IMPROVING FOOTBALL PERFORMANCE IN THE HEAT

PRACTICAL PRE-COOLING OPTIONS FOR THE PRACTITIONER

– Written by Paul B. Laursen, New Zealand

It's game day, and although the morning sun has only just risen, you can already feel the heat in the air. Experience tells you that it's going to be almost unbearable on the pitch later today. You've heard it a million times before: you'll need to ensure players keep their fluid levels up to combat the effects of dehydration. But is there anything else you can do to improve your team's performance in these stifling conditions?

Actually, there is; it's called 'pre-cooling'. As the term implies, pre-cooling is the practice of lowering a player's body temperature before they start exercising in hot conditions. But before we discuss the different ways to achieve that, let's first consider how and why this occurs.

HOW THE HEAT AFFECTS PERFORMANCE

The problem of lowered exercise performance in hot conditions is not just the dehydration that naturally occurs, nor is it the hot day – it's the higher than normal body temperature. The combination of high-intensity exercise (remember that heat is a leftover by-product of metabolism) and the inability to transfer the produced heat to the environment, because the high ambient temperatures and humidity lower the heat transfer gradient, causes more of the exercise-produced heat to be stored in the body. Core body temperature rises, providing feedback to the brain that it needs to put a clamp on the problem and lower the heat-producing metabolic rate.

Core body temperature normally sits around 37°C; during submaximal exercise, it typically hovers around 38°C. During very high exercise intensities in hot conditions, core temperature can climb to so-called 'critical' levels, which range from 39 to 41°C, depending on individual fitness and motivation levels. Again, these higher than normal temperatures are detected in the brain. The brain then innately (and intelligently) attempts to lower motor output so that the rate of heat produced from exercise is reduced. For the player, this is important because it halts the development of a heat illness, but it is not a desired outcome for the coach whose player has been beaten to the ball, causing the team to lose possession and the opposing team to score.

So, what is the solution to this finite heat storage problem for the athlete? As the title of this article suggests, 'pre-cooling', or the process of lowering the body's temperature before exercise, is the solution. Pre-cooling makes available a greater heat sink during the critical exercise period. This in turn delays the time to reach the higher or critical core temperature which we know lowers exercise performance.

There are a number of ways we can lower the body's temperatures. The balance of this article will go through the various methods that can be considered by practitioners in the field. All of these methods have the potential to improve performance on the pitch, but some are more practical than others to actually administer.

PRE-COOLING METHODS

Researchers and practitioners have used a number of methods to pre-cool athletes before they exercise in the heat. Popular methods have included athletes taking

a cold plunge bath, taking a cool shower, sitting in a cool air-conditioned room, being administered cold saline intravenously, wearing an ice jacket or being draped in cold wet towels. The following is a brief review of the most common methods that have some level of practicality.

Plunge baths

The plunge bath, or cold-water immersion, is probably the most effective means of lowering core body temperature prior to performance in the heat. This is due to the high cooling power of water (its high specific heat). Any combination of water temperature and duration of immersion is possible, but generally the body better tolerates smaller thermal gradients (not too cold) and longer duration times. When the water bath temperature is low, causing the body heat removal to be fast, a stress and shivering response is triggered as the subject tries to defend against the rapid heat removal. Therefore, slower heat removal rates using immersion temperatures nearer to skin temperature (~32°C) tend to be more effective in practice. For example, Quod et al[1] successfully lowered core temperature by 0.7°C when using a 30-minute progressive cold-water immersion protocol beginning at 29°C and finishing at 24°C by the end of the procedure. The large drop in core temperature caused by this protocol resulted in a 1.8% improvement in a 40-minute time trial performance in the heat, compared with the control condition in well-trained cyclists.

Using an intermittent sprint protocol in rugby players, Duffield and Marino[2] showed that athletes were able to run a greater distance during hard running after a cold-water immersion pre-cooling procedure. Thus, pre-cooling using cold-water immersion can be useful for aspects of team sport performance, allowing more work to be done on the pitch by players.

While the cold-water immersion procedure is most effective in terms of its cooling power, the practicality for football competitions is somewhat limited. Although it is possible to arrange for large cold pools to be available in the home team's dressing rooms, it is a challenging procedure for players to plunge, change, warm-up and take on board a coach's words and strategy just prior to competing. In theory, it can be done using 10-person tubs; however, the reality of achieving this in a competition scenario is unlikely.

Ice jackets

Ice jackets have been a popular means of pre-cooling athletes prior to exercise in the heat. In this procedure, the practitioner must prepare the jackets ahead of time by freezing either the entire jacket or the jacket's inserts, then administering these on the athlete either in the dressing room or during the warm-up. In addition to the challenging logistics and resources required to freeze and distribute ice jackets to a team of athletes before the ice melts, the jackets are effective for a short period (~30 minutes on a good day). Indeed, their effect on lowering body temperature has been shown to be moderate to small. While some peripheral (skin) cooling occurs, the effect on core temperature is small to negligible, and the effect on mean body temperature is modest. Further, although some studies have shown improvements in exercise performance in the heat following ice-jacket pre-cooling, others have not.

The positive aspect of using ice jackets is that they can effectively cool the periphery (skin), which can provide both a physiological and psychological lift as the player perceives a treatment effect. However, the procedure and cost of administering ice jackets to a team, relative to the minor effect on lowering core temperature, brings into question the usefulness of this method.

Cold towels

A somewhat more practical procedure similar to ice jackets is the use of towels that have been soaked in a bin full of ice-water. The limitation of this technique for the practitioner is the quick turnaround time required to maintain effectively cold towels, because the cooling power of the cold towel is quickly lost through transfer of heat from the athlete and environment. Therefore, although more cost-effective, the procedure requires some labour. Nevertheless, the technique can be quite practical, as it requires only tubs, ice, water and towels, and players can be taught to self-administer the treatment.

Ice-slurry ingestion

The ingestion of cold fluids and ice-slurry prior to exercise in the heat has attracted much interest of late. Siegel et al[3] were the first to show how the ingestion of 7.5 g/kg (~500 to 600 ml) of ice-slurry 30 minutes before running in the heat at threshold significantly increased run time by 19% (or about 10 minutes) compared with drinking cold (4°C) fluids. The authors speculated that added heat removal from the phase change (solid ice to liquid water)

> ***The plunge bath, or cold water immersion, is probably the most effective means of lowering core body temperature prior to performance in the heat.***

Above: Tennis player Andy Murray using an ice towel to cool down between sets, Sony Ericsson Open, Florida, USA

Right: Harry Kewell and Tim Cahill from the Australian Socceroos in an ice bath in Doha, Qatar

created the additional heat sink and cooler temperatures. Another interesting finding from this study was that final core temperature was about 0.3°C higher at exercise completion, a finding unique to the thermoregulation literature. Prior to this finding, it was thought we have a set 'critical' core temperature (discussed earlier) that we will not voluntarily surpass. Thermal sensation and rating of exertion were the same in both trials, which suggests that the ingestion of ice-slurry may improve exercise in the heat by lowering brain temperature, which could occur conductively due to the proximity of the mouth to the brain and associated arteries.

To lend further evidence for this, Siegel et al[4] repeated their study and added a second comparison trial of a 30-minute cold-water immersion. Although both pre-cooling methods were shown to be equally effective at prolonging exercise in the heat, final core temperature was again highest in the ice-slurry trial, lending further support to the hypothesis that the likely influence ice-slurry ingestion has on lowering brain temperature is the main mechanism for improving exercise in the heat[5].

Due to both its effectiveness and practicality, ice-slurry ingestion is a good means of pre-cooling athletes prior to exercise in the heat. It has been shown to be as effective as cold-water immersion, and it is much easier to serve cups of ice-slurry prior to competition in the heat than it is to plunge in a bath. In addition, there are added hydration effects when the ice melts.

Combination strategies

A combination strategy of using cold towels and ice-slurry may be the best solution in terms of effectiveness and practicality. For example, Ross et al[6] compared the combined effects of a possibly less practical procedure of plunging in cold water followed by wearing an ice jacket with the combined procedure of using cold towels and ingesting ice-slurry. Both protocols resulted in improved cycling time-trial performance in the heat, but a comparison between the two combined strategies revealed no difference in terms of effectiveness. Therefore, the improved practicality of ice-slurry ingestion and cold-towel application makes these two procedures the more sensible choices for the practitioner interested in administering a pre-cooling strategy to football players before competition in the heat.

KEY POINTS

1. Exercise performance is lowered in hot conditions, mostly due to higher than normal core temperatures detected by the brain.
2. Reducing one's core temperature before exercise, termed 'pre-cooling', has been shown to be effective at delaying the time before high core temperatures are reached, which in turn improves exercise performance.
3. Popular means of pre-cooling that have been examined in the laboratory setting include cold-water immersion, ice jackets, cold towels and ice-slurry ingestion.
4. Cold-water immersion may be the most effective method and ice jackets have received much attention. However, the most practical means of pre-cooling may be the combination of ingesting ice-slurry, or crushed ice (~500 to 600 ml) combined with the application of cold towels over the extremities, during the 30 to 45 minutes prior to competition.

Due to both its effectiveness and practicality, ice-slurry ingestion is a good means of pre-cooling athletes prior to exercise in the heat.

Inset: Mali's national football team player Seydou Keita refreshes before the match against Bostswana at the Stade de l'Amitie.

Below left: Cold-water immersion is one of the most effective means of pre-cooling.

SUMMARY

In summary, pre-cooling is a strategy that can lower a player's body temperature before they commence competition in the heat. This procedure delays the time before critically high core temperatures are reached and may be a useful means of improving aspects of team sport performance. Possible strategies that have been researched include cold-water immersion, wearing ice jackets, being draped in cold towels and ingesting ice-slurry during the 30 to 45 minutes prior to competition. Although all such strategies have been shown to have varying degrees of success in the laboratory setting, use of cold towels and ice-slurry ingestion appear to have the highest level of practicality and effectiveness in the real-world setting.

References

1. *Quod MJ, Martin DT, Laursen PB, Gardner AS, Halson SL, Marino FE et al. Practical pre-cooling: effect on cycling time trial performance in warm conditions. J Sports Sci 2008; 26:1477-1487.*
2. *Duffield R, Marino FE. Effects of pre-cooling procedures on intermittent-sprint exercise performance in warm conditions. Eur J Appl Physiol 2007; 100:727-735.*
3. *Siegel R, Maté J, Brearley MB, Watson G, Nosaka K, Laursen PB. Ice slurry ingestion increases core temperature capacity and running time in the heat. Med Sci Sports Exerc 2010; 42:717-725.*
4. *Siegel R, Maté J, Watson G, Nosaka K, Laursen PB. Pre-cooling with ice slurry ingestion leads to similar run times to exhaustion in the heat as cold water immersion. J Sports Sci 2012; 30:155-165.*
5. *Siegel R, Laursen PB. Keeping your cool: possible mechanisms for enhanced exercise performance in the heat with internal cooling methods. Sports Med 2012; 42:89-98.*
6. *Ross ML, Garvican LA, Jeacocke NA, Laursen PB, Abbiss CR, Martin DT et al. Novel pre-cooling strategy enhances time trial cycling in the heat. Med Sci Sports Exerc 2011; 43:123-133.*

Paul B. Laursen, Ph.D.

High Performance Sport
Auckland, New Zealand

Contact: PaulL@nzasni.org.nz