



Thermoregulation: Beating the Heat

During exercise, there is a major by-product of energy production and muscle function: Heat. The process of turning energy stores into muscle "work" is quite inefficient and heat production increases in proportion to the intensity of exercise. Around 70-80% of energy from body stores is lost as heat during the metabolism process with only 20-30% of that energy actually being used for muscle contraction or "work". This does mean that controlling body temperature during and after exercise is essential, particularly during hot weather conditions, to avoid the potentially serious effects of an increase in core body temperature i.e. heat exhaustion or heat stroke. Normal core body temperature in horses at rest is 37.5-38.5°C (99.5-101.5°F). If body temperature rises to above 41-42°C, side effects and signs of heat exhaustion can be seen ranging from excessively high heart rate, high respiratory rate to dehydration, fatigue and poor recovery. If untreated, this can progress to heat stroke where the body is unable to regulate its own core temperature. Ultimately this can lead to multi-organ dysfunction including kidney and liver failure, abnormal heart rhythm, loss of co-ordination and in severe cases, death.

Evaporative cooling i.e. sweating, is the most important mechanism by which horses control their body temperature during and after exercise. Water from sweat evaporates into the air taking heat energy with it. Body heat is also lost (about 30%)



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through the lungs and respiratory tract during normal breathing. However these methods of heat loss are most efficient when there is a reasonable difference between the skin temperature and surrounding air temperature, which creates a temperature gradient i.e. its easier to lose body heat during cool dry weather. As weather temperatures rise and air humidity increases the rate of evaporation declines.

A good deal of the research into the most effective ways to cool horses down at the end of competitions came from the preparations for the Olympic equestrian competitions held in hot humid conditions particularly Atlanta in 1996 and Beijing in 2008. Difficulties experienced by event horses during the cross country phase at the 1992 Barcelona Olympic Games highlighted the risks of heat stress during high level competitions in hot weather (in spite of the relatively low humidity at that event). In hot and humid conditions, evaporation of water from the skin surface during sweating is less effective as the surrounding air is already saturated with water and the temperature difference between the air and skin is minimal. This means that sweat starts to drip off the body but doing so only removes 5-10% of the heat that evaporation of sweat would have done. In these extremes of climate, even the fittest horses struggle to

lose enough body heat by sweating and their core body temperature can rapidly climb to dangerously high levels towards the end and immediately after exercise.

Research and collaboration between groups from the UK, USA and Australia has proven that applying cold water (9°C) to horses at the end of exercise helps bring their core body temperature back down to normal faster than using tepid (31°C) water in hot humid conditions. No negative effect of applying cold water was noted e.g. there was no influence on tying-up. At the end of the competition, providing shade in rest areas and adding misting fans to cool the ambient temperature helps cool horses more efficiently hence the misting tents seen at the Beijing games. Fitness and acclimatisation to the local weather are also key factors in avoiding heat stress. Research from the USA under experimental hot conditions showed that with increasing fitness, although the horses' core body temperature increased in the same way as less fit horses (fitness was based on measuring VO₂max), recovery after exercise improved with increasing fitness and the fitter horses lost a lower total volume of sweat.

Dehydration and the associated deleterious effects on blood flow and circulation



(particularly to the skin) makes regulation of body heat less efficient. In warm weather, horses can lose 3kg of body weight for each hour of travel in a horsebox. Most of this weight loss (around 90%) is due to fluid loss and dehydration highlighting how vital adequate preparation and correcting any pre-existing dehydration before the competition is, to maximising any horse's ability cope with hot weather conditions.

In practical terms the ambient temperature and humidity at most competitions in the UK rarely reaches the levels experienced in tropical climates. But that doesn't mean that signs of heat exhaustion are uncommon in horses competing in the UK during the summer, particularly if the weather suddenly becomes hotter. Signs of heat stress and exhaustion to look out for include a prolonged and delayed recovery (longer than 10-20 minutes after the end of the competition), shaking, weakness, loss of awareness of surroundings, persistently elevated heart rate and breathing rate along with continued excessive sweating. Ongoing increases in rectal temperature after the end of exercise are a strong indicator of heat stress and the potential to develop heat stroke. In its most severe form, horses with heat stroke are unable to sweat, won't drink water or walk and show signs like staggering and depression and may even collapse. Urgent veterinary treatment including intravenous fluids is vital in these cases.

What are the most straightforward or ideal ways to cool horses at the end of competition?

A combination of applying copious amounts of cold water over the whole horse, offering water and electrolyte solutions to drink and hand walking to promote good circulation through the muscles should be adequate in most cases and allow horses to recover from exercise with minimal side effects. If the horse is slow to recover and the body temperature continues going up after exercise is finished, repeated application of cold water (apply, scrape it off with a sweat scraper and the reapply cold water again) will help get rid of some of the excess body heat. Offering electrolyte solutions as well as plain water to drink during the recovery period has the additional benefit of beginning to replace the salts that were lost in sweat during exercise. This has the added benefit of helping to restore normal circulation and promote good recovery. It is however important to give horses the choice of both plain water and electrolyte solutions to encourage them to drink and self-regulate electrolyte intake, particularly as some horses will show a strong preference for one over the other. During the cooling out period, it is important that rugs and sheets are not be applied until after the horse has fully recovered and returned to a normal body temperature otherwise the rug will "insulate" the horse and prevent normal heat loss from the skin.



Key points for competing in hot (& humid) weather

Preparation for competition:

- Fitter horses are better able to come with hot weather
- Allow enough time to recover from journey to the competition
- Replace any fluids lost in transport before beginning the ride

After competition:

- Monitor horse's demeanor, heart rate and rectal temperature
- Look for signs of excessive or inadequate sweating
- If horse is recovering slower than normal, make sure they are washed down with plenty of cold water, have access to water and electrolyte solutions to drink and walk in hand (in a shaded area if possible)
- If the horse shows any signs of heat stroke including incoordination, shaking, persistently high heart rate or has a persistently high (>41 °C) or climbing temperature after a normal cool down period (about 20-30 minutes after the end of competition) seek veterinary advice urgently

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