS because of the combined effects of intense physical exertion, substantial protective gear, and adverse environmental conditions. These factors, coupled with the increased body mass typical of linemen, significantly heighten their vulnerability to EHS (35). Given that EHS remains one of the leading causes of death in sports, athlete safety must be recognized as an urgent and critical priority (4,15,33).

To effectively address these challenges, a comprehensive approach to EHS prevention is essential, one that transcends basic hydration protocols and environmental adjustments. This approach must incorporate advanced health metrics monitoring, individualized risk assessments, robust acclimatization protocols, and immediate on-site treatment capabilities (14,24,40,52). Such an approach necessitates a fundamental shift in sports policies, educational programs, and the broader athletic culture, prioritizing athlete health and safety above traditional performance-driven practices.

Role of Strength and Conditioning Coaches in Exertional Heat Stroke Prevention

Strength and conditioning coaches are pivotal in implementing this advanced approach to EHS prevention. Their expertise in designing and overseeing position-specific training regimens is crucial for mitigating the risks associated with EHS. Tailored conditioning programs that account for the unique physical demands and body types of athletes are essential. For instance, linemen, who possess larger body masses and distinct metabolic profiles, should focus on strength development and anaerobic conditioning through high-intensity, short-duration workouts. These activities optimize the phosphagen system, which is critical for the quick, intense efforts required during play. Conversely, skill position players benefit more from serial sprinting and endurance drills, which enhance aerobic capacity and overall stamina (3).

The proper oversight of these training practices by S&C coaches ensures alignment with safety protocols, thereby reducing the risk of EHS. By integrating these evidence-based strategies across athletic programs, S&C coaches can play a crucial role in significantly lowering EHS-related morbidity and mortality rates. Key measures include educating coaching and medical staff, using the real-time wearable technology for physiological monitoring, conducting environmental assessments, implementing tailored acclimatization protocols, and ensuring immediate on-site cooling treatments.

Advancing Exertional Heat Stroke Prevention Through Evidence-Based Practices

The adoption of cutting-edge, evidence-based strategies is essential for fostering a proactive culture of EHS prevention within athletic programs. This involves establishing stringent organizational policies that enforce best practices across all levels of the program. Strength and conditioning coaches must lead by example, using technologies such as WBGT monitors to accurately assess environmental conditions and wearable sensors to track core body temperatures. The strategic implementation of these comprehensive measures will significantly enhance the safety and well-being of athletes. By aligning training protocols with the latest scientific evidence, incorporating advanced technological tools, and emphasizing position-specific training, collegiate athletic programs can better safeguard their athletes against the severe consequences of EHS (34). This holistic and sustained approach not only promotes athlete health but also reinforces the enduring success and integrity of collegiate sports programs. The proactive mitigation of risks through evidence-based practices is essential not only for preserving the health and safety of athletes but also for upholding the reputation of collegiate sports programs (Table 1).

In summary, the critical role of S&C coaches in the prevention of EHS fatalities cannot be overstated. Their leadership in adopting and implementing advanced, evidence-based strategies is crucial for transitioning from reactive to proactive approaches in athlete safety. By leveraging modern technologies, fostering a culture of continuous improvement, and ensuring that all preventive measures are tailored to the specific needs of athletes, S&C coaches can play a decisive role in reducing the incidence of EHS in football. This comprehensive strategy is fundamental to the evolution of player safety protocols, ensuring that athletes can compete at their highest level within the safest possible environment.

Exertional heat stroke represents a significant and ongoing safety challenge in collegiate athletics, necessitating comprehensive, evidence-based prevention strategies that prioritize the health and well-being of athletes. Effective prevention requires the implementation of position-specific training protocols, precise environmental monitoring, and personalized risk assessments to mitigate the risks associated with high-intensity sports such as football (13,14,16,30). The utilization of tools such as WBGT monitors is crucial for guiding real-time adjustments to training loads and schedules, ensuring that activities are conducted under safe conditions (15). Moreover, a multifaceted approach that includes rigorous education, stringent policy enforcement, and comprehensive emergency preparedness is vital for enhancing the effectiveness of EHS prevention efforts (29,30).

Strength and conditioning coaches play an indispensable role in this preventative framework, particularly through the development of tailored conditioning programs that address the unique demands of different player positions. For example, linemen benefit from strength-focused and short-burst energy system training, which is critical for reducing their susceptibility to heat-related illnesses (4,30,34). Looking forward, future research should prioritize the translation of theoretical findings into practical applications, including the exploration of genetic predispositions and the integration of wearable technologies for real-time monitoring (13). These advancements will enable more precise identification and management of at-risk athletes. Collaboration among S&C coaches, athletic trainers, sports scientists, policymakers, and other stakeholders is essential for fostering a culture of safety that is adaptable across diverse athletic environments. By working together, these professionals can ensure the consistent implementation of evidence-based strategies, thereby creating a supportive environment that prioritizes athlete health and welfare. This collaborative effort will not only reduce the incidence of heat-related illnesses but also enhance the overall college sports experience, benefiting athletes and the broader sports community alike. The effective prevention of EHS in collegiate football requires a coordinated, multidisciplinary approach rooted in scientific evidence and best practices. By integrating advanced preventive strategies and ensuring their rigorous application across all levels of athletic programs, we can significantly enhance athlete safety and well-being, ultimately enriching the integrity and success of collegiate sports.

Practical Applications

This brief review synthesizes and contextualizes the current scientific literature on EHS prevention, providing S&C professionals with an evidence-based framework to optimize athlete safety in high-risk environments, particularly collegiate football. Given their unique proximity to athletes during periods of peak physiological strain, S&C coaches are ideally positioned to operationalize multifactorial prevention strategies targeting thermo-physiological load, metabolic demands, environmental conditions, and behavioral adherence. Key applications derived from this review include the systematic implementation of progressive heat acclimatization protocols, the design of position-specific conditioning regimens that reflect the anaerobic and biomechanical profiles of linemen versus skill-position athletes, and the integration of real-time

monitoring tools, such as core temperature sensors and WBGT indices, to inform dynamic training modifications. Moreover, leveraging behavioral science constructs like the Health Belief Model and Self-Determination Theory enables coaches to enhance athlete engagement and compliance by aligning intervention strategies with individual perceptions of risk, motivation, and autonomy. By moving beyond reactive responses to heat-related pathology, this translational framework empowers S&C professionals to adopt a proactive, systems-based approach that advances physiological readiness, accelerates recovery, and safeguards long-term health outcomes. Ultimately, this synthesis underscores the expanding role of S&C coaches as critical agents in athlete health protection, program sustainability, and performance longevity.

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