
RINGS OF
FIRE
HEAT RISKS AT THE 2024
PARIS OLYMPICS

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FOREWORD

BY LORD SEBASTIAN COE,
PRESIDENT OF WORLD ATHLETICS

This report will be published a month out from what will undoubtedly be a memorable Paris 2024 Olympic Games, when once again the world gathers to be captivated by **some of the very best of human qualities**. Yet amongst this excitement, it's important to recognise that the world of sport - like the wider world around us - currently faces sobering challenges in a constantly changing landscape.

An important part of our sport is about records. **Our planet is breaking records too**. 2023 was the hottest year on record. January 2024 was the hottest January on record.

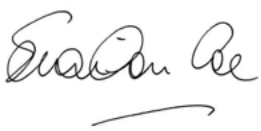
It is a time of great uncertainty and instability. And one of the gravest of those challenges comes from ever-increasing temperatures. Athletics (track and field) is the No 1 Olympic Sport in terms of diversity of participation, popularity and global audience. We have 214 Member Federations based around the World – more than countries who are members of the United Nations – over 40 of which will have an athlete who wins a medal at the Paris 2024 Olympic Games. At least a dozen, probably more, of our member federation countries will no longer be inhabitable by 2060.

For athletes, from smaller performance-impacting issues like sleep disruption and last minute changes to event timings, to exacerbated health impacts and heat related stress and injury, the consequences can be varied and wide-ranging. Whilst global temperatures continuing to rise, **climate change should increasingly be viewed as an existential threat to sport**.

The wellbeing of athletes must always be paramount in our considerations which is why World Athletics continues to research, collaborate and set best in class heat processes, policies and medical practices and procedures to support elite athletes and the massively growing road, mountain and trail running communities.

There has never been a greater need for heightened awareness, discussion and research into what is happening on the planet and why. Sport is just one part of that, but **we cannot be spectators**, we must all play a role.

We are in a race against time. And this is **one race that we simply cannot afford to lose**.



FOREWORD

BY LT. GEN (RTD) J. K. TUWEI, PRESIDENT OF ATHLETICS KENYA

This time of year is a period of **anticipation for our nation and the rest of the world**, as we contemplate coming together at the Paris Olympic Games. There, we will see the drive, resilience and courage of our athletes as they inspire one another on to feats of greatness, **creating memories for all of us across the globe** in the process.

Our athletes have always been a source of the greatest **pride and hope** for our country: Olympic heroes from Kipchoge Keino to Eliud Kipchoge, Paul Ereng to David Rudisha, Faith Kipyegon to Pamela Jelimo and Catherine Ndereba to Brigid Kosgei. My heart therefore aches to see this current generation of runners, and those that have the hopes of coming after them, who have such a fragile future.

The findings of this report are grave, but they are unsurprising to us as a country that this year has received such vivid reminders of the **devastating impacts of climate change** - most recently in the floods that claimed so many lives in April and May.

Challenges are mounting for athletes regarding air pollution, food and water insecurity and lack of shade. And, as this report makes especially clear, the challenges of climate-change induced extreme heat for athletes are extensive and pose risks of devastating outcomes.

At the very least, heat impacts place athletes under a competitive disadvantage, disrupting sleep and forcing them to train earlier and earlier into the morning just to avoid the worst temperatures of the day.

But it is **what comes after that**, if we do not act with sufficient urgency in addressing climate change, which worries me most. Incidences like athletes collapsing during or after finishing competitions, remind us of this threat and the impact of climate change on sports.

The stories in this report are a reminder of the **imperative challenge we face**. It is for all of us to aspire to the qualities of our athletes - their **drive, resilience and courage** - in coming together to face that challenge.

EXECUTIVE SUMMARY

The Tokyo Olympics offered a window into an alarming, escalating norm for Summer Olympics. As temperatures rose to over 34°C and humidity reached almost 70%, the Games in Japan went on to become "the hottest in history" with condition described as "torturous." [1] Competitors vomited and fainted at finish lines, wheelchairs were deployed to carry athletes away from sun-scorched arenas and the fear of dying on court was even raised mid-match by the Tokyo Games' number two seeded tennis player Daniel Medvedev.[2]

The next Olympics in Paris is now upon us, and notable cases of extreme heat undermining the health and enjoyment of sporting spectacles have only increased in the intervening years.[3] Due to inaction on climate change and the continued rate of fossil fuel use, **the world continues to get warmer and stay warmer for longer**.[4]

Sceptics may dismiss the disruptive capabilities of heat at an Olympics mainly taking place in northern France (though locations for various events include the sailing in Marseille, football in Nice and even Tahiti for the surfing).

That would be a mistake. A deadly heat wave in the summer of 2003 killed more than 14,000 people in France.[5] Climate change from human activities doubled the likelihood of that heatwave and increased the risk of heat-related mortality in central Paris by 70 per cent.[6] At the time, the maximum temperature recorded in Paris was 39.5°C.[7] Extremely hot summers similar to 2003 are now ten times more likely to occur because of climate change.[8]

By 2019, when a further 1,435 deaths were linked to two bouts of heat, the hottest day in French history was recorded at 45.9°C, with Paris registering a temperature of 42.6°C.[9] The warmest year in French history followed in 2022 with a flurry of intense heat waves.[10] The next year, last summer, brought further death as nearly 5,000 people lost their lives as a result of the sweltering heat.[11] This report further contextualises the pattern of increased temperatures in France and the Paris area since the city last hosted the Olympic Games 100 years ago.

The fact that the Olympics will take place during high summer means that the threat of a devastating hot spell is a very real one.[12] As highlighted in the first *Rings of Fire* report, the delay of a couple of weeks for the Paralympics is unlikely to have much of a mitigating effect. This is especially concerning given the past precedent for heat waves to hit France later in the summer.[13] Additionally, there are increased risks of exertional heat illness Paralympic athletes may face – with academic studies detailing how more than one in five Paralympic athletes experienced at least one heat-stress related symptom at the Tokyo Paralympics.[14]

It is not just the temperature that is increasing. The alarm amongst the athlete community is growing too. As the Paris Games approach, we hear from a host of elite sportsmen and women from around the world and from an array of events to get a sense of how they viewed the challenges that come with training and competing in extreme heat. The feedback is deeply disconcerting.

New Zealand tennis player **Marcus Daniell**, who won a bronze medal at the Tokyo Games in the men's doubles, reveals his fears of heat-related deaths in sport as athletes compete in a climate of "true

risk – the type of risk that could potentially be fatal." He describes having to "play in conditions where an egg can literally be fried on the court. This is not how sport should be played."

British marathon swimmer **Amber Keegan** highlights the "nasty cocktail" that extreme heat can conjure up for even the best prepared athletes in an already challenging open water environment: "extreme heat is dangerous no matter how much prep you have done. We do all get in that water knowing that people have died from the heat. It's not something to be trifled with."

Top Indian triathlete **Pragnya Mohan** describes being exposed to similarly "scary" dangers "that can be fatal" as "your body feels like it's shutting down", and recounts how she can no longer train in her home country because of the heat.

Japanese race walker and 2019 World Champion **Yusuke Suzuki** explains how the enduring consequences of heat illness derailed his Tokyo Olympic dreams and took a profound personal and professional toll – including on his physical and mental health.

And it is not just endurance sports that are being affected. Olympic pole vault bronze medallist **Eliza McCartney** discusses how her physical wellbeing can be jeopardised in competition as her grip loses its adhesion with increased sweat. Australian **Kelsey-Lee Barber**, an Olympic medallist and double World Champion in javelin, expresses her worries about the lack of information and strategies being offered to athletes around "the risk in competing in high heat conditions." She reveals how heat-related risk is becoming "a familiar trend and a familiar conversation when it comes to preparation for a major competition – it's concerning how quickly this has become a reality".

Paris will be **Hugo Inglis's** fourth time competing for New Zealand's hockey team at the Olympics. He describes how playing in heat negatively impacts on the tactical side of the game and results in a far less exciting spectacle for fans and broadcasters alike. He believes that pre-match ice baths used to try to counter the heat effectively ended his Tokyo Olympic dream prematurely, but thinks that many athletes are too afraid to speak out about having to play in such gruelling conditions because of concerns about how they might be perceived: "The current environment is one of fear".

This report provides these athletes with a platform to counter that environment of fear, bringing together competitors from vastly different sports and parts of the world to voice their alarm and hopes for change.

It is up to the rest of the sporting world – from federations and governing bodies to organising committees and beyond – to listen and engage with those concerns and recommendations. And fundamentally, both within and beyond sport, we must accelerate action on climate change and urgently reduce global emissions driven principally by fossil fuels. The welfare of athletes and fans, the future of the Olympic Games, and the survival of sport depends on it.

> "We do all get in that water knowing that people have died from the heat."
>
> **Amber Keegan**

THE CHALLENGE OF HEAT: A SUMMARY

BY MIKE TIPTON MBE, PROFESSOR OF HUMAN & APPLIED PHYSIOLOGY AND JO CORBETT, ASSOCIATE PROFESSOR OF ENVIRONMENTAL PHYSIOLOGY, EXTREME ENVIRONMENTS LABORATORY, UNIVERSITY OF PORTSMOUTH

Climate change has and will continue to increase average environmental temperatures, as well as the frequency and intensity of extreme weather events. These include events which may coincide with summer Olympic and Paralympic competition dates. Hot and/or humid conditions make it harder to lose heat to the environment and more difficult to regulate deep-body (core) temperature. This impairs physical performance, particularly when the exposure is prolonged and sustained high work rates are required; as temperature increases beyond around 11 °C, so does the performance impairment in this type of activity. High ambient heat and humidity can also cause further harmful impacts: from sunburn and heat cramps, through to heat exhaustion or even collapse from heat stroke, potentially putting health and well-being at risk. This may occur in athletes, but also in officials and spectators (Figure 1).

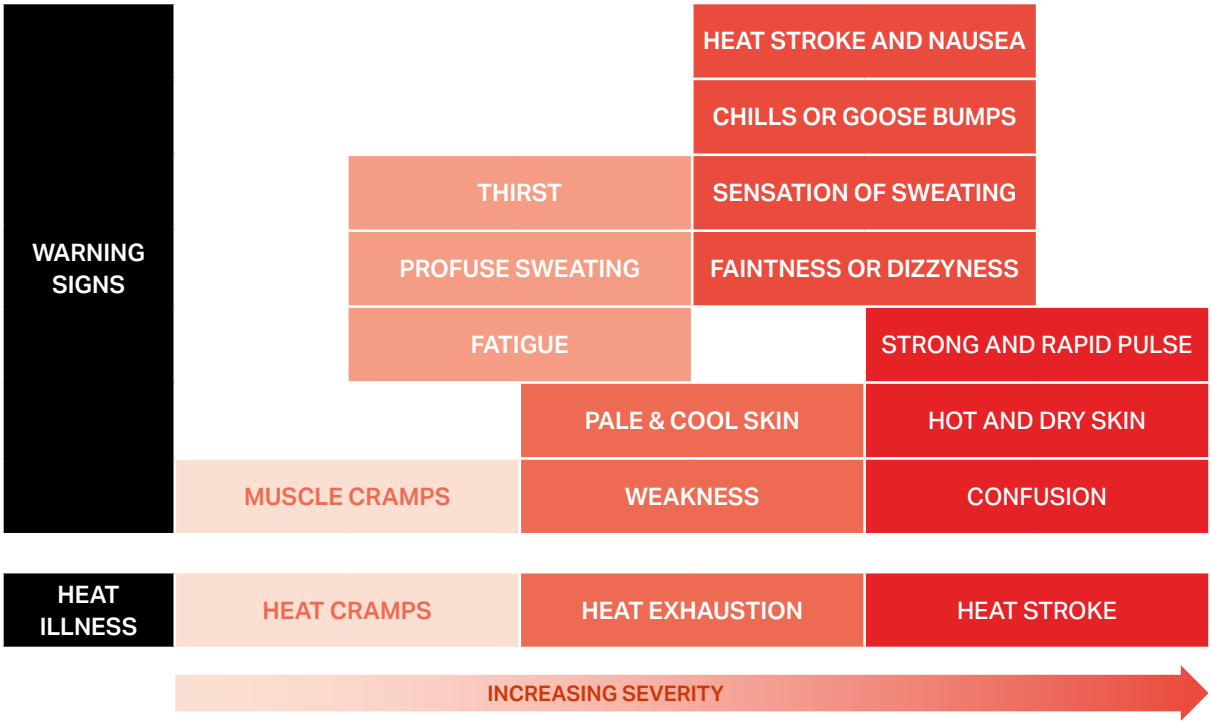


Figure 1. *The impact of heat on performance and health.*

HEAT CRAMPS

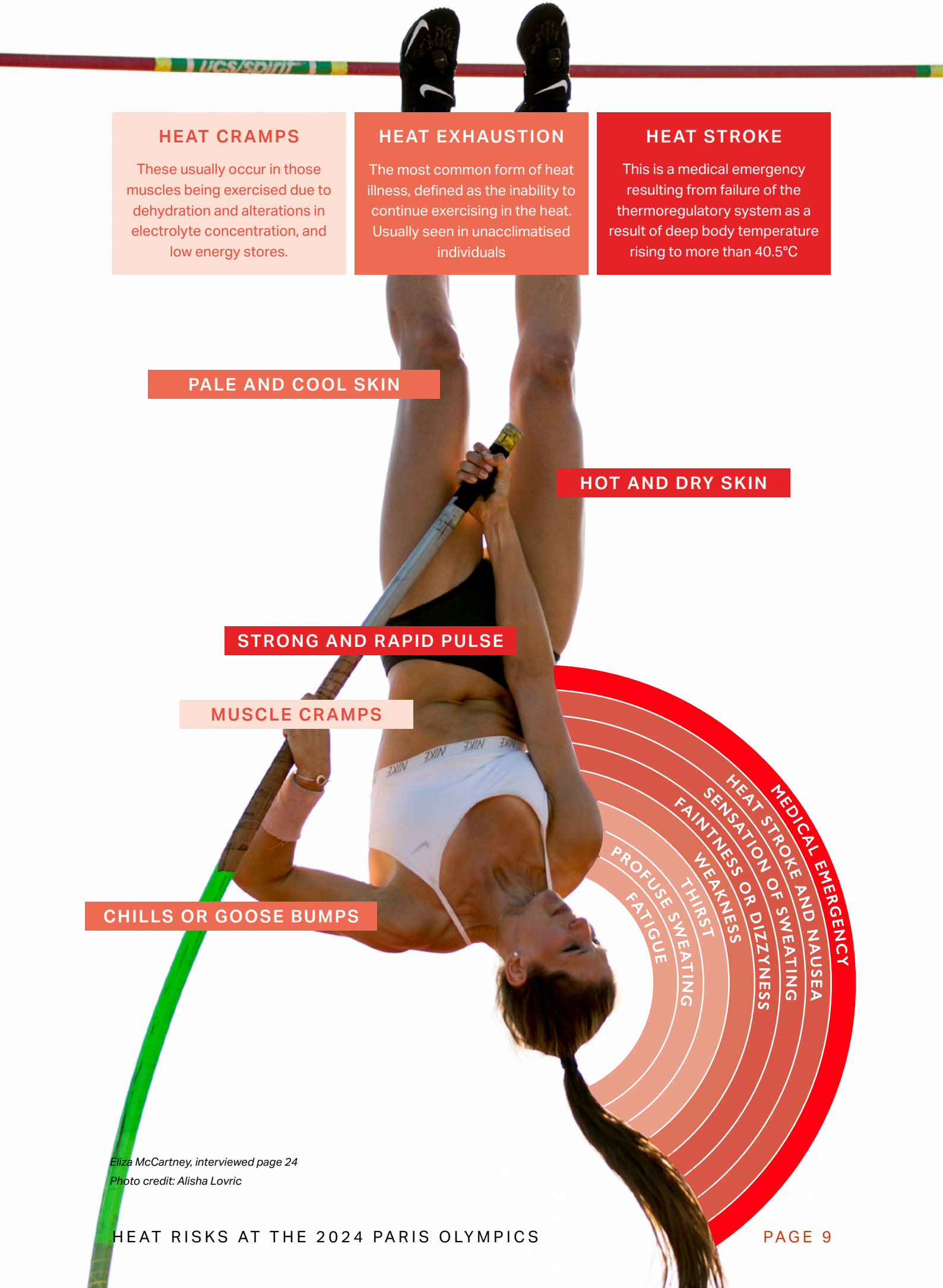
These usually occur in those muscles being exercised due to dehydration and alterations in electrolyte concentration, and low energy stores.

HEAT EXHAUSTION

The most common form of heat illness, defined as the inability to continue exercising in the heat. Usually seen in unacclimatised individuals

HEAT STROKE

This is a medical emergency resulting from failure of the thermoregulatory system as a result of deep body temperature rising to more than 40.5°C



Eliza McCartney, interviewed page 24
Photo credit: Alisha Lovric

PHYSIOLOGICAL EFFECTS OF HIGH HEAT AND HUMIDITY

High ambient temperatures result in behavioural responses (i.e. seeking shade) and physiological responses (i.e. increasing blood flow to the skin, secretion of sweat onto the skin) to reduce heat gain and/or increase heat loss, and support effective thermoregulation. This process can result in compromised cardiovascular and muscle function, perceptual discomfort (i.e. feeling uncomfortably hot), cognitive impairment (particularly during complex tasks), as well as dehydration caused by insufficient replacement of fluids lost through sweating. These effects might be exacerbated in individuals with underlying medical conditions as well as in some Paralympians, where their condition may affect their ability to thermoregulate. Where these processes are insufficient to prevent unabated heat gain, heat stroke can result: this is a serious medical condition that may have long term, multi-organ consequences and may even be fatal.[15]

MITIGATION STRATEGIES

The threat of heat on health and performance necessitates the introduction of mitigation strategies, which may include: scheduling events to cooler times of the day/year (as notably happened with the 2022 FIFA World Cup in Qatar when it was moved from the summer to November-December); shifting events to alternative locations; alteration in competition regulations (e.g. shortening of events); introduction of "cooling breaks" into events; acclimatisation strategies; use of cooling and rehydration innovations; adjustments to selection policies; alterations in game/race strategy; and clothing innovations.

Even if the health of those involved is not threatened (and it is quite possible that it will be), the overall experience will be diminished by uncomfortable conditions for spectators, and impaired performance by athletes and officials. The expectations of all involved in some sporting events will need to be adjusted.

As detailed in the *Hit For Six* report looking at the impact of climate change on cricket, the most widely used measure of hot environments is the "Wet Bulb Globe Temperature" (WBGT) index.[16] It is regarded by many as the criterion standard for the assessment of thermal stress during physical activity. The index combines dry (Tdb) and wet bulb (Twb) air temperature with radiant (Tg e.g. sunlight) temperature in the following formula:

$$WBGT = 0.1Tdb + 0.7Twb + 0.2Tg$$

The high weighting for 'wet bulb' (which relates to the humidity [water vapour pressure] in the environment) emphasises the large impact humidity has on the body's ability to evaporate sweat and the importance of sweating in avoiding heat stress.

Below are some examples that help to demonstrate why measuring WBGT is more important than measuring just air temperature. Taking a fixed air temperature of 30°C and wind speed of 0.5 metres per second in all cases:

Example 1:
Cloudy day (no sun), relative humidity 50 percent,
WBGT = 25.9°C

Example 2:
Sunny day, relative humidity 35 percent,
WBGT = 29.5°C

Example 3:
Light cloud cover, humid day (relative humidity 90 percent),
WBGT = 32.0°C

CLIMATE SCIENCE:
100 YEARS OF WARMING

CLIMATE CENTRAL

BY CLIMATE CENTRAL: A NON-PROFIT AND INDEPENDENT GROUP OF SCIENTISTS AND COMMUNICATORS WHO RESEARCH AND REPORT THE FACTS ABOUT OUR CHANGING CLIMATE AND HOW IT AFFECTS PEOPLE'S LIVES.

Data Summary of Heat Trends (1924-2023) for the 2024 Olympic & Paralympic Games.

TEMPERATURES IN PARIS

Annual temperatures

Since 1924, when Paris last hosted the Olympics, annual temperatures in the French capital have warmed by 1.8°C,[17] while on average there are 23 more "hot" days (25°C+) and nine more "scorching" (30°C+) days per year.[18]

The Paris area has seen 50 heat waves from 1947-2023, which have been increasing in terms of frequency and intensity as a result of climate change.[19] This year's Olympics will take place at around the same period of the year that the deadly 2003 record heatwave unfolded with such devastating consequences.[20] Significantly, summer heat is intensified in Paris due to the Urban Heat Island effect (whereby urban areas tend to be warmer than surrounding rural areas).[21]

Meanwhile, tropical nights, when temperatures do not drop below 20°C, have become significantly more common in Paris in the past century.[22] Over the 10-year period from 1924-1933, only four tropical nights were observed in the French capital. In comparison, over the most recent decade (2014-2023), Paris has seen a total of 84 tropical nights – a 2100% increase. Sleep disruption due to heat has been cited in the build-up to the 2024 Games as a major concern by athletes, especially given the lack of air conditioning in the Olympic Village.[23]

Monthly temperatures

The late-summer months – July, August, and September – have all warmed since 1924, with the month of August seeing the largest increase in minimum (+2.9°C), mean (+2.7°C), and maximum (+2.4°C) temperature (i.e. the average temperature in August 2024 will be 2.7°C higher than in August 1924).[24]

Minimum temperatures, which generally represent night-time temperatures, have warmed faster than mean or maximum temperatures.

MONTH	MIN TEMPS	AVG TEMPS	MAX TEMPS
JULY	+2.8°C	+2.4°C	+2°C
AUGUST	+2.9°C	+2.7°C	+2.4°C
SEPTEMBER	+2.1°C	+1.7°C	+1.2°C
JULY – SEPTEMBER	+2.6°C	+2.2°C	+1.9°C

Table 1. *Changes in monthly temperatures in Paris from 1924-2023.*

Temperatures during the Olympics (24 July – 11 August) and Paralympics (28 August - 8 September)

Average temperatures during the months that the Summer Olympic Games take place have warmed by 3.1°C since 1924,[25] while average temperatures during the Paralympics have warmed by 1°C.[26] Minimum temperatures increased by 3.3°C for the same period, whilst the minimum temperatures during the Paralympics rose by 1.6°C.[27]

DATES	MIN TEMPS	AVG TEMPS	MAX TEMPS
OLYMPICS	+3.3°C	+3.1°C	+2.8°C
PARALYMPICS	+1.6°C	+1°C	+0.3°C

Table 2. *Changes in temperatures over the dates of the 2024 Olympic and Paralympic Games, 1924-2023.*

TEMPERATURES ACROSS FRANCE

Annual Temperatures

Europe is the fastest warming continent in the world, with its cities particularly vulnerable to the impacts of rising temperatures.[28] Average annual temperatures across France have increased by 1.9°C since 1924.[29] To put such an increase into context, seemingly minimal increases in temperature can have far-reaching 'tipping point' impacts – for example, a rise in core body temperature of just 0.5°C will increase a person's heartbeat by up to 10 beats a minute, which can lead to the onset of heat exhaustion.[30] This is especially dangerous for the most vulnerable groups of the population.[31]

Since the start of the 20th century, the hottest three years in France have all occurred since 2020 and nine of the ten hottest years have all occurred since 2010.[32]

Warming Stripes

To the right are the climate stripes which illustrate average annual temperature anomalies from 1924-2023 for Paris (top) and France (bottom), relative to a 1971-2000 baseline. Each stripe colour represents the average temperature for that one year: the blue shades reflect cooler-than-average years, whilst the red are indicative of warmer-than-average years. Climate stripes were originally created by Professor Ed Hawkins at the University of Reading in 2018.[33]

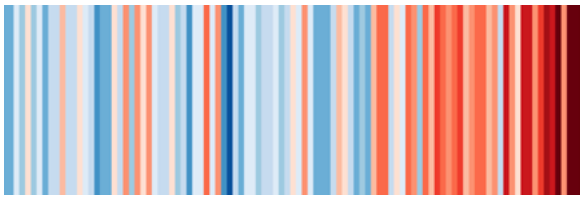


Figure 2: *Paris warming stripes (data from the Paris-Montsouris station)*

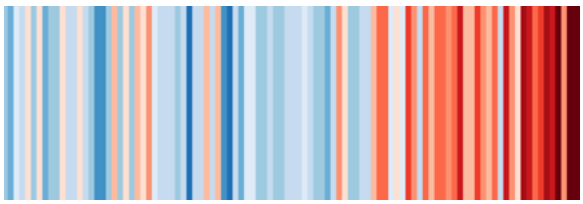


Figure 3: *France warming stripes (data from the national thermal indicator)*

SPORT & FOSSIL FUELS

The link between fossil fuels and global warming is clear. As the Intergovernmental Panel on Climate Change (IPCC) demonstrates, fossil fuels – coal, oil and gas – are the largest contributor to climate change, accounting for **nearly 80 percent of global greenhouse gas emissions**.[34] Most of global emissions can be attributed to 'Carbon Majors', the largest coal, oil and gas companies that have most significantly contributed to cumulative emissions since the 1980s.[35] In moves that are receiving increasing scrutiny, many of these companies sponsor the sports events, teams and leagues whose future is threatened by the climate change that Carbon Majors hold most responsibility for. The **fossil fuel sponsorship list is lengthy and grows year-by-year**. It includes Saudi Aramco's involvement in FIFA, the International Cricket Council, the Indian Premier League, the T20 World Cup, Formula 1, ATP and Esports; TotalEnergies' sponsorship of the Rugby World Cup and African Cup of Nations; Shell's eight-year deal with British Cycling and Team GB's partnership with British Gas.[36]

In the world of football alone, in the wake of the controversial 2022 Qatar World Cup and with Saudi Arabia potentially hosting the 2034 tournament, companies involved in the global game include Chevron Corporation and ExxonMobil in the US, Repsol in Spain, Eni in Italy, Eneos Holdings in Japan, Rosneft in Russia and TotalEnergies in France.[37]

Looking to Olympic sport, whilst the Paris host committee has explicitly committed to hosting a 'fossil fuel free' Games, it's notable that the sponsors of national Olympic and Paralympic teams include British Gas for Team GB, Hancock Prospecting for the Australian Olympic Team and Reliance Industries Limited for the Indian Olympic Association.[38]

Former Australia rugby union captain David Pocock is amongst those to have called out the developments. "I really think fossil fuel sponsorship is the new cigarette sponsorship, where they are **advertising a product that we now know is destroying our home planet and our futures**," he said after the Wallabies signed a deal with Santos, "it's hard to stomach."[39]

If sport is going to take its sustainability and environmental commitments seriously to minimise the climate change impacts experienced by athletes and spectators during sporting events, it will need to conduct a **radical reassessment** of its relationship with fossil fuel companies as an essential component.

TENNIS

VENUE AT PARIS OLYMPICS: Roland Garros, Paris

POTENTIAL KEY ATHLETES: Novak Djokovic; Iga Swiatek

TEMPERATURE LIMITS: Individual tournaments have their own guidelines. At the Olympics, once the WBGT threshold reaches 30.1°C, the Extreme Weather Policy is activated. This allows for a 10-minute break. If temperatures continue to rise (with a WBGT of 32.2°C as a guideline limit), a decision is taken by the tournament referee and medical staff as to whether play should be suspended.[40]

Photo by Moises Alex on Unsplash

Tennis at the Olympics has become a popular feature of the modern Games, with matches in the men's and women's singles adhering to a best-of-three-set format.

The sport has hit the headlines in recent years due to a litany of high-profile cases of heatstroke at major tournaments.

At the last Olympics in Tokyo, the Games' number two seed Daniil Medvedev took a number of medical timeouts as the extreme heat wreaked havoc on his match against Fabio Fognini. When asked by the umpire if he was ok to carry on, Medvedev pointedly replied, "***I can finish the match but I can die***. If I die, are you going to be responsible?"[41]

Medvedev later spoke of the "darkness" he felt in his eyes, recounting that he "didn't know what to do to feel better. I was ready to just fall down on the court".[42]

Meanwhile, Spain's Paula Badosa had to retire from her quarterfinal match against Marketa Vondrousova, **leaving the court in a wheelchair** with her head under a towel due to the effects of the stifling heat.

The legendary Novak Djokovic described the conditions during the match as 'brutal,' remarking "I've played tennis professionally now 20 years and I've never faced this kind of conditions in my entire life on a consecutive daily basis."[43] Argentina's Diego Schwartzman likened the players to zombies from 'The Walking Dead.'[44] These experiences occurred despite the fact that organisers shifted starting times back to later in the day.[45]

Unfortunately, those experiences have been repeated at major events since, with a recent analysis showing how average high temperatures at the biggest tournaments have become markedly higher and more dangerous over the last 40 years as a consequence of climate change.[46] At the Australian Open alone, the average high temperatures have risen by around 3.5°C since 1988.[47] When combined with high humidity, this significantly increases the risk of heat stress and affects both player performance and spectator comfort. The final of the French Open in 2023 exemplifies this. Played at the 2024 Olympic venue, the event was punctuated by some feisty clashes between players Djokovic and Casper Ruud and the umpire. The finalists grew exasperated with a perceived haste being enforced between points when they were desperate for some respite from the scorching Paris heat, in temperatures of around 30°C and humidity of 64%.[48]

The escalating situation led Medvedev to speak out emotionally on court once again, this time at the US Open in New York in 2023, issuing this solemn warning: "One player is going to die. And they're going to see."[49]

Paris France May Court philippe chatrier at le stade Roland Garros during round match

Marcus Daniell, photographed above, who won a bronze medal at the Tokyo Games in the men's doubles, has direct experience of such gruelling conditions. He told this report about some of the impacts of extreme heat:

"At the Tokyo Olympics it was impossible to hydrate well enough to combat the heat and humidity. Dehydration, headaches and lethargy were normal and it was pure bad luck if you had to play through the hottest part of the day.

*At the time I felt like the heat was bordering on true risk – **the type of risk that could potentially be fatal**. One of the best tennis players in the world [Medvedev] said he thought someone might die in Tokyo, and I don't feel like that was much of an exaggeration, especially when you're playing for your country and the desperation to perform is running through your veins.*

*We sometimes have to play in conditions where **an egg can literally be fried on the court**. This is not fun or healthy. Heatstroke is relatively common in tennis.*

*For me it's like you are in the build-up to the worst part of a bad flu – shivery and weird and hot and cold. Your mind can't focus and your mouth is disgustingly dry. And the dangerous thing is that athletes often don't know when to stop, because **we're conditioned to push ourselves beyond limits as a rule**."*

Like Medvedev and many others on the tour, Daniell believes the threat to physical health needs to be taken extremely seriously and harbours profound concerns about the potentially disastrous consequences if previous warnings go unheeded.

*"I feel like we have brushed up against the true limit of what could be expected of athletes' resilience a number of times, and **I don't believe there should have to be a series of heat-related deaths for us to put reasonable limitations in place**.*

*"I am worried. I have been at tournaments where there have been double digit heatstroke withdrawals in a day. **This is not how sport should be played**."*

MARATHON SWIMMING

VENUE AT PARIS OLYMPICS: Pont Alexandre III, Paris

POTENTIAL KEY ATHLETES: Sharon van Rouwendaal; Florian Wellbrock

TEMPERATURE LIMITS: Maximum water temperature limit for competition of 31°C.[50]

Swimmers dive Open Water Women's 10km in 18th FINA World Championships at Yeosu EXPOO Ocean Park Water Swimming Competition Venue in Gwangju, South Korea on July 14, 2019. (The Yomiuri Shimbun via AP Images)

Marathon swimming is a 10 kilometre event held in open waters, with 22 athletes due to take part in each race at Paris. Resilience, strength, adaptability and tactical acumen in often choppy waters are heralded as vital attributes for elite marathon swimmers in a pursuit that has been likened to a "Formula One race" by Gregorio Paltrinieri, the Italian bronze medallist at the Tokyo Games.[51] The race takes around two hours to complete and the final three kilometres, which often unfold amidst changing tides and currents, are usually when the swimmers plot their final strategic moves to overcome their rivals.[52]

The physical nature of this endurance event, pitting athletes against each other as well as the unpredictable water conditions, means that extreme heat can pose an additional layer of unique challenges.[53]

This came to the surface during the Tokyo Olympics when some swimmers and federations lobbied the organisers to move the location of the race from Tokyo Bay to cooler waters.[54] That request was declined, though the start time was brought forward to 6:30am. That meant wake-up times of around 3am on race day for the athletes in order for them to be at their optimal physical state for the start of the race.[55] In Paris a similar move has been implemented, with the races taking place at a local time of 7:30am.

For marathon swimming, the sport's governing body FINA has imposed an upper water temperature limit to 31°C (whilst for pool events, the limit comes in at a lower 28°C). This followed the tragic death of American swimmer Fran Crippen at an open water race in the UAE in 2010 in water that was cited as being overly warm and above 30°C.[56]

Hydration and prior acclimatisation to lengthy exposure in warm water are crucial parts of any marathon swim, with hydration taking on even greater significance in raised water temperatures. Like their counterparts on the roads and on bikes, marathon swimmers will refuel without stopping.[57]

As well as the possibility of extreme heat, which contributed to the American Haley Anderson dropping out of the Tokyo test event in 2019 less than 2.5 kilometres into the race, swimmers must sometimes contend with pollution. This was illustrated by the controversy at the 2016 Olympic Games in Rio de Janeiro when reports highlighted how levels of bacteria and viruses were so high at the various open water venues that ingesting just three teaspoons of water was 'likely to lead to severe stomach and respiratory illnesses.'[58] This remains a prominent problem for the Paris Games. In 2023 the marathon swimming test event was cancelled after dangerously high levels of E.coli were found in the River Seine.[59] Some teams are opting to receive typhoid and hepatitis A vaccines before racing in the open water.[60]

Hector Pardoe is acutely aware of this. The Tokyo Olympian suffered a severe case of heatstroke at the 2022 World Championships in Budapest that left him suffering severe impacts:

*"**It was absolutely horrible, one of the worst experiences I've ever had**, no exaggeration," he says. "**I was practically paralytic, I couldn't speak or move** and had a very painful migraine. I suffered from vomiting, blurred vision, muscular fatigue. It has made me very cautious with events and heat and post-race protocol and pre-race hydration."*

Amber Keegan is a British marathon swimmer who has also won multiple national titles in the pool. She told this report about how climate-related impacts, including extreme heat, increase the various pressures on open water swimmers in an already difficult sporting environment:

"Open water swimming is a sport where everything can change in a split second, so if your brain is foggy, if you're trying to make decisions about when and where to position yourself in a pack or overtake, that will affect you. Physically, there are many impacts of extreme heat – cramp, fatigue (much more so than normal), and vomiting (which is especially bad as you're losing the nutrition you've been consuming during the race).You don't want to be using energy for cooling yourself down when you could be using it to swim faster.

That's just the performance side, but from a safety side, if you're struggling to think clearly, you're not going to make a sensible decision about whether you're overheating so much that you should be getting out. Of course, there is safety support, but at the end of the day it's you that has to put your hand up and say "get me out." You're so far away from anyone that knows you that it really would be easy to push it too far without realising. ***Extreme heat is dangerous no matter how much prep you've done****.*

When you're layering potential extreme heat on top of the existing open water stresses on the body such as sheer exhaustion, dehydration, possible concussions etc, it really has the potential to become a nasty cocktail. We recognise that not all athletes make the most sensible decisions about whether it is or isn't sensible to race, because athletes are competitive: we want to do what we love, and might have additional pressures from sponsors, governing bodies, the public... and we all know that if we sit out, someone else will be willing to get in (unless races are called off by organisers)!

We do all get in that water knowing that people have died from the heat. It's not something to be trifled with."

Tobias Robinson is a fellow British marathon swimmer. He also outlined his personal experiences of training and competing in raised temperatures, once again emphasising what can be at stake for these athletes in a brutal sport in which the body's normal sweat responses in water are inherently far less effective than on land:

"[When in the water] extreme heat impacts performance massively, especially when racing over long distances. Dehydration, loss of concentration and exhaustion are the main symptoms I have noticed when swimming in hot temperatures.

I once raced a World Series 10km race in the Seychelles. I wasn't prepared for the hot temperature of the sea. My body completely lost energy approximately half way through the race and my end result suffered massively due to this.

Rising global water temperature is a possibility for future events. The risks are very real, and very serious." [61]

VIEW FROM THE BOAT

As highlighted in the first Rings of Fire report, heat also affects sports that take place on the surface of the water such as sailing and rowing.[62]

For this report, we heard from double Olympic Champion sailor **Hannah Mills**, double World Champion rower **Imogen Grant**, and record holder and Olympian rower **Jenny Casson**, and on their experience of extreme heat on the water:

Photo credit: Pete Reed OBE

Hannah Mills OBE - SAILOR, GREAT BRITAIN
(two-time Olympic Champion and most successful female Olympic sailor ever)

"Extreme heat in sailing has meant we have to do much more acclimatisation in heat chambers before regattas to help our bodies adapt and put them under much more stress than ever before. Staying hydrated is a huge challenge as we are on the water for up to 5 hours a day in incredibly high temperatures. Recovery time is much longer and fatigue over a week's competition is much higher.

We've had athletes whose core body temperatures have gotten up to 39.5°C during training in extreme heat, which poses really significant health risks. It's scary."

Imogen Grant - ROWER, GREAT BRITAIN
(Olympian and two-time World Champion)

"Extreme heat negatively affects recovery because it can be hard to sleep well when it is so hot, and heat often suppresses appetite so makes it hard to eat enough to recover and train well. I believe that dealing well with extreme heat can be the difference between winning and losing races.

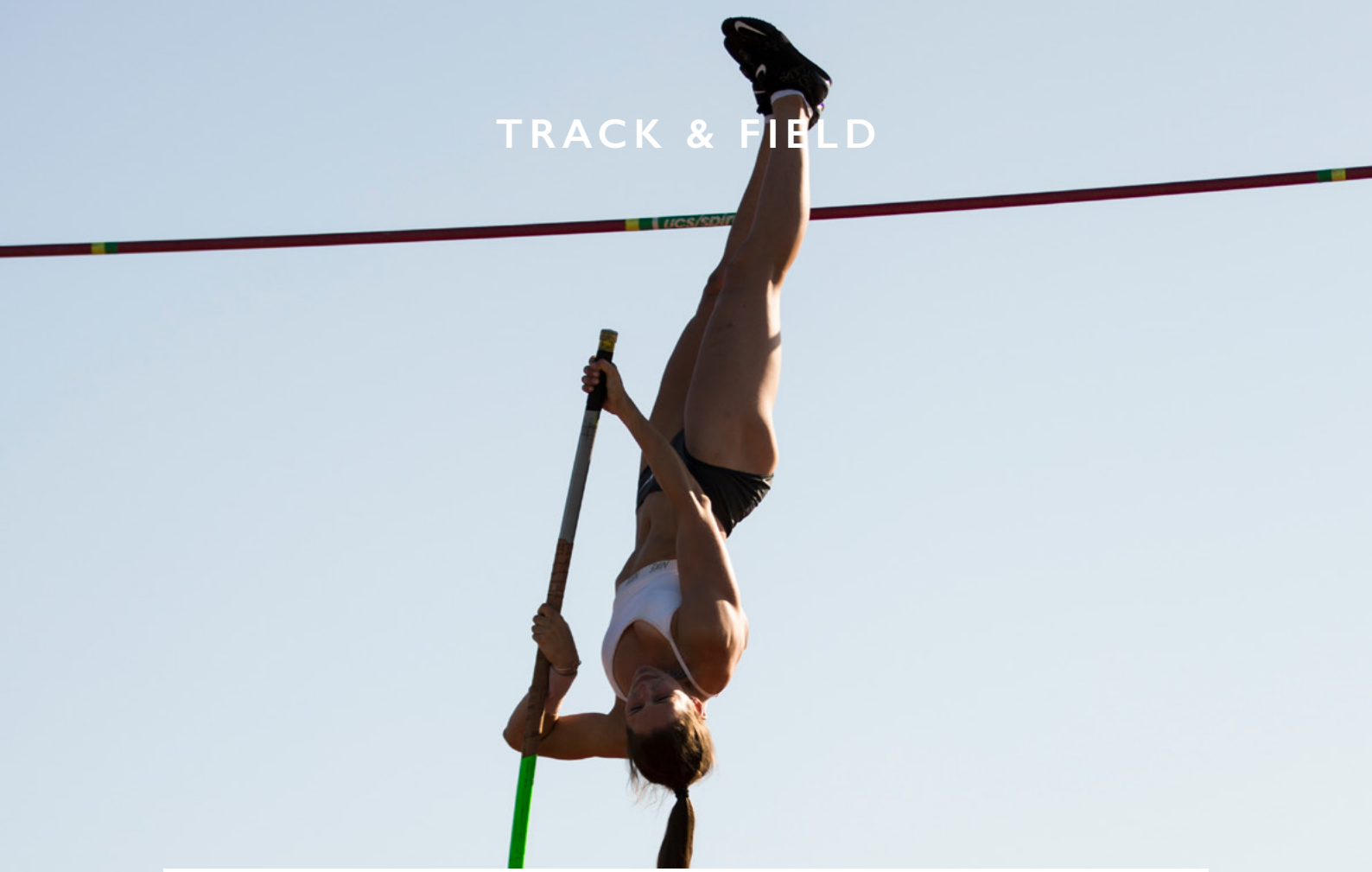
***It [makes it] feel like your body is fighting you every step of the way to do what you need to do to get your body into a better place**. When I get too hot I really struggle to drink water or eat without feeling sick, especially after strenuous races where the most important thing to do to recover is to drink and eat.*

[There's been a] noticeable increase in adverse weather events in my 9 years in the sport of rowing. Floods, strong winds, storms. Our semifinal in Tokyo had to be rescheduled due to an unforeseen typhoon that was due to the changing climate."

Jenny Casson - ROWER, CANADA
(Tokyo Olympian, in 2019 broke the 2,000m world indoor rowing record)

*"I have had to change my training in Canada and train in a "heat chamber" (a vehicle designed to recreate a humidity and heat as desired by the user) to prepare myself for the 40°C heat of summertime racing. On numerous occasions I have been unable to complete sessions and have broken down mentally because **physically my body cannot respond any more to the demands a workout is asking of it**. I get scared because when my internal body temperature rises too much, I feel as though I cannot breathe and that is a very worrisome state to be in. I've felt suffocated because often the air is so heavy it is a challenge to get it in. **I am still worried for what those experiences did to my body and the long term effects**. Looking back on it now, I think it was dangerous and my body was responding to a very real fear of overheating."*

TRACK & FIELD



Track and field events provide the much-celebrated cornerstone of the Olympic schedule, furnishing some of the most cherished memories of iconic achievement over the decades.

They too have been subject to unpredictability and uncertainty caused by the threat of extreme heat at competitions across the globe. Examples include the marathon at the 2019 World Championships in Doha being moved to midnight, the racewalking taking place in Sapporo instead of Tokyo at the last Olympics and the part-suspension of the US Olympic trials in June 2021.[63] More recently, U.S.A. athletes petitioned together for the start time of their marathon trials for the Paris Olympics to be brought forward earlier so they weren't having to race in the heat of the day.

These are trends that athletics' governing body has been proactive in engaging with. Last November, World Athletics released results from their third annual survey of athletes' views on climate, when **75% of the 350+ athletes polled perceived a direct negative impact on their health and performance due to climate change**. In addition, 85% expressed that the sport of athletics has experienced adverse consequences due to climate change, up from 72% the previous year.[64]

These are concerns that athletics' governing body has been proactive in engaging with, setting WBGT limits and publishing a Beat the Heat guide for athletes, coaches and road race organisers which has been widely shared and adapted by other sports. Their Race Emergency Course also provides online and face-to-face education for race medical directors and staff to early identify, diagnose and treat exertional heat stroke. In 2022, they launched the 'Champions for a Better World' programme, which has aimed to draw attention to this phenomenon through nine athletes representing each of its six continental areas, a number of whom were amongst those to relay their experiences and concerns to this report.[65]

Photo credit: Alisha Lovric

Yusuke Suzuki - RACEWALKER, JAPAN
(Olympian and 2019 World Champion)

"At the World Championships in Doha 2019, my heart rate was high even when I was standing. In the 50km walk race, after about 35km, I found myself feeling cold, and was having diarrhoea during the race. I think that it happened due to the damage in my stomach because of the heat. I insisted that I continued competing, and luckily I won the race and was exhilarated, but I believe that I had symptoms of dehydration and heatstroke.

After the championships I needed to get back in training immediately because I secured a place at the Tokyo Olympics. But even after a couple of months, my body stayed tired and did not recover. I was very weak, and even at a jogging level, I felt exhausted, and my muscles were in pain. When the Olympics were postponed, I finally went to see a doctor, and was told that I had an overtraining syndrome. I was told to stop training immediately and rest. ***I decided to rest but I did not recover****. I had to make a difficult decision to withdraw from the Olympics. The overtraining syndrome takes its toll not only physically but also mentally. It is easy to get into depression, which was the case for me. It took me two years to start training again and the first race I was able to attend was the spring in 2023. But it has been ups and downs, the overtraining syndrome came back again, and I am again on a rest.* ***The 2019 Doha race took a toll on me until this day****. I was very happy that I won the Worlds. It was the best moment of my life. But that memory is now only a torture. I wonder if I was able to stop racing during the race, it might have been a different story now.* ***I absolutely do not want young athletes to experience what I have experienced****."*

Ajla Del Ponte - SPRINTER, SWITZERLAND
('Champion for a Better World', Olympian and 60m gold medallist at 2021 European Athletics Indoor Championships)

"In Napoli, for the University Games in 2019, the heat exposure caused a long fatigue that followed me for almost 2 months. I had symptoms similar to overtraining, but it was ***basically the heat exposure that "fried" my nervous system****. I felt tired, exhausted mainly. Completely empty of energy to only lift my leg in skipping. I was devastated because I didn't understand what was happening to my body.* ***It feels like you have chains around your ankles*** *and wrists that slow down every movement you do.*

We see in more sports athletes being carried away for heart failures. This is a risk that we have while sporting in extreme conditions. It's a real risk for the athletes and for the staff."

Kelsey-Lee Barber - JAVELIN, AUSTRALIA
('Champion for a Better World', Olympic bronze medallist and two-time World Champion)

"I worry that not all athletes are offered information or strategies to manage extreme heat exposure and therefore aren't as well prepared or understand the risk in competing in high heat conditions. This is definitely becoming a familiar trend and a familiar conversation when it comes to preparation for a major competition. ***I think it's concerning how quickly this has become a reality****, and while we have adapted to the likelihood of competing in extreme heat, the bigger picture of why we are experiencing it isn't being addressed, it's just been accepted and planned for. I think there should be more awareness around the bigger picture when it comes to rising temperatures."*

Sam Mattis - DISCUS, USA
('Champion for a Better World', Olympian and gold medallist at the 2019 Outdoor USA Track and Field Championships)

"These days, it feels like every major championship comes with an unprecedented heat wave. I am for sure worried about athletes' health as the climate continues to warm. Being an athlete is about the art of pushing your limits just enough to get the most out of your body. When a variable like heat or wildfire smoke enters the equation, it throws off that balance and it can be hard to know where your limit is. We've already seen plenty of this in the last few years – from things as simple as athletes dropping out of a race, to more serious health issues like athletes passing out from heat stroke during competition - and it's just going to continue to get worse in number and severity with rising temperatures. Unfortunately, ***in the US, athletes dying from heat stroke is not new****. As extreme heat events become more commonplace, and the stakes remain unchanged for athletes (perform or go broke), it seems likely that it will happen again."*

Eliza McCartney - POLE VAULT, NEW ZEALAND
('Champion for a Better World', bronze medallist at the 2016 Olympics and silver medallist at the 2018 Commonwealth Games)

"I was told once I had experienced heat illness, it was likely to come on more readily next time, and that was a problem for not only my training camp in Cyprus, but the thought of how I would handle the upcoming major competitions that were in hot places (Doha and Tokyo). It was both a physical and psychological concern. Another consideration is safety – I use a black sticky grip that loses its adhesion with sweat. I've had issues (as well as other vaulters) with slipping on the pole in high humidity and heat."

Rhydian Cowley - RACEWALKER, AUSTRALIA
('Champion for a Better World', two-time Olympian at Rio and Tokyo)

"We already know that ***extreme heat is a silent killer*** *among the general population, and that even with prior preparation and intervention, it can still be risky for athletes to compete in. So absolutely I'm concerned that extreme heat in competition could threaten the lives of athletes.*

For sports that do not have a science-based extreme weather policy, and for grassroots sports with fewer resources with which to adequately respond to extreme heat, it is a genuine worry that athletes' (and officials') health and safety will be endangered in extreme heat events. And for bigger sports with the resources and policies in place – how much will things such as commercial interests influence their use when extreme heat occurs?

Elena Vallortigara - HIGH JUMP, ITALY
('Champion for a Better World', Olympian and 2022 World Championships bronze medallist)

"The National Championships in Rieti in 2022 were very difficult due to the weather conditions: I started warming up in the early afternoon and during the presentation ***I couldn't stay upright****, I had the sensation of fainting from the heat and the strong sun. At the end of the competition it looked like I had taken a shower due to how much water I had thrown on myself."*

Katie Snowdon - MIDDLE-DISTANCE RUNNER, GREAT BRITAIN
(1,500m specialist, Olympian at Tokyo Olympics)

"Extreme heat has a really negative impact as it leaves you feeling a lot more drained and tired. Spectators and the media only see the performance but it isn't always taken into account that preparing in these conditions accumulates fatigue for the athletes and it's difficult to then give of your best on the day."

HOCKEY

VENUE AT PARIS OLYMPICS: Yves du Manoir Stadium

POTENTIAL KEY ATHLETES: Alexander Hendrickx (Belgium); Savita Punia (India)

TEMPERATURE LIMITS: Breaks for rehydration implemented when temperatures reach 35°C. Additional and extended breaks when they hit 42°C.[66]

Hugo Inglis, interviewed page 27

Hockey, also known as field hockey, first became part of the Olympic program at the 1908 Games in London, with the women's tournament added to the Moscow Olympics in 1980.[67]

India dominated for much of the last century, with the men's team winning seven out of eight Olympic titles at one stage. The global nature of the sport is illustrated by the recent range of finalists, which includes Belgium, Argentina, Germany, Spain, South Korea, Great Britain and China. Hockey is one of the most gender balanced of sports – 51% of players around the world are women, 49% are men.[68]

Originally played on grass, the move to a synthetic surface dramatically increased the speed and tempo of the modern game, especially as the pitch is watered to further accentuate the pace of the ball. As well as being a highly technical sport, stamina is a fundamental attribute. Matches last 60 minutes, split into quarters.

Hockey was one of the 'high athletic endurance sports' to have been affected by the heat at the Tokyo Games, as detailed by a 2023 study in the British Medical Journal.[69] During the Games, at least one hockey athlete suffered heat stroke, while another three reported heat-related illnesses. Given this, it is particularly concerning that – despite the threat of heatwaves during the Paris Olympics – the International Hockey Federation (FIH) is only allowing reserves to be drawn from the 16-person squads. For the Tokyo Games, FIH was one of five sports to relax competition rules, allowing nations to draw players from the 17th and 18th squad members (who would previously only be used if injury occured within the original squad of 16).[70]

In addition to the resultant threats to health, studies have been conducted to test the impact of heat on hockey skill performance and found that hot environmental conditions led to a decline in levels of coordination.[71]

Hugo Inglis, for whom Paris would represent a fourth Olympic appearance for New Zealand, has his own experiences to draw upon when discussing how much of an impediment extreme heat can be for a hockey player.

"Hockey as a product is seriously affected when playing in extreme heat. The heat and humidity deteriorate athletic performance, affecting physical output and cognitive functions like decision-making and skill execution. Individually I've found my performance significantly worsen in high heat and high humidity. This combination is tough. When it is just high heat there is less decline in performance but this is not negligible."

One particular memory stands out for Inglis when recalling unforgiving conditions.

"We played a tournament in Kuantan, Malaysia. We had 40°C conditions for the entire tournament. On the field this rises to 45-47°C. We were forced to play three matches in the midday heat back to back. In the final game, a few of us had heat stroke, and I remember being on the verge of blacking out in the changing room.

"I felt terrible. Physically sick, head pounding, body going limp, some shivers. The room goes dark and vision is hard to focus."

It is of course not just on matchdays that the possible consequences of heat will impact upon an athlete. Training schedules and preparation will also be influenced, sometimes to extreme degrees.

"We have done the most ridiculous heat protocols leading into major events," says Inglis. "Training in heated rooms, with additional clothing on. Then in the sauna for 30 minutes after sessions. This takes up lots of energy that we would rather use to become better at our sport.

Inglis even believes that the "crazy heat protocols" **led to the premature ending of his Olympic dream**:"Before the Tokyo Olympics we [did] full-body ice baths before the games to cool the body. We had three hamstring tears, including my own... **ending my Olympics before the second match had even begun** and resulting in a really difficult time for me."

According to Inglis, tactics can be negatively impacted too: "We will often change our tactics when playing in these conditions resulting in a far less exciting brand of hockey being played". This leads to a diluted spectacle for fans and broadcasters alike and is replicated in other team sports such as football and rugby.[72]

Rising temperatures and humidity can also lead to particular challenges for goalkeepers, given the additional thick insulating equipment they are required to wear as a protective measure. A Dutch study ahead of the Tokyo Olympics looked into this in depth and noted that 'a rise in body temperature can deteriorate their responsiveness, raising the chance of letting an opponent score.'[73] As also outlined in the realm of cricket in the *Hit For Six* report, the threat to performance levels is compounded by the severe health risk.[74]

Inglis believes that ultimately major change is still required in elite sport's culture for the consequences of climate change to register more widely.

"The current environment is one of fear. Athletes don't speak up or take action due to calls of hypocrisy - [the worry that they will be told] 'shut up and play'. It made me want to stop competing in my sport for quite a while. I felt extreme guilt flying from New Zealand all around the world to chase a hockey ball around the field.

"My pipe dream is that sporting authorities/bodies would work with athletes to reshape the mainstream media narrative around sports and negative environmental externalities."

VIEW FROM THE PITCH

Among other sports, Football and Rugby 7s join Hockey as Olympic pursuits where athletes must combine physical endurance and high levels of dexterity alongside physical and mental skill, coordinating with their teammates in fast-paced matches where split-second decision-making is key.

As well as the immediate impacts on athletes' performances, at the Tokyo Games high temperatures played havoc with scheduling, when the women's football final was moved at the last minute due to concerns over extreme heat.[75]

Here, we hear from two international footballers, **Morten Thorsby** and **Katie Rood**, as well as GB Rugby 7s player **Jamie Farndale** about the impacts they've felt on their own performance, and the risks posed for the future.

Jamie Farndale, interviewed page 29

Morten Thorsby - FOOTBALL, NORWAY

(International player for Norway; current player at Genoa CFC (Serie A); former player for the Bundesliga; Founder of We Play Green)

"Extreme heat can impact [athletes'] performance drastically. Especially in the summer months I have felt how the heat makes it really difficult to perform. ***Overheating makes it impossible to make good decisions on the pitch****. It also makes the games less interesting for the supporters. Heatstroke is a terrible feeling of being overheated without the possibility of cooling down. At a certain point, your system kind of shuts off and it is impossible to focus on what you are doing. I believe more and more players are suffering and that we will see more cases of injuries and sickness because of it."*

Katie Rood - FOOTBALL, NEW ZEALAND

(Forward for national team and Hearts FC; former player for Juventus FC and Southampton FC)

"There's a mental drain that comes with the heat that takes a lot more energy to focus and make good decisions.[The effects of climate change have] impacted the way I move in the world and has often left me wondering what the point of high performance sport is when it has such a big impact on it. I think often the education isn't there and expectations are on athletes to perform. It's a terrifying prospect when we see the direction things are heading and how rapidly the climate is deteriorating around us. I think using sport as a vehicle for positive change is a key element to a habitable future."

Jamie Farndale - RUGBY SEVENS, GREAT BRITAIN

(Has represented both Scotland and Great Britain, including as Scotland's Rugby 7s Captain)

"I remember we prepared for Dubai Sevens one year by doing heat chamber sessions at our training base in Scotland to prepare for the heat. ***You just couldn't cool down all day, you were tense and angry – fights would break out in our sessions which never ever happened normally****. It was pretty scary to see the effects! On the pitch I remember just wanting to get through the match – which is crazy!* ***Something you dedicate your life to because you love it so much and here you are on the world stage willing it to end!***

What we do is push ourselves to our limits, and if we have to do so in conditions that are unsafe I don't think the athlete would hold back. It is not in an athlete's DNA to stop and if the conditions are too dangerous I do think there is a risk of fatalities."

TRIATHLON

VENUE AT PARIS OLYMPICS: Pont Alexandre III, Paris

POTENTIAL KEY ATHLETES: Alex Yee; Flora Duffy

TEMPERATURE LIMITS: Event cancelled if WBGT index above 32.2°C; Swim leg cancelled if water temperature above 33°C.

Triathlon category women in the context of the 2023 Pan American Games Chile, in cycling development. Pan American Games Santiago 2023, Women's Individual Triathlon, held at Playa El Sol in the city of Viña del Mar. (Photo by Cristobal Basaure Araya/SOPA Image/Sipa USA) Credit: Sipa US/Alamy Live News

The sport of triathlon has enjoyed a surge in popularity over the years following its first official event in 1974 in California.[76] Since its introduction to the Olympics in 2000, Great Britain has been leading the way on the gold medal tally. A triathlon race consists of the disciplines of swimming, cycling and running, with Olympic distances of 1500 metres, 40 kilometres and 10 kilometres, respectively.

In the first *Rings of Fire* report, we outlined the heat-related issues faced by triathletes, with the athletes entering the final run with an already elevated core body temperature following their high-intensity exertions in the swim and cycle.[77] In Tokyo, despite the organisers moving the start time to 6:30am, water temperatures still reached 30°C.

The men's race was won by Kristian Blummenfelt and the toll that his exertions in the heat took were clear for the world to see. As he reached the finish line, the Norwegian **vomited and crumpled to the floor before he was put into a wheelchair** and led to medical assistance.[78] Several other athletes similarly suffered, including Blummenfelt's compatriot Casper Stornes and Switzerland's Max Studer.

A University of Montpellier study last year highlighted how the number of sporting competitions taking place in extreme weather environments is growing.[79] Triathlon is one of the sports to experience this, exemplified by the abrupt cancellation of the World Triathlon Championship Series Opener in Abu Dhabi earlier in 2024 due to 'severe adverse weather' forecast.[80]

World Triathlon, the sport's international governing body, has been proactive in providing athletes and federations with information to help them prepare for extreme weather conditions. This includes the creation of the 'Beat the Heat' document in association with Professor Périard at the University of Canberra, and the implementation of temperature parameters.[81] These were updated after the Tokyo test event in 2019 when the heat and humidity wreaked havoc, forcing the running segment of the women's race to be halved to five kilometres and leading to the outright cancellation of the paratriathlon swim.[82]

The temperature boundaries developed by World Triathlon's medical team include:[83]

	EXTREME RISK. ABOVE 32.2°C. EVENT CANCELLED
	VERY HIGH RISK. BETWEEN 30.1°C AND 32.2°C. RUN IN AN OLYMPIC DISTANCE TRIATHLON SHORTENED FROM 10KM TO 5KM. THIS HAPPENED AT THE TOKYO TEST EVENT IN 2019 IN THE WOMEN'S EVENT
	HIGH RISK. BETWEEN 27.9°C AND 30°C. EVENT CAN BE RUN AS NORMAL BUT PLAN TO MITIGATE RISK AND MONITOR AT RISK INDIVIDUALS CLOSELY
	MODERATE. BETWEEN 25.7°C AND 27.8°C. NORMAL
	LOW. BELOW 25.7°C. NORMAL

[N.b. Air temperature/conditions are based on Wet Bulb readings. As set out on page 10 of this report, these take into account ambient heat, humidity and radiant heat stress from direct sunlight]

Meanwhile, water temperature parameters for triathlon comprise the following bands:[84]

UP TO 30.9°C	**SWIM DISTANCE AS PER NORMAL**
31-31.9°C	**MAXIMUM SWIM DISTANCE IS 750M, SO AN OLYMPIC DISTANCE TRIATHLON WOULD GO FROM A 1500M SWIM TO A 750M SWIM**
32-32.9°C	**EVENTS WITH SWIMS UP TO 300M CAN BE HELD. EVENTS WITH SWIMS LONGER THAN 300M SWIM ARE CANCELLED**
ABOVE 33°C	**SWIM IS CANCELLED**

Triathletes also face the same issues of open water pollution as the marathon swimmers. In the build-up to the Paris Games, there have been doubts about the viability of the swimming section of the triathlon, due to fears around heavy rain affecting water quality.[85] Paris 2024 Olympic Games President Tony Estanguet raised the possibility of postponing the event until later on in the Olympics or even cancelling it.

"We can postpone for rainy conditions. Because it's programmed at the beginning of the Games, we can wait for better conditions [...]. And ***there is a final decision where we could not swim****,"* Estanguet told the Sport Accord conference in Birmingham this year.[86]

Pragnya Mohan is the highest-ranking triathlete in Indian history: she is revered in her country for her pioneering exploits in a sport that is growing in popularity in India. The National and South Asian Triathlon Champion shared her experiences of training and competing in extreme heat with this report:

"Triathlon is a very intensive sport and heat enhances the amount of energy required. This leads to severe dehydration resulting in cramps, and in some cases can also be fatal. For this reason, athletes need to train in such conditions because it can lead to adverse effects if your body is not used to it.

From April to October the temperature in India is very hot so all outdoor training must finish by 8am. The rest of the training is indoors. It is very difficult to train in a country like India where we have tropical weather. ***I have to stick to Europe for training****.*

When you are dehydrated, the brain stops functioning at its normal speed. This affects the time required to make decisions impacting reflexes. For example, during cycling you have a few milliseconds to decide to either draft or break away or apply any other race strategy. Hence performance suffers.

[When heat illness strikes] one starts feeling cold. Your body starts shivering, you feel dizzy and your body feels like it's shutting down. It does not make sense, what is happening at that time. In the end you faint. Definitely [I fear for the lives of athletes] - it is scary and can be fatal."

RECOMMENDATIONS

Ahead of the Tokyo Games, our first *Rings of Fire* report listed a number of key recommendations to help mitigate the disruptive and potentially dangerous effects of extreme heat at both local and global competitions. These included:

- More developed guidelines to help inform decision-making around when sporting events should be postponed, amended or cancelled due to the risk of heat illness.
- Deployment of enhanced technology to monitor heat and body temperatures.
- Greater sharing of resources and information around heat illness between different federations and sports.[87]

In the intervening years, a number of federations and sporting bodies have taken steps to further implement such measures.[88]

For this report, we invited athletes to add their input and contribute to the ongoing conversation – speaking from experience and their position as protagonists in the greatest of sporting spectacles.

The feedback we received addressed a wide range of issues, from fossil fuel sponsorship to cooling strategies. We have compiled the athletes' recommendations into a list of key requests:

1 **SMART SCHEDULING:**
Sporting authorities must take into account heat extremes when scheduling events, avoiding the hottest parts of the day for exposed sports and rescheduling events when needed.

2 **KEEP ATHLETES SAFE:**
Limiting heat exposure and having water breaks in training and competition are positive developments but as extreme heat events become more common, organisers need to invest more in protecting competitors, fans, support staff, workers, and volunteers.

3 **SUPPORT OUTREACH:**
Many athletes do not speak out about heat risks or the environment due to fears of being called weak or being accused of hypocrisy for travelling to events. This needs to change to deliver progress -- athletes must be empowered to speak up about their experience with the ongoing and future impacts of climate change.

4 **COMMIT TO COLLABORATION:**
By speaking as one, sporting bodies and athletes have the potential to significantly alter the current narrative towards climate action while simultaneously educating and mobilising their fanbases to follow suit.

5 **REASSESS FOSSIL FUEL SPONSORSHIP:**
The main cause of climate change is clear: emissions from fossil fuels. Sport needs to re-examine its relationship with fossil fuel companies. Sponsorship may bring in much-needed finance, but the long-term cost of such partnerships must be reassessed.

The next two Summer Olympics are being held in the United States and Australia respectively, with reports of bids for the 2036 Games in the pipeline from South Korea, Egypt, Qatar and Saudi Arabia (joining the already confirmed bids from India, Turkey and Indonesia).

These locations, and accelerating global temperatures driven by inaction on climate change, mean that without concerted action and a rapid reduction in fossil fuel emissions, the instances of extreme heat are only set to intensify further over the coming years.

This trajectory poses striking risks, not just for athletes but for spectators, broadcasters, volunteers, support staff and construction workers building new stadia.[89]

To adopt the old footballing cliché – it is about far more than just a game.

ENDNOTES

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