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Exertional Heat Illness: A Yearly Preventable Cause of Illness and Death in Athletes

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INTRODUCTION

Every summer, exertional heat illness in athletes becomes the center of attention among coaches, athletic trainers, and physicians across the United States. This topic has recently received increased attention as seven football players died from exertional heat illness between July 2020 and August 2021[1]. Health professionals believe that sport-related heat illnesses can be prevented through following published sports guidelines, protocols for weather monitoring and water breaks, and using appropriate conditioning during practice sessions. This topic has become such an issue that several states and local governing bodies have enacted legislation and policy for exertional heat illness education and training for coaches, players, and parents[2,3,32]. Every year there are coaches and programs that abstain from following guidelines, disregard weather conditions, and force extreme conditioning, referred to as "irrational intensity"[4]. This blatant disregard for player safety can lead to severe cases of exertional heat illness and even death. The COVID-19 pandemic has had an impact on athletics for nearly two years. When looking at the scope of athletics this upcoming summer, it is reasonable to say that we may be heading towards a return to more typical summer activities. As COVID-19 restrictions loosen, there will likely be an increase in sports participation this summer compared to the summers of 2020 and 2021. Therefore, it is of the utmost importance that the sporting community is educated on a preventable illness that plagues athletes during hot weather seasons. Through education, accountability, enacting protocols, and following guidelines set by health professionals[5-7], we can help prevent these needless cases of severe heat illness and death.

Exertional Heat Illness

Exertional heat illness is a condition in where the body is unable to dissipate heat from the body due to a disruption in thermoregulatory mechanisms typically stemming from intense physical activity in hot and humid conditions[8-10]. The defining characteristic of exertional heat illness is a core body temperature above 104°F and central nervous system (CNS) dysfunction[8-12] CNS dysfunction is defined as any abnormal behavior, and does not require loss of consciousness[8-12]. Exertional heat illness can lead to severe pathologies such as multiorgan dysfunction, disseminated intravascular coagulation (DIC), cardiovascular compromise, and even death[8, 10, 12].

While traditionally, heat illness is due to the macroenvironment or ambient temperature, the microenvironment of the athlete has been known to cause heat illness if similar temperatures are met[13]. Additional factors such as genetics, clothing, and acclimatization have shown to play a role in the development of exertional heat illness[14]. Uniforms in football have been shown to be a significant risk factor[15]. The body regulates temperature based on environmental thermal conditions, metabolic heat production, and thermal insulation of clothing and equipment[16].

Medical professionals must undertake rapid intervention in order to minimize severe complications and death in heat stroke[17-19]. The gold standard treatment for exertional heat stroke is cold water body

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immersion[20]. Cold water body immersion has proven to be a life-saving intervention[11]. However, athletes may still exhibit multiorgan dysfunction and complications from exertional heat illness[12]. The primary interventions in the management of heat stroke include resuscitation and immediate cooling[11,21]. Immediate cooling is a vital intervention in treating heat exhaustion and heat stroke[11,17,21]. However, prevention is far better than any treatment modality used for heat stroke[19].

Epidemiology and Risk of Exertional Heat Illness

In the United States, thousands of high school athletes are treated for exertional heat illness annually, with the largest number of these cases disproportionately coming from American football[22-24]. Heat illness has caused deaths in high school, collegiate, and professional athletes and is the third most common cause of death amongst athletes[22,25]. From July 2020 to August 2021, there were seven deaths due to sports-related heat illness in the United States[1]. Nearly one-third of heat induced illness cases occur when practice is greater than two hours in length or when no medical personnel is present[23]. Lack of personnel or trained professionals leads to an increased risk of exertional heat illness[26]. Exertional heat illness has been noted to have a dramatically larger risk within the earliest practices of a football season[27,28]. The outside environment also plays a major role in exertional heat illness. Football players practicing at the beginning of the season have a substantially greater risk for exertional heat illness when wet-bulb globe temperatures frequently reach above 82°F[27,28]. When wet-bulb globe temperatures are high, there is an increased risk for exertional heat illness[26]. Time of exercise, such as when temperatures are highest, may also influence the risks for exertional heat illness[26,29]. Additional factors have been proven to be key in addition to extreme temperatures. Proper acclimatization of full uniform is also needed to decrease risks for football, as clothing has been implicated as a large risk[29]. Increased BMI and inappropriate work to rest ratios have also been implicated as major risk factors[26,29] . For this reason, current guidelines express the need for proper acclimatization and adjustment of exercise intensity[5-7]. The following are an additional non-exhaustive list of key risk factors for heat illness that include: lack of heat acclimatization, dehydration, hot and humid temperatures, exercise intensity, underlying medical conditions, fitness level, poor education, and lack of proper infrastructure[8,30] . Many factors play into the development of exertional heat illness; however, key risk factors have been consistently noted amongst academic research and sport guidelines[5-8,26,29,30].

Current Expert Guidelines

Several leading organizations, including the National Strength and Conditioning Association (NSCA)[5], American College of Sports Medicine (ACSM)[6], and National Athletic Trainers Association (NATA)[7], have laid out guidelines to prevent and manage exertional heat illness in athletes. The NSCA recommends that strength coaches provide education on recognizing heat illness, athlete heat acclimatization, fitness testing for new athletes, emergency action plans, and following the return-to-training protocols, as laid out in their guidelines[5]. The ACSM recommends athlete heat acclimatization, proper hydration status, and use of exercise modification tables dependent on wet bulb globe temperature[6]. The NATA recommends many strategies for implementation. Some critical strategies with strong recommendations include athlete heat acclimatization, modification of exercise on wet bulb globe temperature, rest breaks, proper hydration, emergency preparations, education on recognizing heat illness, emergency action plans, and rectal temperature assessment in patients with exertional heat stroke[7] . The NSCA, ACSM, and NATA share similar thoughts on how to prevent heat illness in athletes. Some key overlapping recommendations are proper heat acclimatization, adequate hydration, emergency preparedness plans, education in recognizing and preventing heat illness, and exercise modification based upon the environment. These factors are all modifiable risk factors for sports. Guidelines and research have expressed the clear need for proper athlete acclimatization, use of the wet-bulb globe thermometer, and modifications to athlete fitness levels[5-7,27,28]. Using a wet-globe thermometer per field of play is another important consideration, as different fields of play reflect a different amount of heat[31]. Wet-globe thermometer algorithms use a variety of factors to determine a safe heat level such as temperature, humidity, and wind speed[31]. Implementing these recommended strategies by the guidelines is vital for preventing heat illness in athletes. These adjustments are simple life-saving measures that must be undertaken and upheld at all levels of athletic competition.

Legislation

On top of following guidelines by leading organizations, some states have taken the initiative a step further and have required education and training on exertional heat illness. In 2021, Connecticut passed House Bill 6492 which will require education and training on exertional heat illness for coaches, players, and parents in high school athletics[2]. Florida, in 2020, also enacted a heat illness bill in response to a heat illness-related death of a high school football player in 2017[3]. Additionally, there are other states who have implemented some degree of legislation for exertional heat illness. Legislation marks a major step in promoting educational awareness of heat illness and the preventability of exertional heat illness. Not only can legislation come from states, legislation and policy can come from governing bodies, such as the Georgia High School Association, a frontier in exertional heat illness policy[32]. Many state high school associations and local governing bodies are working towards enacting the necessary policies. While there has been clear progress, we must continue to push policy and legislation forward to ensure everyone is protected.

Protocols and Implementation

Several collegiate athletic conferences and high school athletic organizations have firmly committed to strict weather policy and acclimatization guidelines to prevent severe cases of exertional heat illness and death. After data-driven heat policy revision by the Georgia High School Association to increase acclimatization and use of wet-bulb globe thermometer, there has been a significant drop off in heat illness cases, and most importantly, no deaths during football practices since the implementation of this policy[32]. Several other states have followed Georgia by implementing evidence-based policies. Emergency preparedness plans and requirement of cold water immersion tubs (the gold standard exertional heat illness treatment) by high school football mandates, have been shown to be crucial in prevention[33]. At the collegiate level, the NCAA recently expanded its pre-season acclimatization time[1]. Heat acclimatization has been shown to reduce the incidence of heat illness, and is necessary for all levels of sport[34]. Through diligent work by sports medicine and athletic training staff, many collegiate athletic conferences and college athletic programs

have taken it upon themselves to develop, enact, and enforce weather policies[35-37]. Implementing these rules and providing strict accountability to adherence has shown positive results[32]. The commitment to implement these exertional heat illness policies by the collegiate and high school associations is a major step towards reducing exertional heat illness.

DISCUSSION

Sports-related heat illness is a preventable cause of morbidity and mortality. Every year, this topic is brought to the center of attention in the sports world, usually due to a tragic and preventable death. There must be change and strict adherence to the guidelines set forth by the leading organizations in the industry[5-7]. Each organization lays out similar guidelines that are easy to follow, feasible, and evidence-based. Quality exertional heat illness plans should include acclimatization, wet-bulb globe thermometer usage, reasonable practice intensities and rest, education on exertional heat illness, and cold water immersion tubs for treatment in the event of an exertional heat illness case. These are life-saving interventions that can prevent deaths and severe injury annually. Coaches and programs must should be held accountable by governing bodies and should strictly follow the guidelines laid out by the NSCA, NATA, ACSM, and their additional governing bodies.

In addition to the usage of the guidelines, we also must continue to educate coaches, athletes, and parents about the dangers of exertional heat illness and its prevention. The states of Connecticut and Florida agree on education and prevention of heat illness, with both states enacting bills to prevent exertional heat illness in high school athletics[2,3]. Education and accountability will create more buy-in to following guidelines as people learn the dangers of exertional heat illness. At both the high school and collegiate level, there has been an implementation of heat illness policies by a number of organizations[1,3,32,35-37]. These are major steps in helping to educate and enforce data-driven recommendations. Through the use of data-driven athletic policies, we have seen a decreased incidence of heat illness and associated fatalities[32].

While there are ways to prevent these cases of exertional heat illness, we do also acknowledge that there may be some barriers to implementation. Some school districts and athletic organizations may struggle with implementation due to limited funding and resources. We recognize this as a challenge; however, we believe that as there is increased attention to this topic from legislation and administrators, we acknowledge that these barriers to implementation may be reduced. We also acknowledge that due to multifactorial causes, such as genetics, it may be impossible to prevent every single case of exertional heat illness. However, we insist that an overwhelming majority of cases can be prevented through the implementation of preventative measures.

Through continued education, enacting protocols, and following the guidelines set forth by the leading sport organizations, exertional heat illness can be prevented in athletes. As these measures continue to evolve, we can hopefully one day see a large growth of education regarding exertional heat illness in athletes and a decrease in the related morbidity and mortality numbers across the country.

Conflict of Interest

The authors of this research declare no conflicts of interest.

Author Contributions

These authors have all contributed equally to this work.

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