Qualitative Survey of Requirements, Recommendations, and Educational Efforts for Extreme Heat and Wildfire Smoke by High School Athletic Associations in the Midwest/Great Lakes Region of the United States

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Abstract

Climate change fundamentally impacts all aspects of life, including athletics. Two of the most pervasive impacts of climate change that are becoming especially dangerous for athletes are air pollution and extreme heat. To better understand the policy implications for youth athletics, a survey was conducted to determine the extent and variability of high school athletic policies aimed to protect student athletes from extreme heat and poor air quality in the Midwest/Great Lakes region of the United States of America. Nine high school athletic

association websites were reviewed for their policies relating to these adverse conditions. The associations were subsequently contacted via phone and email to schedule an interview during which additional details were gathered, clarifying questions asked, and documentation requested. Results found there is considerable variability in the extreme heat and air quality practices of high school athletic associations in the Midwest/Great Lakes region. None of the policies in the focal region were as robust as policies seen in states that had experienced prolonged extreme heat and poor air quality events. Even in an age of feasible measurement of heat and air quality conditions, immediate communication of information, and deep understanding of health consequences of these environmental conditions, uniform and exact policies needed to protect young athletes were not found within the surveyed associations.

Introduction

On July 19, 2006, a day that reached a maximum heat of 97°F, 16-year-old Ryan Owens died from heat-related complications after football practice in Henderson, Kentucky (Patwa 2021). At the time, Kentucky did not have regulations or recommendations to guide decisions made by coaches and school staff during hot weather. Ryan's parents subsequently pushed for state legislation—Kentucky House Bill 383—to reduce future risks and avoid fatalities (Patton 2016). However, Ryan Owens' death is not an isolated event. Over the past 25 years, at least 50 high school football players have died from heat stroke (Murfree and Brison 2022). In 2024, at the time of writing, at least seven middle school and high school athletes had died due to heat related complications during practices or competitions (Chappell 2024). Heat illness continues to be a major concern for athletes at the collegiate and professional levels, too. Recently, Douglas Casa, CEO of the Korey Stringer Institute, an organization devoted to improving the protection of athletes from environmental threats, stated, "I don't think the policies will keep up with the dramatic changes that we're seeing. I just don't think they're going to keep pace with

them because it takes so long to change health and safety policies" (Murphy and Hajducky 2023).

Just as prominent heat fatalities and complications swept through athletics more than twenty years ago, air quality concerns, specifically related to wildfire smoke, are an emerging hazard in the United States (Kekatos 2023). Smoke originating from Canadian wildfires in summer 2023 brought degraded air quality to cities across Canada, the United States, and other countries in North America (Wang *et al.* 2024, Laurent *et al.* 2024). Wildfires and smoke in these regions, otherwise unaccustomed to such poor air quality, rapidly expanded the portion of the U.S. population asking, "how do we protect our athletes from this?" (O'Kane 2023). Practices for protecting professional athletes, and in some cases spectators, have become more widespread in recent years and become more widely known to the public following high profile athletic competitions, such as the 2024 Summer Olympics (O'Kane 2023).

Literature Review

To understand why athletes should be protected against hazardous conditions, background knowledge on the effects, both short and long term, is important to know. Heat illness, including heat strokes and stress, can cause brain damage as well as damage to vital organs such as the heart (Ebi *et al.* 2021, Mayo Clinic 2024, Center for Disease Control and Prevention 2024). Heat illness can also cause a decrease in performance, muscle cramps, exhaustion, and fainting, even if it is not fatal (American Red Cross Training Services n.d.). Additionally, heat illness can worsen pre-existing conditions in athletes with heart disease and other cardiac complications (Centers for Disease Control and Prevention 2024).

In the short term, poor air quality may cause extreme discomfort, irritation, and inflamed airways, with symptoms including coughing, wheezing, and shortness of breath (Minnesota Pollution Control Agency n.d.). Paired with athletes breathing at much faster rates, fine particulate matter can worsen symptoms such as bronchoconstriction, a narrowing of airways in

the lungs (Pierson 1989). This can exacerbate the conditions of athletes with prior respiratory illnesses, such as asthma or chronic obstructive pulmonary disease (COPD) (Minnesota Pollution Control Agency n.d., Reid *et al.* 2016, Cusick *et al.* 2023). Research has also concluded that PM 2.5 and PM 10, two major constituents of wildfire smoke, are the main contributors behind this range of conditions, with PM 2.5 being a far greater risk to health due to its smaller size (Environmental Protection Agency 2023). The long-term consequences of poor air quality can be life altering. Breathing in fine particulate matter over time—which can come from sources that include wood and wildfire smoke—can increase the chances of a person developing COPD, chronic bronchitis, cardiovascular disease, and lung cancer, causing hundreds of thousands of estimated deaths worldwide each year (Minnesota Pollution Control Agency n.d., Johnston *et al.* 2012). But smoke can have numerous other sources beyond wildfires, which include vehicle emissions, by-products from manufacturing and power generation, and fumes from chemical production, that still carry the same risks (National Institute of Environmental Health Sciences 2024).

As a precaution against these threats to athletes' health, some athletic organizations have implemented educational efforts, recommendations, or even mandates to protect athletes. Georgia is a state whose high school athletic association has taken deliberate, informed actions to reduce risk. Before they took this action, Georgia led the country in heat-related deaths over a 30-year period from 1980-2009 (Cooper *et al.* 2020). However, in 2020, the Georgia High School Association revised their heat policies for high school athletes to include a mandated five-day heat acclimatization period where no practices could exceed two hours of activity and implemented a WetBulb Globe Temperature (WBGT) metric to determine proper exercise conditions (Georgia High School Association 2023). This decision did two things. First, it allowed athletes to prepare their bodies for the stress put on them by their regional weather, otherwise known as heat acclimatization. Second, it gave specific guidelines on when teams were allowed to play based on a WBGT metric, a well-established measurement of the effective

temperature on the human body by accounting for three factors: humidity, sun exposure, and temperature (Brimicombe *et al.* 2023). Georgia mandates provide clear thresholds at which coaches, trainers, and school staff must take specific actions to protect youth—with normal activities under 82°F, practice restrictions between 82°F and 92°F, and no outdoor workouts over 92°F (Georgia High School Association 2023). A reading from a WBGT heat stress meter is found by using three sensors: a globe thermometer, wet-bulb thermometer, and a dry-bulb thermometer. These three sensors work in tandem to measure the environmental conditions and calculate the effective WBGT temperature (National Weather Service 2021). Additionally, government websites, such as the National Weather Service, offer digital alternatives in case the WBGT cannot be measured directly at an event (National Weather Service 2019). Since the mandate was implemented, there have been no deaths in fall football practice sessions, which is impressive as football is a sport where athletes are 11.4 times more likely to suffer from heat-related illness (Cooper *et al.* 2020, Samuel 2022, John Hopkins Medicine 2023). Additionally, heat illness rates were reduced over a three-year period following adoption of the mandates (Cooper *et al.* 2020). Georgia is not alone in mandating their associations keep athletes safe; about half of the other states in the U.S. also have some form of required heat acclimatization plan and follow some form of WBGT metric (Korey Stringer Institute 2023). However, rarely do state associations also account for the dangers of air pollution and place guidelines on air quality.

In the Western U.S., where extreme drought, changing weather patterns, and more people living at the wildland-urban interface have resulted in greater population exposure to wildfires smoke over the past few decades, some states already have guidelines to keep athletes safe (Oregon School Activities Association 2023). For smoke, Oregon is at the vanguard for policies to protect high school athletes. The Oregon School Activities Association (OSAA) implemented a metric based on the Air Quality Index (AQI) to determine what actions need to be taken under particular air quality ranges (Oregon School Activities Association

2023). This is done by using government websites to gather accurate AQI readings, followed by instructions for schools if the AQI is within certain ranges (Oregon School Activities Association 2023). The ranges and instructions are clearly shown in a chart published on the OSAA website. The state also utilizes a visibility test (5-3-1 Visibility Test) to determine if smoke or smog are present by viewing the haze or smoke at different distances around an event site when air monitoring equipment is not available (Oregon School Activities Association 2023). Moreover, Oregon's association has also enacted a strict heat acclimatization policy (Korey Stringer Institute 2023).

Considering all of this, the purpose of this study is to broaden athletics leadership's knowledge of events that are likely to become more common in a larger geographic region, discuss measurements and thresholds that are already in use in some regions to protect athletes, provide data collected from a survey of associations in the Midwest/Great Lakes Region, discuss the implications of the findings, and identify considerations for future actions by youth athletics leadership.

Method

Information on policies regarding heat and air quality was gathered from athletic associations in states in the Great Lakes/Midwest Region of the United States. The selected states were chosen based on their proximity to Ohio—where the study was done—as well as similarities in climate with Ohio. Specifically chosen were the Ohio High School Athletic Association, Michigan High School Athletic Association, Indiana High School Athletic Association, Illinois High School Association, Wisconsin Interscholastic Athletic Association, New York State Public High School Athletic Association, Pennsylvania Interscholastic Athletic Association, Minnesota State High School League, and the Kentucky High School Athletic Association. The individual state organizations are informed by guidelines from the National Federation of High School Associations (NFHS), whose primary responsibility is protecting the

welfare of high school students and recommends safety standards for all high school state associations (National Federation of State High School Associations n.d.). The safety guidelines are then adapted for individual states by their respective associations. High School athletic associations were chosen as (1) they are present in all states and connect with most schools within those states, (2) serve to set standards for high school athletics as well as educate school staff, and (3) are organizations that schools look to for guidance and best practices that would be difficult or time consuming for schools to independently gather.

Interview questions were composed by the project team and designed to be limited in scope to respect staff time and increase likelihood of participation while also broad enough to capture each association's unique policies. The questions aimed to gain an understanding of high school athletic association's efforts related to heat and air quality, specifically to find out whether athletic association guidelines were made as educational efforts, recommendations, or mandates. The questions included: (1) What has been your association's policy for extreme heat events and heat related illness, (2) What do you think the future of high school athletics will look like with the rise in extreme conditions such as in heat, (3) Is your association planning any education efforts, recommendations, or mandates to do with either extreme heat or air pollution, and (4) What has been your association's policy thus far with particulate matter or air pollution?

To gather relevant information for each organization without overburdening their staff, a preliminary review of each organization's website was performed to find their current policies. However, athletic organizations publish large guidebooks relaying their policies for their schools and sometimes do not include recent updates to these policies or discussions that are ongoing. To gain a fuller understanding of practices each organization followed, interviews were scheduled via email or telephone call with each association's chosen representatives who had the most experience with the policy decisions of that organization. Interviewees were scouted based on job titles found on each organization's directory. For example, staff members listed

with qualifications in “sports medicine” were sought out as the project team thought they were most likely to be familiar with association policies regarding athlete health. From there, questions were shared, via email, in advance of the interview. Of the nine athletic associations contacted, three—the high school athletic associations of Kentucky, Minnesota, and Pennsylvania—were unable to coordinate an interview after multiple attempts to connect with their policy representatives. Additionally, their general service numbers were contacted but no response was received.

During the interviews, which mostly took place over a Zoom and telephone with one via email, representatives from each organization were asked the same questions and their responses recorded. Interviews ranged from twenty to thirty minutes in length and were conducted by the lead student author. Based on their responses, additional follow-up questions were asked. The interviewee was asked to share documentation (a weblink, PDF, etc.) for any educational efforts, recommendations, or mandates that were mentioned during the interview to substantiate their comment. It should be noted that assessing the quality or extent of each state’s education efforts, recommendations, or mandates was beyond the scope of this study. Instead, it was limited to identifying any efforts, regardless of how preliminary or superficial, that had already been undertaken.

Results

Findings from the interviews were organized in Table 1. From these findings, it was discovered that all the athletic associations had some form of education effort for heat illness that would be shared with schools to train staff on how to keep athletes safe. It was also found that organizations had some similarities between their policies, but had their own style to achieve results. Association policies were broken down into three categories—education efforts, recommendations, and mandates. For example, in Ohio while the OHSAA does have policies regarding heat acclimatization, they tend to be less regulatory and more educational as a

Table 1: Actions taken to respond to extreme heat and air quality by state high school athletic associations in the Midwest and Great Lakes Regions.

	Extreme Heat			Air Quality			Details
	Education	Recommendations	Mandates	Education	Recommendations	Mandates	
Illinois	✓	✓	✓	✓	—	—	Has a detailed WBGT policy for heat that outlines specific actions to take, along with recommendations, for various heat index ranges. During the interview the representative said that the organization had entertained discussions about additional air quality actions.
Indiana	✓	—	✓**	✓	—	—	State law requires that coaches receive heat training, which the Indiana High School Athletic Association provides, but the organization itself has no mandates beyond state law and does not have formal recommendations. Representative explained that the organization trusts schools to determine best course of action based of information they provide (regular educational seminars, emailed reminders, and general NFHS guidelines). Ultimately allows schools to act within their discretion.
Kentucky	*	*	*	*	*	*	
Michigan	✓	✓	✓	✓	✓	—	Detailed "Heat and Humidity Policy" that, similar to Illinois, outlines specific instructions for range of heat index temperatures. During Canadian wildfires in summer 2023, schools requested air quality guidelines. Based on general NFHS guidelines, the organization made basic recommendations for schools to follow.
Minnesota	*	*	*	*	*	*	
New York	✓	✓	✓	✓	✓	✓	Provides both recommendations and mandates in heat policy. Mandates, however, only enforced when heat index is 96 degrees or higher. During Canadian Wildfires in summer 2023, published guidelines for air quality policy for tournament: no events allowed to play in AQI over 150. Offers other recommendations for AQI less than 150.
Ohio	✓	✓	✓	—	—	—	Only mandates a heat acclimatization policy. Offers generalized recommendations for breaks and water under a WBGT metric. Does not feel safe mandating anything else without experts and potential government backing. No air quality policy.
Pennsylvania	*	*	*	*	*	*	
Wisconsin	✓	✓	—	✓	✓	—	Offers a list of recommendations for certain ranges of temperature under a heat index. Finds that recommendations followed well by schools. Only general recommendations for air quality based on NFHS guidelines.

*Information was sought for high school athletics associations in Kentucky, Minnesota, and Pennsylvania, but they did not respond to numerous inquiries via e-mail and phone.

**Mandate is from an organization external to the state association.

source available for coaches to better protect student athletes. When asked why, the interviewee listed several reasons: they do not have the experts needed to feel safe making such a drastic decision, there is a financial component to consider, and they can only truly make regulations if and when there is a legislative push behind the decision (Mason 2023).

Intuitively, it makes sense that associations would proceed along sequential steps, starting with education efforts, advancing to recommendations, and eventually enacting mandates. Indiana stands out as the sole state that does not follow the sequential steps, having education efforts as well as mandates without recommendations. This unique circumstance results from an external body, the state legislature, establishing mandates for the athletic association to enforce. The mandate only specifies that coaches receive training on heat illness and prevention and does not enact specific athlete acclimatization periods or threshold measures where coaches need to take specific actions (Ind. Acts. 49 2018). The Indiana High School Athletic Association allows schools to act within their discretion beyond the 2018 mandate from the Indiana General Assembly. Among the high school athletic associations interviewed, each shared various reasons and rationale for their current balance of policies. Unique facets of each state's situation were captured in the Details column of Table 1.

In regards to air quality, it was found that state association policies had not progressed as far compared with extreme heat. It was found that none of the states, aside from New York, had permanent air quality requirements. This is further emphasized with comments from one of the interviewees that, "Canadian Wildfires were an eye opener for air pollution" (Mason 2023). Additionally, vast differences were seen in how high school athletic associations utilized their positions. Some organizations may enforce mandates to eliminate any blind spots in their protection efforts, while others prefer to recommend and guide local schools on how to best safeguard their athletes. An example of the effort to address these blind spots can be seen in Michigan, where the high schools requested concrete guidance on air quality conditions from

the Michigan High School Athletic Association during the Canadian Wildfires of 2023 (Geoff 2023).

Information was sought from three additional states, Kentucky, Minnesota, and Pennsylvania, but numerous attempts to contact appropriate staff members at their respective athletic associations via email and phone were unanswered. The lack of this data does leave a blind spot in this study. However, substituting information found on each of their websites is a challenging replacement. Often policies from athletic association websites can be hard to find and, if located, possibly outdated. Additionally, policies published by athletic associations do not clearly state the extent of their guidelines and often articulate them with vague phrasing. For these reasons, direct discussion with athletic association representatives was deemed essential for information accuracy and athletic associations that did not respond were merely marked as not responding instead of assuming policies based on potentially misleading guidelines.

Discussion and Implications

Although limited by the amount of data collected—with only six of the nine athletic associations responding for an interview—this study was able to document the general policy landscape. Overall, the findings of the study are not unexpected. Concerns over heat illness and exhaustion have been around for much longer on a wide geographic area than concerns over air quality. Unlike twenty years ago when high school and college athletes alike were dying of heat illness, the threats of poor air quality were generally not seen on such a large regional scale. Furthermore, while there was medical knowledge of the health concerns associated with pollutants such particulate matter and cigarette smoke, public sentiment and air quality standards still allowed actions such as indoor smoking. Survey results show that these organizations have all taken some action on extreme heat and are now looking into actions for air quality. The differences of whether an association has enacted requirements or recommendations appears to depend on the organization and its state circumstances.

Reasons for enacting specific policies can be based on a variety of factors, beyond the scope of this study, that include: (1) High school athletic associations are separate entities that have unique ways of governing themselves. These differences in how each individual organization chooses to operate can be informed by their organizational history and regulations within the state where they operate. (2) The states that were researched have a wide spectrum of geographies and climatologies, spanning from forests and plains of Wisconsin to the Appalachian Mountains of New York. Likewise, policies that were unnecessary in the past might become necessary in the future as conditions change within a state over time, with some states already having a history of standout events that inform their practices. (3) Associations have a lot of demands on their plates, for which medical expertise is but one and environmental hazard knowledge is a specialized subset. We saw that some states had a difficult time replying to our requests in a timely fashion, with some not responding at all to numerous requests. We were not able to attribute this lack of response to a staffing/capacity/organizational problem or a desire to avoid being on record. (4) Associations may face pressure from parents, school officials, elected leaders, and students not to change or limit advantages to their team. While not perfectly analogous, examples of the pressures faced by higher education athletic administrators during the COVID-19 pandemic, that reflect challenges in the United States, are articulated by Ferguson et al. (Ferguson *et al.* 2020). (5) Lastly, associations relying on funds coming in from various sources might be averse to change policies that alter stable revenue streams.

The findings from this study show the current state of policies undertaken by high school athletic associations in the Midwest/Great Lakes Region of the United States. Looking beyond this region to other parts of the country, we see those states that have experienced more prevalent extreme heat and smoke pollution were earlier to adopt more aggressive actions to keep athletes safe. As a growing number of states face similar threats, the population affected will increase and a wider recognition of the threat is likely to emerge. With climate change

impacts becoming more pronounced, extreme heat and wildfire smoke should be anticipated to be a more persistent challenge to athletics. Swift changes in climate impacts, as seen in the 2023 Canadian Wildfires, leaves associations needing to respond more rapidly to address circumstances with which they have little past experience. Athletic organizations want to keep athletes safe from harm while at the same time giving them the liberty to participate in athletic activity. We have seen that athletic associations are balancing these two interests, which sometimes conflict, with regard to extreme heat and air pollution.

It is worth mentioning that assessing the quality or extent of each association's education efforts, recommendations, or mandates was beyond the scope of this study. The authors limited efforts to identifying actions, regardless of how preliminary or cursory, based on exchanges with staff of the association as well as documents they provided and information on the organization's website. Likewise, while this study focused on air pollution resulting from wildfires, which blanket a large area and impact numerous communities, there are places in the United States that have suffered from chronic air pollution from more localized sources, such as industrial operations.

A few considerations for those professionals and volunteers working in youth athletics, whether it be with high school aged youth, include: (1) ensuring that trainers and coaches have sufficient training to make decisions for extreme heat and air pollution, (2) having clear protocols that are unambiguous for trainers and coaches to follow, (3) ensuring that youth and parents understand the protocols and rationale, and (4) having access to knowledgeable trainers and medical professions to assist in decision making when circumstances are not clear cut. This study articulates how states are implementing different education efforts, recommendations, and mandates. For those individuals working at the state level, a platform or venue to share best practices and seek out expertise, such as via the NFHS, would help expedite knowledge transfer within the community. NFHS does convene a Sports Medicine Advisory Committee to advise member associations and provide a conduit between research and practice, and the

association offers an online course on heat illness (National Federation of State High School Associations 2023, NFHS Learning Center n.d.). Cooperation with outside organizations that seek to educate and provide guidance on how to keep athletes safe, such as the Korey Stringer Institute, is also an option. As one of the interviewees stated, athletic associations “want to be preventative and not reactive” (Geoff 2023).

The Occupational Safety and Health Administration (OSHA), which sets and enforces workplace standards across the United States, offers employees protections for both extreme heat and air quality under the General Duty Clause of the Occupational Safety and Health Act of 1970. This act states that places of employment are, "free from recognized hazards that are causing or likely to cause death or serious harm to employees" rather than specific heat and air quality criteria (OSHA n.d., OSHA n.d.). Some states have gone farther and set their own specific criteria. College athletes, who were previously not paid and thus not legally considered employees, have recently been placed under the purview of OSHA due to moves by universities to pay athletes and a decision by the National Labor Relations Board to reclassify college athletes as employees (Surma 2023). While these decisions provided some standardization across the country and raised the safety standards for many college-level athletes, there are still no universal protections for athletes participating in younger, pre-professional levels. Furthermore, OSHA lacks jurisdiction with professional athletes, who are classified as independent contractors rather than employees, and spectators, who are neither employees nor independent contractors (Fairfax 2008).

Better protection can come from a variety of sources, beyond athletic associations. Whether it be from universities researching the effects of these environmental conditions on health and finding new ways to treat them, to climate service providers giving reliable early detection of hazardous weather occurrences, to youth athletic and recreation organizers knowing when environmental conditions are too dangerous to participate, full protection of athletes comes from the cooperation of everyone in a community. While climate change impacts

offer ever morphing challenges for the safety of athletics, it is important for the policies implemented to protect athletes be adaptive and practical. Ultimately, as the climate evolves, so too must the strategies to ensure safety and well-being for athletes.

In light of these findings, future research should explore the effectiveness of the policies implemented by athletic associations and which policies prove to be most beneficial. These studies should also attempt to capture side effects, such as the total time and expense required for mandated training and confusion caused by policies for which staff do not have information or knowledge on which to act. Additionally, a larger national survey of more states beyond the Midwest/Great Lakes Region would gauge protections put in place for athletes in states with higher average temperatures and humidity, such as in the South and Southwest. Depending on the findings, it may be prudent for a larger body, such as the NFHS, to advocate for stricter basic protections for athletes to be implemented on a national level.

Additional Information

This study was deemed *Exempt - No Review Required* by the Ohio State University IRB.

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