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EDITORIAL

An Athlete's Guide to Training in the Heat

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Introduction

Athletes face many factors that can limit performance. Proper nutrition, sleep, and even the environment are all contributing factors to an athlete's overall performance. However, when we look a little deeper, the athlete's ability to handle the environment can be one of the more difficult challenges. The healthy athlete's ability to tolerate a hot climate during exercise can be the most significant threat to performance [1]. Exposure to high heat cause premature fatigue, dehydration, and challenge the cardiovascular and neurological systems faster and harder. Training at higher temperatures has also been demonstrated to reduce power output by up to 15% in 14 different research articles [2]. So, what are the options for athletes who must compete or train in the heat?

Hydration may be the most critical aspect of training in the heat. As athletes increase their fitness level and acclimate to higher temperatures, they naturally sweat faster and at higher rates than their untrained counterparts [1]. Due to this, athletes are a higher risk of depletion of fluids and electrolytes, something that can have catastrophic implications to performance goals. During the hottest months, a pre and post-training session weigh-in should be implemented so athletes can be sure to consume enough fluid. Current guidelines state that athletes should consume 150% of fluid lost during training in the hours after [1].

Acclimation

Heat acclimation may be one of the best ways to deal with climbing temperatures. Athletes can quickly build up a tolerance to higher temperatures by exposing themselves in a progressive, intelligent manner. Daanen, et al. [3] suggest that acclimation can be maximized in as little as five days of exposure and that a mix of intensity and duration is necessary to improve core temperature tolerance, heart rate changes, and sweat rates. Therefore, athletes should program days shorter exposure on the hottest days and more prolonged exposure on the slightly cooler days. Coaches and athletes should be careful to note that acclimation decay or deterioration takes place at nearly 2.5% per day of non-exposure. Therefore, athletes should be encouraged to keep up with heat exposures even on light and non-training days. Preparing athletes for handling environmental stressors can pose one of the bigger challenges for the coaching staff. Knowing the details of how heat, humidity, and even colder temperatures affect human physiology can be the difference between winning and losing.

Heat poses one of the single biggest threats to the healthy athlete [1]. When exercising in hot environments, the athlete can experience numerous physiological changes that can limit performance. Reduced muscular function, cardiovascular strain, and even central nervous system fatigue can all manifest because of excess heat. In preparing athletes to deal with the extreme heat, acclimation is key. It is important to remember that acclimation takes and takes the athlete anywhere from one to two weeks from the first day and completely lost within 28 days [1]. Training for the heat will result in nearly a 10-12 percent increase in blood plasma to distribute blood to the skin and reduce body temperature effectively. Interestingly, athletes can continue to benefit from heat acclimation with the use of heat baths when other means of exposure are not available. Zurawlew, Mee, and Walsh [4] discovered

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that by implementing post retraining, hot baths athletes could retain the heat acclimation for up to two weeks. This is a fantastic discovery for many athletes as time off the field does not have to equal a complete reset in acclimation.

When it comes to exposure, there is little we can do to influence that outside temperature. However, there are many things we can do to promote our body's ability to withstand the heat. Pretraining-cooling has demonstrated positive results for those training in high heat environments. Pre-cooling can reduce blood lactate, thereby reducing muscle fatigue, but can also reduce the athlete's perception of an overly hot environment. Reducing fatigue and environmental heat perception can help the athlete power through tough training sessions and competitions, thereby improving performance [5-7]. Pre-session cooling is easy to implement with the gyms already existing cold baths but can also be done easily with ice packs (Figure 1).

Supplementation

The acid-base balance in the body is one of the most tightly controlled systems in human physiology. With a survivable range beginning at 7.4 and deviating a mere .4 unites in either direction before death [1], one can see why regulation of these numbers is crucial. While a large shift is highly detrimental, a small shift towards arterial acidosis has been implicated in muscular fatigue along with the burning sensation described in muscle tissue after extensive exercise [1]. This burning sensation was previously blamed on lactic acid accumulation, not H^+ ion accumulation. Understanding of the acid-base balance and how it can serve as a limiting factor in exercise can be vital to performance outcomes.

Supplementation with select key ingredients has been implicated in the reduction of systemic arterial and cellular acidosis, thereby creating a physiological environment conducive to high performance [8,9]. An ideal supplement sack would be multifactorial in its ability to buffer acidosis and provide quality effects to the human energy system allowing for increased energy and reduced fatigue. A stack comprised of sodium bicarbonate (baking soda), beta-alanine and glycerol would improve athletic performance while mitigating some of the risks associated with training in the heat.

Sodium bicarbonate is a cheap supplement that can provide a large benefit to performance. Acting as an acidic buffer sodium bicarbonate helps regulate intra and extracellular pH, which has been shown to increase an athlete's time to exhaustion [1,10]. Sodium bicarbonate works by buffering out intra and extracellular H^+ ions from the muscle tissue, thereby decreasing the painful sensation of intense exercise but also the fatigue associated with H^+ accumulation. Suvi, et al., [11] demonstrated ingestion of other alkalizing substances such as sodium citrate helped reduce the acute effects of dehydration and may alleviate the physiological stress of intense activity in the heat.

Beta-Alanine is responsible for up to 10% of the muscle's buffering capability. It has been demonstrated as a powerful performance aid for its potent abilities to increase muscle carnosine. Carnosine acts as an intracellular pH buffer as well and can serve to regulate

Figure 1: Acclimation.

intracellular calcium usage [12]. Carnosine also has been shown to serve as a potent antioxidant [13], indicating both therapeutic and sports performance benefits. Examples of therapeutic benefits were demonstrated by Blancquaert, et al. [12] to improve cognitive function along with antiglycation properties. Glycation is the deleterious effects of protein and lipid oxidation in the body leading to advanced aging and even decreased life span along with many other physical conditions [14]. At just 6.4 grams per day, Beta-Alanine has been shown to improve performance [15]. Overall, the benefits of beta-alanine on the brain, body, and performance cannot be overlooked.

Creatine is one of the most studied supplements on earth. Traditionally, creatine was known for its ability to improve water retention, maintain ATP homeostasis and support muscle power during exercise [16,17]. Recently, however, Golini [18] demonstrated that alkaline creatine could serve as a potent anti-inflammatory and even protective against cytotoxicity.

Finally, glycerol and betaine have been shown to improve the body's ability to hold water during extreme heat. Also, known as hyperhydration, these supplements promote water retention, thereby mitigating some of the deleterious effects of training by decreasing core temperature and heart rate elevated temperatures while improving time to exhaustion [15]. Glycerol should be taken in doses of 1.2 g/kg bodyweight 60 minutes before exercise. The benefits of glycerol and its hyperhydrating effects can be seen for up to 49 hours according to come literature [19]. Although the literature is conflicted on muscle power, betaine has been shown to improve muscle endurance and time to exhaustion in doses of 1.25 grams/day in as little as ten days [15] (Figure 2).

Figure 2: Supplementation.

Clothing

Until recently, the only thing an athlete could do to cope with an environment of elevated temperature would be to work on exposure and tolerability with proper hydration. However, recent breakthroughs in apparel science have shown a third option, specialized clothing designed to keep athletes cool via more efficient evaporation.

Evaporation is the most effective, efficient means of cooling the body when humidity is low [1]. A well-designed clothing line takes full advantage of this system. Advancements in clothing technology have begun to change the circumstances for athletes competing in the heat. Discoveries such as those by Davis, et al. [20] show that new developments in synthetic fabric improved the athlete's perception of heat and their difficulty rating of the performed exercise session. Jiao, et al. [21] also demonstrated that clothing with specific zones of heat-dissipating fabrics improved running performance in male runners. This information is promising for athletes

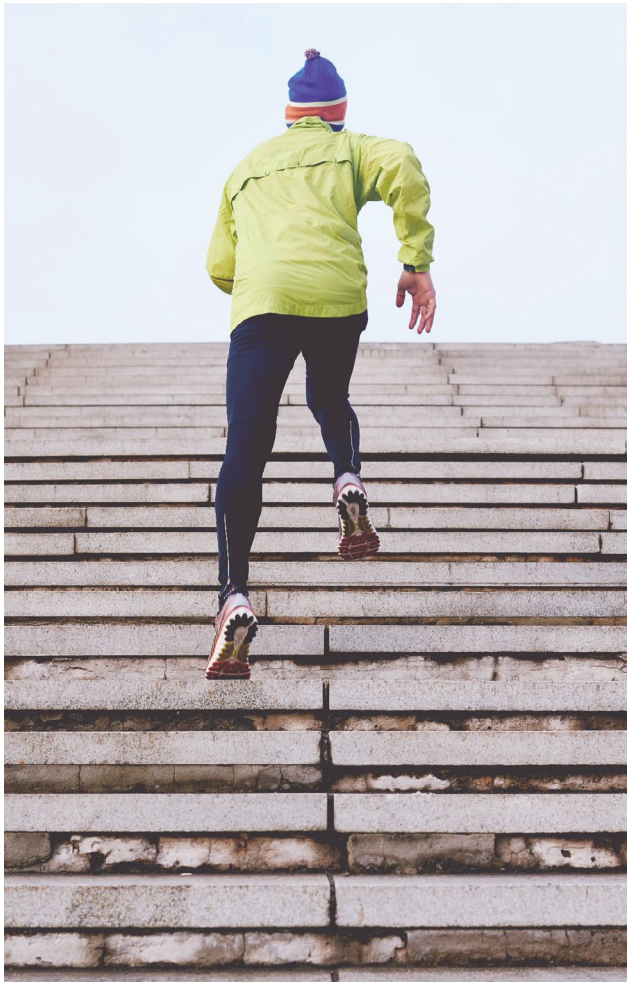

Figure 3: Clothing.

who compete in hot environments as it suggests clothing can help with making an already effective natural system more efficient.

A clothing line that takes advantage of the natural sweat mechanism and wicks water away from the body while allowing for little fluid retention and fast evaporation would prove most effective in hot environments. In designing clothing for hot weather training, a synthetic blend such as polyester has been shown to hold less moisture while providing better evaporation qualities [22]. Ideally, such a design would be snug to the skin allowing for immediate transfer of moisture through the fabric to the environment. Apparel that aides in sweat evaporation is essential in these conditions. Tight-fitting polyester style clothing has been shown to wick sweat from the body and resist fluid retention allowing evaporation to happen faster and more effectively [22]. Making sure athletes choose proper training apparel can help reduce heat injury and even improve performance by taking advantage of the body's most effective form of heat reduction [1] (Figure 3).

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