Athletes can beat the heat, even during an Australian summer

January 21 2014, by Adam Trewin

Shifting hemispheres? A good training plan must include time to acclimatise. Credit: Vox Efx

Two of Australia's biggest international sporting events kicked off last week – the Australian Open in Melbourne and the Tour Down Under in Adelaide – coinciding with a heatwave over southeast Australia, where temperatures exceeded 40C for most of the week.

So is it really "inhumane" to hold sporting tournaments in extreme heat?

You may have seen reports of players and a ball boy fainting on court. Canadian tennis player Frank Dancevic hallucinated Snoopy before collapsing at Australian Open on Tuesday.

This year's Tour Down Under started in mild weather but the lead up was anything but. AAP/Dan Peled

Northern hemisphere athletes competing in Australia's summer require at least five to seven days of training in the heat to become adequately acclimatised after living in cold winter conditions (not great for cyclists training before the start of the Tour Down Under on Sunday).

Humans have a remarkable ability to tolerate hot conditions, but most heat stress related issues appear to be the result of inadequate acclimatisation to the conditions prior to competition.

We're not particularly energy efficient – only about 22% of the food energy we consume is used as biological "fuel" while the remainder is lost as heat. This is helpful for keeping us warm in cold conditions (a process called thermogenesis), but presents a challenge when the ambient temperature exceeds that of our internal temperature.

Because our bodies can only tolerate a core body temperature within a small window around 37C, we need to achieve heat loss via:

- evaporation of sweat
- radiation (infrared)
- convection of heat to the air (such as a cool breeze)
- conduction (such as sitting on a cold chair).

If you can't stand the heat …

Athletes who will be competing in high temperatures as well as high humidity must become acclimatised to exercising in the heat, or they risk impaired performance or more serious thermal stress injury.

After just a few days of training in the heat, adaptations begin to occur in the athlete. These include a lower sweat threshold (they begin sweating from a lower temperature, and sooner), an increased sweat maximal rate, increased plasma volume (the fluid component of blood) and decreased concentration of electrolytes (such as salts) within the sweat itself.

Other preventative measures for thermal injury are regular fluid intake and pre-cooling methods such as wearing ice vests and consuming ice-slushie drinks.

During competition

When we exercise, the rate of biochemical reactions in our bodies are greatly increased to supply energy to exercising muscles. As a result we also generate large amounts of heat, putting pressure on our heat loss mechanisms.

During exercise in high environmental temperatures, there are a range of responses which occur in the body. A region of the brain (hypothalamus) senses rising core temperature and signals for sweat production to increase evaporative cooling and for blood flow to be diverted to the skin to benefit from those cooling effects.

The trade-off here is that this robs the working muscles of oxygen-rich blood flow and reduces exercise capacity. There is also a decrease of the plasma volume as exercise continues, meaning that blood flow to working muscles and other organs is further reduced. Dehydration can occur quickly if fluid intake doesn't match these fluid shifts and losses. Furthermore, perception of effort (such as fatigue) is increased as the central nervous system heats up, limiting exercise performance.

Cycling vs tennis

Different types of exercise also lead to different responses to heat. For example, road cyclists at this week's Tour Down Under will ride at a sustained moderate to high-intensity effort, whereas tennis players at the Australian Open perform many short bursts of intense movement.

While these two activities may therefore seem quite different, the average workloads are both very high and crucially may last for more than five hours at a time, meaning that there is a good opportunity for thermal gain to set in.

A major difference in the rate of thermal gain is that a cyclist travels at higher velocity through the air relative to a tennis players which is a major factor for heat loss ("windchill factor" – think of a gym class with fans on versus off).

So while exercise in the heat can be a challenge for the human body, with some time to adapt during training, it is still possible to perform (albeit at a reduced pace) even in the most searing of temperatures.

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