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The Summer Time Blues: Training In The Heat

We all know that training in the heat can become a real challenge. It seems like it's harder to maintain any pace – if anything, you may feel like you're running slower. You're lethargic. Perhaps it just seems like a lot of work. But why does this occur? And can it be prevented?

The goal of the human body is ***homeostasis*** - the ability or tendency of an organism or cell to maintain internal equilibrium by adjusting its physiological processes. Part of homeostasis is ***thermoregulation***.

Thermoregulation is accomplished by 4 primary mechanisms:

1. conduction – heat escapes from your body i.e. when you sit on a cold rock. This will typically account for 3% of heat loss.
2. convection – cooler air currents remove heat from the surface of your skin. This will typically account for 15% of heat loss in moderate climates.
3. evaporation – evaporative cooling occurs when water (often from perspiration) leaves the skin surface as a vapor, lowering the body temperature by taking the heat of evaporation from the body. This will typically account for 22% of heat loss.
4. radiation – such as acquiring heat from solar radiation (i.e. "sunning" yourself). "Heat waves" will typically account for 60% of heat loss.

Your core temperature is 98.6 degrees (range = 96.8 – 99.5 degrees).

Being active in hot conditions provides a "heat challenge" for the body to overcome. The heat challenge must be offset by heat loss (either active or passive), otherwise heat injury will occur. In order to reduce your risk, you either need to decrease the heat challenge or increase your heat loss.

The ***heat challenge*** is comprised of 4 primary factors:

1. Exercise
2. Temperature and Humidity (Heat Index)
3. Body wetness from sweating
4. Wind

It is not only the temperature that is important – the humidity plays an important role. When both elements are factored in, we call it the heat index. For example, the heat index when it is 100 degrees air temperature and 20% humidity is 99 degrees. But if the air temperature is only 85 degrees, there will be a similar heat index if the humidity is 80%.

The humidity also affects the body's ability to lose heat via evaporation (see below).

	air temperature (F°)									
	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°
relative humidity	apparent temperature									
10%	65°	70°	75°	80°	85°	90°	95°	100°	105°	111°
20%	66°	72°	77°	82°	87°	93°	99°	105°	112°	120°
30%	67°	73°	78°	84°	90°	96°	104°	113°	123°	135°
40%	68°	74°	79°	86°	93°	101°	110°	123°	137°	
50%	69°	75°	81°	88°	96°	107°	120°	135°	150°	
60%	70°	76°	82°	90°	100°	114°	132°	149°		
70%	70°	77°	85°	93°	106°	124°	144°			
80%	71°	78°	86°	97°	113°	136°	157°			
90%	71°	79°	88°	102°	122°	150°	170°			
100%	72°	80°	91°	108°	133°	166°				

There are passive and active ***heat loss*** factors. The primary passive heat loss factors are body fat and insulation (type of clothing layers). Heavier fabrics that do not wick moisture away from the skin will tend to not work well for heat loss.

The primary active heat loss factors are radiant heat from the body and evaporation (sweating – which is limited by fluid levels and your level of fitness). Evaporative cooling will benefit from being able to wick moisture away from the skin – hence materials like CoolMax and DriFit. It is also affected by the humidity (high humidity – more difficult to evaporate). Acclimatization to the heat will certainly help by making the body's sweating mechanism more efficient.

Dehydration

There can be a 20% loss of power output with dehydration. Thirst is typically not signaled until about 3% dehydration – so by the time you feel like you need to drink, you're already sliding down the slippery slope of dehydration. I would suggest that there is a 5-10% decrease in per mile pace while running in hot conditions. For a 9:00/mile runner, this would mean that a 9:26-9:54 mile would feel the same as a 9:00 mile in cooler conditions – so factor this in on your training runs!

How do I prevent dehydration? The primary task is to a) stay well-hydrated regularly (though 60% of the population is chronically dehydrated), and b) take in fluid during your workout to offset any losses – in essence, to match your sweat rate. Most people will probably fall into a range of 24 – 32oz per hour. There is a synergistic effect between carbohydrate, water, and sodium – intake of carbohydrate (such as a sport drink) will actually facilitate fluid absorption. Sodium is also required for glucose transport. Think of "heat loss" as being similar to running your air conditioner – it requires fuel to do so!

Pre-workout: There are many approaches to daily hydration. One is to aim for eight 8 oz glasses of water – 64 oz in total – on a daily basis. Another is to aim for one liter (33oz, or approx. one quart) for every 1000 calories expended. Another guideline is to drink enough such that you have urine output every 2 to 4 hours that is straw colored. Proper hydration will enhance glycogen storage as well.

During the workout: Your goal is to match your sweat rate, though for many this can be a challenge. First of all, there is a limitation to the fluid volume that can be emptied from your stomach and at which it can be absorbed. Though the stomach can empty at a rate of about 2000ml per hour (66oz), the maximum absorption rate of the small intestine is about 1500ml per hour (49oz).

> Calculating your sweat rate:
> Sweat loss = change in body mass (kg x 1000) + fluid intake (ml) – urine loss (kg x 1000)
> Sweat rate (ml/hr) = Sweat loss (ml) ÷ exercise duration (hr)
> % dehydration = change in body mass (kg) ÷ pre-exercise body mass (kg) x 1000
> ** note – 1 kg = 1000g = 1000 ml of water

Restoring fluid post-workout: Fluid loss from exercise is best established by monitoring changes in body weight pre- and post-training. A loss of one kg equals one liter of fluid. A volume equal to 150% of this fluid deficit should be consumed over the 2 to 4 hours post-training session to restore fluid balance. Sport drinks facilitate this restoration due to the inclusion of electrolytes.

What about wearing a hat? Sunscreen? Light colored clothing?
There may actually be a bit of a mixed effect with a hat. Though a light-colored hat may reflect some of the sun, it may also prevent evaporative loss and convection loss. Sunscreen is also a bit of a mixed effect, as some may actually prevent you from sweating normally and thus maintain heat.

Heat injuries range from heat cramps to heat syncope to heat exhaustion to heat stroke. The symptoms will start off with discomfort, sweating and redness. The first sign of problems is when you become pale and clammy with weakness and feeling "sick". The progression of this is when you are hot but not sweating – this is a medical emergency.