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# Extreme heat in sport—why using a fixed temperature cut-off isn't as simple as it seems

January 12 2018, by Ollie Jay And Samuel Chalmers

Record-breaking temperatures during the Ashes cricket test match in Sydney on Sunday led many to wonder: how hot is too hot to continue playing sport safely?

Exertion-related heat illnesses are a very real concern, even for professional athletes in peak condition. In extreme cases, the heat can be deadly; Rugby League international Kato Ottio died this week after suffering complications from severe heat stroke following training.

While fatal cases of heat illness in sport are mercifully rare, a milder form, heat exhaustion – characterised by nausea, vomiting, and fainting/light-headedness – are much more common in many summer sports.

Some commentators have recommended that play should be suspended when the mercury reaches a particular temperature, such as 41°C.

However, there are several factors that must be collectively considered when predicting heat stress risk of an athlete.

The "temperature" that most people are familiar with through weather forecasts is actually measured in the shade. But physiological strain (rise in heart rate, sweating, body temperature) is very different depending on whether an athlete is directly in the sun or not.

Black globe temperature, which is used to help measure the heat absorbed from the sun, can be as much as 12 to 15°C higher. In fact, our own measurements at the Sydney Cricket Ground on Sunday reached a peak value of 57.6°C when the air temperature was 41.9°C.

> Nice photo by @RyanPierse of our #heat stress measurement unit at the #ashes test match today @SCG #cricket #sydney @ThermalErgLab @USydFHS @Sydney_Uni https://t.co/7jdiDsPRiD
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> — Ollie Jay (@ollie_jay13) January 7, 2018

> A heat stress tracker displays a temperature of 57.6 degrees celsius in the middle of the SCG during day four of the Fifth #Ashes Test #gettyimages #gettysport #cricket #weather #heat #hot #sydney pic.twitter.com/xPpu0pFIuS
>
> — Ryan Pierse (@RyanPierse) January 7, 2018

## What happens to sweat

Humidity (the amount of moisture held in the air) directly impacts the effectiveness of the most important physiological mechanism that humans have for keeping cool in the heat – sweating. After all, it is the evaporation, not the production, of sweat that allows the body to shed excess heat.

Evaporative drive becomes much lower with increasing humidity. This results in sweat either pooling or dripping off the skin, which contributes to dehydration without cooling the body.

In less humid but often hotter conditions, sweat freely evaporates from the skin, releasing large amounts of heat. But body water stores still

deplete if they aren't replaced.

Importantly, sweat evaporation is determined by "absolute" humidity. Yet "relative" humidity – the percentage of the total water-carrying capacity of air that is filled with water vapour – is most commonly reported.

Because the capacity of air to carry water vapour increases exponentially with air temperature, absolute humidity can be high despite a seemingly low relative humidity (RH) during the hottest time of the day. For example, absolute humidity is higher at 45°C with 25% relative humidity than at 30°C with 50% relative humidity.

Many people who have experienced heat with high humidity are familiar with the sweet relief of even the lightest breeze. This is because wind also promotes evaporation; it helps replace air directly above the skin that is saturated with water vapour with drier air.

The heat loss capacity of an athlete in hot or humid conditions is therefore oppressively low when it is still, but much higher when there is some wind.

## Not all sport is equal

During exercise, muscle contractions can produce large amounts of heat. However, different sports, and even different positions within a particular sport, result in varying levels of heat production.

Actions requiring vigorous levels of activity that engage large muscle groups (such as running, jumping, squatting, kicking) produce a lot of heat. In contrast, sports with lighter levels of activity (such as standing, walking, light jogging) generate relatively small amounts of heat.

It is probably not surprising that the heat produced playing cricket is two- to three-times lower than soccer or rugby. However, depending on the format, a cricket match typically lasts much longer.

Some sports require protective equipment that create a barrier to heat loss, yet can result in a greater heat production to carry or wear them. Sweat rates are typically highest on the head, back, and shoulders. So wearing a helmet and padding on the upper body probably has the greatest relative impact on the amount of evaporative cooling possible.

## A blanket maximum won't work

A simple universal cut-off temperature cannot be applied across all sports because exposure, equipment and activities vary so much. Even within a particular sport, a fixed critical temperature for suspending or modifying play isn't appropriate as physiological strain can be so different depending on humidity, cloud cover, wind speed.

Nevertheless, some sports associations, such as Football New South Wales, have adopted this approach, presumably because it can be easily employed. Other sports organisations, such as Sports Medicine Australia, use combinations of temperature and humidity, but this still does not account for the important effects of the sun and wind.

The Wet Bulb Globe Temperature (WBGT) index, when measured properly, provides a weighted average of the effects of the sun, air temperature, and humidity. Tennis Australia uses a threshold WBGT value of 34°C to recommend the suspension of play.

However, WBGT limits for many sports are not well supported by evidence, and the WBGT index is particularly limited in hot conditions with high humidity or low wind speeds. WBGT values are often inaccurately estimated instead of measured because the required device

can be prohibitively expensive.

Accounting for all environmental and sport-related factors to accurately determine the real heat stress risk continues to be a challenge. However, the needs are clear, and relatively recent technological advances present opportunities to develop modern heat policies that ensure player welfare while preventing unnecessary interruptions of play.

## What athletes can do

Before suspending play altogether, several strategies can be used to reduce the risk of elevated body temperature, known as hyperthermia.

Placing damp towels containing crushed ice around the neck, or wetting the arms, legs and neck with a damp cloth to promote evaporation are more effective in a tennis-related context for both hot/dry and warm/humid conditions.

Such is the power of evaporation, cooling potential is much greater when pouring water over the body than drinking cold or even iced water.

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