# Heat Acclimatization to Improve Athletic Performance in Warm-Hot Environments

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*Adapted from SSE 153*

## Introduction

As baseball players are arriving at training camp, the environmental conditions can vary significantly from where the players have been living. The following article provides practical suggestions to help athletes as they transition to the new environmental conditions. For detailed information about the physiological processes involved in heat acclimatization, please refer to SSE 153: Heat Acclimatization to Improve Athletic Performance in Warm-Hot Environments.

If given sufficient time to adapt, and access to shade and adequate water, healthy persons can tolerate extended exposure to virtually any naturally occurring environmental heat stress (Sawka et al., 1996). Heat stress results from the interaction of environmental conditions (temperature, humidity, solar radiation), physical work rate (body heat production) and wearing of heavy clothing/equipment that impedes heat loss (Gagge & Gonzalez, 1996; McLellan et al., 2013; Sawka et al., 1996). Environmental heat stress and physical exercise interact synergistically to increase strain on physiological systems (Sawka et al., 2011). Thus, conducting physical exercise in warm-hot conditions induces elevated body temperature, cardiovascular strain and altered metabolism that can cause thermal discomfort, impaired aerobic performance and increased risk of serious heat illness (Nybo et al., 2014; Sawka et al., 2011). Heat acclimatization confers biological adjustments that reduce these negative effects of heat stress (Horowitz, 2014; Sawka et al., 1996, 2011). Heat acclimatization, or acclimation, develops respectively through repeated natural (acclimatization) or artificial (acclimation) heat exposures that are sufficiently stressful to elevate both core and skin temperatures, which induce profuse sweating (Périard et al., 2015; Sawka et al., 2003).

## Introduction of Heat Acclimatization

The magnitude of biological adaptations induced by heat acclimatization depends largely on the intensity, duration, frequency and number of heat exposures (Périard et al., 2015; Sawka et al., 2003; Taylor, 2014). Even resting in the heat or exercising in a temperate environment allows for some limited acclimatization, exercise in the heat is the most effective method to develop heat acclimatization.

Usually, about 7-14 d of heat exposure are needed to induce heat acclimatization. Optimal heat acclimatization requires a minimum daily heat exposure of about 90 min (can be extended to 2 h and broken into two, 1 h exposures) combined with aerobic exercise, rather than resistance training. Athletes should gradually increase the exercise intensity and duration, or just the heat exposure duration, each day of heat acclimatization.

## Heat Acclimatization Strategies for Athletes

Most experimentally tested heat acclimatization strategies were developed for occupational/military settings and not for competitive athletes (Périard et al., 2015). Competitive athletes are fitter and participate in events requiring higher metabolic intensities. Therefore, the “specificity of training” and “specificity of adaptation” principles might require higher intensity exercise bouts than what has been experimentally tested. Indeed, most heat acclimatization protocols were conducted over many days eliciting a “slow” adaptation. However, athletes may rapidly travel from a temperate environment to a warm-hot climate, or from a humid heat to a dry heat climate, and may need a more rapid (and complete) induction of heat acclimatization to optimize performance.

The exercise-heat acclimatization phenotype is generally achieved through one of three induction pathways: i) constant metabolic rate; ii) self-paced and iii) controlled hyperthermia, or isothermic heat acclimation (Périard et al., 2015). The magnitude of adaptation may also relate to the induction pathway as Taylor (2014) has argued that repeated exposure to a constant metabolic rate regimen (i.e., traditional heat acclimatization) results in a less complete adaptation, whereas the progressive overload approach (e.g., controlled hyperthermia to a given core temperature) likely induces more complete heat acclimatization. It has recently been proposed that a controlled exercise intensity protocol whereby a given level of cardiovascular strain (e.g., heart rate) is maintained during daily exercise-heat exposure may further optimize adaptations (Périard et al., 2015).

To optimize performance, the exercise-heat stimulus should as closely as possible simulate the expected climate-exercise conditions during competition. However,

this may require a gradual increase in the climatic heat stress, exercise intensity and duration and there may be trade-offs made by the athlete. For example, it has been shown that low-intensity long duration exercise elicits similar heat acclimatization benefits (i.e., reduced exercising heart rate, core temperature and metabolism) to that of moderate-intensity short-duration exercise (Houmard et al., 1990).

Heat acclimatization in a dry environment confers a substantial advantage in humid heat, but the physiological and biophysical differences between dry and humid heat lead one to expect that humid heat acclimation would produce somewhat different physiological adaptations from dry heat acclimation. The crossover benefits of humid and dry heat acclimatization and the benefits at higher exercise intensities have not been well studied. If heat acclimatization needs to be induced for both dry and humid heat, and if rapidity of induction is important, then we postulate that first acclimatizing athletes to dry heat (producing adaptations to sweating with some cardiovascular benefits) and secondly acclimatizing athletes to humid heat (likely inducing greater fluid regulatory and cardiovascular adaptations) might be most efficacious.

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| Strategy | Suggestions for Implementation |
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| **Start Early** | 1. Optimize physical conditioning prior to initiating heat acclimatization.<br>2. Start at least 3 wk prior to competition.<br>3. Be flexible and patient: heat acclimatization performance benefits take longer than the physiological benefits.<br>4. Provide time to experiment with your heat exposure routine and to build confidence. |
| **Mimic the Competition Climate and Exercise Tasks** | 1. In warm climates, acclimatize during the heat of the day, and conduct physical training in cooler parts of the day (morning or evening).<br>2. In temperate climates work out in a warm room wearing cotton sweats.<br>3. Exercise induces greater adaptations than resting in the heat.<br>4. Slowly replicate your future competition conditions (environment and work rates) as acclimatization is specific to the stressors. |
| **Ensure Adequate Heat Stress and Recovery** | 1. Induce profuse sweating.<br>2. Use exercise-rest cycles to progressively increase your physical work capacity.<br>3. Work up to 100 min of continuous physical exercise in the heat.<br>4. Once you can comfortably exercise for 100 min in the heat, then continue for at least 7-14 d with added exercise intensity.<br>5. Sleeping in air-conditioned rooms will not affect heat acclimatization status and will aid in recovery from heat stress. |
| **Drink and Eat Adequately** | 1. Your thirst mechanism will improve as you become heat acclimatized, but you will still under-drink if relying on thirst sensation.<br>2. Heat acclimatization will increase your water requirements, so consume sufficient fluids to avoid hypohydration.<br>3. You will sweat out more electrolytes when not acclimatized, so pay particular attention to consuming fluids/foods containing electrolytes during the first week of heat acclimatization.<br>4. Do not skip meals, as this is when your body replaces most of its water and salt losses. |

**Table 1:** Heat acclimatization strategies for athletes preparing for competition in warm-hot weather (modified from NATO TR-HFM-187, 2013).

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