Running in warm to hot environmental conditions

By Peter Sandery

With summer bringing warmer weather for training and racing it is worth re-examining what you might be consider to avoid heat related problems. While what follows looks at factors that may impact on you when you undertake endurance running events in hot, humid conditions (locally or in other states/countries), the nature of those conditions and how individuals react to them varies widely, there is no "one size fits all" approach. If you decide to compete in an event, you need to prepare your own strategy on how best to do this, balancing competitive goals and personal safety.

Accumulation of heat in the body

One of the outcomes of muscle action is heat production. Heat production is a function of exercise intensity, lean muscle mass and running efficiency. Heat loss is influenced by ambient temperature, humidity, airflow over the body and body surface area. If more heat is produced than is lost by the body, then stored heat energy builds up and body temperature increases. The brain reacts to increasing body temperature by increasing blood flow to the skin to increase heat loss and reducing the recruitment of muscle fibres to decrease heat production. This results in a decrease in pace. All runners slow down progressively as their internal body temperature approaches 40C and usually stop if that temperature is reached. This happens regardless of precautions that may have been taken prior to commencement of exercise. There is a theory that an inbuilt anticipatory regulatory system monitors the rate at which heat energy is being stored in the body and controls muscle fibre activation to prevent damage to body tissues, which may occur at or above a temperature of 40C. Factors such as illness, medication or non-exercise related heat production may cause problems for a small percentage of the population, but generally we slow and stop before body temperature becomes dangerous.

Heat loss from the body

It is simple physics that if you want your core body temperature to remain in a range that is both safe and doesn't significantly detract from performance when you undertake high demand exercise in hot/humid weather, you should maximise heat loss from the body. Heat is lost through radiation, evaporation, convection and conduction. When the skin is at a higher temperature than the environment, heat will radiate from the skin. Evaporation relies on heat being lost from the body through the latent heat of vaporisation of sweat. For this process to be effective, sweat in contact with the skin must evaporate. Sweat that drips from your body without evaporating does not contribute to this process. Convection uses transfer of heat to a cooler fluid (air in this case). The air layer in contact with the skin is heated and this air then flows from the skin taking the heat with it. Conduction requires contact between the skin and a cooler object and contributes very little to heat loss while running (unless you wear something like an ice vest).

Gradients of various forms drive many of the processes in the body, including heat loss.

Radiation, convection and conduction cease to be effective when the air temperature is greater than that of the body and hence there is no temperature gradient away from the body. In this case evaporation becomes the only effective process for heat loss. Humid, still conditions reduce the efficiency of evaporative heat loss from sweating. Loose, light coloured clothing that wicks sweat from the body to its outer surface and allows maximum airflow over the skin will assist evaporative heat loss while reducing the heating effect of direct sunlight on the skin.

Evaporative cooling results in a loss of fluid from the body. The rate of evaporative heat loss can be improved through a graded program of training that results in improved adaptation to hot conditions. As a general guide, a loss of around 2% of body weight as perspiration should not significantly detract from performance or pose a health hazard for a healthy, reasonably fit recreational runner. For a 70kg person that equates to 1.4 litres of fluid. On a hot day moderate exercise could result in a loss of 1.5 litres of fluid per hour, more if exercise intensity increases, but this figure is dependent on several individual and environmental factors.

Acclimatisation

Sensible training in hot conditions can be used to generate a demand that leads to adaptation to improve the ability to perform in those conditions. Because more blood is distributed to the skin (to improve cooling processes) an adaptation is for overall blood volume to increase following a period of training in hot, humid conditions. This facilitates an improved supply to muscles and for sweat production. Adaption to hot conditions may be achieved in a couple of weeks at the beginning of summer. A fit, young adult competitive runner, well acclimatised to running in hot conditions may sweat 3-4 litres/hr and hence have a more efficient evaporative heat loss. In general, older athletes are less able to adapt to running in hot conditions.

Smaller, lean, well-trained, efficient runners are better able to balance their heat equation. The ratio of body surface area to body mass of a runner is a significant factor in rate of evaporative heat loss. Essentially, lean body muscle mass is the heat generator and skin surface area is the cooling system heat exchanger in the human "machine". If your genetic heritage doesn't fit you into the "smaller and lean" category you will have to work harder on the factors you can control.

Hydration

Consumption of 300-500ml of water slowly over a period of 20-40 minutes leading up to exercise should provide adequate hydration without bloating. Given that it takes some time for water to be absorbed after drinking, that intake will compensate for some loss of fluid during the exercise. You may wish to drink small amounts of water during exercise if you feel the need - respond to the signals from your body. Drinking sports drinks instead of water provides some carbohydrate and minerals with the fluid – check the label to see what the drink contains. If you undertake ultra distance races, pace judgment to maintain a balance between heat generated and heat lost is essential, as is planned intake

of fluid and "fuel" based on training experience.

Drinking too much can be dangerous. A good general rule is to drink when you start to feel thirsty. Excessive water intake can lead to a condition known as hyponatraemia. Fluid-electrolyte imbalance resulting from abnormally low plasma sodium concentration can lead to increasingly severe neurological responses. If sodium losses increase through perspiration (a litre of sweat typically contains 1.15g of sodium), to a level that body stores cannot replace and excessive water is taken in, this condition, though rare, can occur.

The above figures should be used as a guide only as individual differences and the conditions in which you run need to be taken into account to determine what is best for you. To determine your rate of fluid loss you can weigh yourself before and after a run, recording fluid consumed during the run and the duration of the run. It is best to do both weighings with as little absorbent clothing on as possible - providing amusement and entertainment for your companions. This should give you an estimate for your rate of fluid loss for the conditions on the day. Even this should only be taken as a guide as your body may react differently to external conditions depending on the other demands that are placed on it.

Training in oppressive conditions - balancing the equation

There are several things you can do to maximise your returns from training while minimising the risk of adverse outcomes:

• Run at the coolest part of the day, usually early morning or after sunset. Depending on your individual circumstances this may not be possible. If running during the hotter parts of the day is your only option, try to use routes that maximise shade and have drinking water available from taps.

• Wear light weight, loose clothing that facilitates evaporative cooling from sweat. If you do get sunburnt, this will reduce sweat cooling efficiency so it may be a good idea to back off training until the injured skin heals.

• Decrease the distance of training runs on very hot days and reduce the pace of longer runs on hot, humid days. You may find it better to find a shaded path and do a session of short intervals with longer recovery periods (to avoid a buildup of stored heat energy) if pace is your focus. Another strategy is to use a treadmill in an air-conditioned gym for some non-acclimatisation sessions (you won't lose your acclimatisation to heat if you do a mix of sessions).

• Last, and perhaps most important, listen to the signals from your body. Run according to your perceived level of exertion rather than to a pre-determined pace. If you think a run feels hard (and you usually have good pace judgement), it ***is*** hard regardless of the pace you are maintaining.

Racing in hot, humid conditions

Much of the above relates to training, but athletics is a summer sport and often races will be scheduled when forecast air temperatures are in the high 30s and are substantially

higher out in direct sunlight on a track. Race distances may be reduced (or the meet cancelled) if the event director considers conditions warrant this. If conditions are oppressive, you will need to make a personal decision about how important a race is to you and if you do compete, how you approach your race preparation and performance. In races that are part of AMA, OMA or WMA Championships, many of the options listed above for running in hot, humid conditions are not under the control of the competitors. The competitors that heat and humidity impacts on most are those who run endurance races - 5000m, 10000m track and 8k cross country. The Championships may be held out of your local T&F season, in a venue that is several times zones different to yours. Travel and accommodation costs may not allow time for acclimatisation. You are required to wear a state/country uniform (or at least the singlet part of that uniform). The materials and design of these singlets are not designed specifically for performance in endurance events. You will have a fairly large number pinned back and front that limits air flow past the skin. The time of day for events is selected by the meet organisers and, while they may try to schedule endurance races in the coolest parts of the day, it is not always possible to do this for all age groups where entry numbers, and hence number of races, are large. There is usually no shade on outdoor tracks for the 5000m/10000m events that are run in direct sunlight hours. For those endurance events that are run in the early evening, the heat radiating from a track that has been exposed to the sun all day significantly adds to the temperature that athletes experience.

The basic equation you have to work with still applies - maximise heat loss from the body while minimising the rate at which heat accumulates in the body. Do your warmup (the process of preparing your muscles for the race that is to come) in the shadiest, coolest place you can find. Allow time for your core temperature to decrease before you have to race. Keep the duration of the warm up to the minimum you are comfortable with. Consider substituting a few short sprints with long walk back recoveries for distance. Do the warm up with a light, loose singlet and change into your competition singlet in the call room. Hydrate adequately, but not excessively. In the race itself avoid irregular pacing. Try to run at a steady pace that feels demanding, but keep in mind that it is better to maintain the demand (the perception of exertion) than the numerical pace if conditions are oppressive. Leaving the track on a stretcher is not a good look

In the World Masters Athletics T&F Championships in Riccione in 2007, the M65 10,000m track event was held in very hot, humid conditions in the middle of a cloudless day. Because the event was a WMA Championship event, there was motivation for those who had entered to do it. There were 57 entrants in the event, of whom 46 confirmed their intention to run (in 2 divisions). Of these, 2 did not start (presumably because of the adverse conditions). Of the 44 starters, 11 did not finish. One collapsed and was taken off the track on a stretcher and 10 made a conscious decision not to continue. That is a dropout rate of 25% and most of the finishers ran more slowly than they might have done under cooler conditions - I know I did. I think this example shows that in very hot, humid conditions, running conservatively may provide the best chance of finishing a race.

If you really don't like running in hot, humid, oppressive conditions there is an ideal option you should consider - run in indoor competitions. The temperature and humidity

are controlled; the only wind comes from your running speed; there is no direct sunlight, and; the maximum race distance is 3000m. The downside is that there are no indoor tracks in Australia so you will have to travel overseas. The WMA Indoor Championships are held in alternate years to the outdoor T&F Championships and there are associated outdoor events - 8k CC, 1/2 Marathon and Walks. Great!..... but sometimes it snows and that brings a whole new set of issues to contend with.

References

1. The Science of Sport (sportsscientists.com); *Heatstroke*; Oct 25 &29, 2008
2. Magness, S. *The Science of Running*, (www.ScienceofRunning.com), 2014
3. https://runnersconnect.net/running-training-articles/running-in-the-heat-bodyweight/
4. Brooks, G. A., Fahey, T. D., Baldwin, K. *Exercise Physiology: Human bioenergetics and its application*, McGraw Hill, 2004.