Fueling in the HEAT

Do extreme conditions call for extreme actions?

By Sunny Blende, M.S., Sports Nutritionist

I just returned from crewing and pacing at the Badwater 135 mile race where temperatures reached into the 120's and runners used all kinds of fueling techniques, ice devices and other gadgets to try and maintain some kind of "cool" while still running down the road through Death Valley and up the mountain to Mt. Whitney portal. The conditions were extreme. While some things such as pace and clothing worn when running in the heat *DO* call for extreme actions – slow down and wear SPF long-sleeved clothing – surprisingly, hydrating and fueling really do not – ***provided you are heat acclimated.***

Heat Acclimatization

Proper heat acclimatization is probably *the most important thing* you can do to decrease the dangers of running in the heat, prevent hyperthermia and increase your performance outcome in a race. This can be accomplished over a two-week period by slowly increasing training volume, and then intensity in the heat. Whether you go to a hot place to train and acclimate, or wear layers of clothes and exercise in a sauna, your body will go through different stages of heat adaptation. As well as environmental heat increasing heat production, the body naturally produces heat as a result of breaking down energy stores and the amount is proportional to exercise intensity, thus raising an athlete's core body temperature. As the brain senses an increase in core temperature, blood flow is increased away from the core of the body, resulting in an increase in cardiac output and increased heart rate during exercise. This blood is then distributed to working muscles to facilitate their function by maintaining oxygen delivery and increasing the removal of waste and body heat. During the first few days of acclimatization there is an increase in plasma volume that causes a decreased heart rate and decreased rate of perceived exertion while exercising. The kidneys then start reabsorbing sodium and chloride to preserve electrolyte balance and therefore less is lost in sweat and urine. The brain resets and increases sweat rate to compensate (for cooling) during exercise. The full increase in sweat rate is completed by two weeks. Complete adaptation is also marked by a significant shift from anaerobic to aerobic metabolism and thus a greater reliance on fat as a fuel source rather than carbohydrate. The increased reliance on fat (and also the move from "anaerobic to aerobic") can be attributed to a reduction in *strain* on the body as a result of increased heat removal through a raised sweat rate, decreased relative exercise intensity, and a decreased number of muscle fibers needed to perform the same amount of work. Together, these markers are evidence of a complete adaptation to the heat.

There turns out to be another pleasant effect of heat training, according to a recent University of Oregon study. That study showed heat-trained runners produced gains in the measures all runners hope to improve: VO2 max, lactate threshold, maximal cardiac output, maximal power output and 1-hour time trial performance, *even when they race in cooler environments.* The only piece of the training that varied was the exposure to heat. The magnitude of the effect was similar to altitude training.

Dangers of Running in the Heat

Dehydration is the word that usually comes to mind when discussing hot weather running. And it's true that hydration is key to fluid *balance*, but it actually does very little for core temperature… the other potential race-stopper of running in the heat. In extreme heat, no amount of drinking is going to change the fact that you're going to go slower. Our body has a self-regulatory system – *regulatory anticipation* - where our nervous system regulates our performance by allowing us to work hard enough to reach our highest safe core temperature, but no higher. So is hydration not important? Being fluid balanced means you keep that fluid concentration the same inside and outside the cells. Fluid balance allows us to go *faster* before we reach a high core temperature. To be more specific, drinking fluids allows us to keep our blood volume close to normal which in turn keeps our sweat rate high and also allows more oxygen per heart contraction to be delivered to our working muscles. According to author Matt Fitzgerald "drinking while running in the heat will not cool you down, it will speed you up". How much should you drink? Current ACSM guidelines recommend drinking "ad libitum" - to your thirst - enough to limit fluid losses to 2 percent or less of your body mass. Drinking more will not keep you cooler, but it could cause you to suffer from bloating - or in cases of over-hydrating for 4-6 hours or more – hyponatremia. **Hyponatremia** is literally "water intoxication", a condition where the runner looks like he/she is mildly drunk. As the blood volume increases with too much water, the body becomes dangerously low in sodium, throwing the electrolyte balance totally out of whack. One symptom is a craving for salty foods and indeed, if you are going to be running in the heat, a sports drink with electrolytes or some salty snacks are a good idea to prevent this.

Heat illnesses are the main concerns of ultrarunners exercising in hot weather when talking about *core temperature*. They include heat cramps, heat exhaustion, heatstroke and hyponatremia. Briefly, **heat cramps** are usually caused by imbalances or deficiencies in electrolyte stores (mostly sodium) and are characterized by stabbing pain. **Heat exhaustion** includes a loss of fluid and electrolytes (water *and* sodium) through sweat that leads to a rise in core temperature, dizziness and weakness as well as possible nausea, vomiting and a headache. **Heatstroke** is where the core temperature rises to 104° or higher and the runner shows weakness, confusion, and possible unconsciousness. Often this happens when heat exhaustion is ignored and runners push themselves towards total thermoregulatory breakdown. Because heatstroke is a complete failure of the body's thermostat, sweating ceases and the skin becomes dry or hot. This is a life-threatening emergency where immediate medial attention is necessary.

Energy and Hydration Needs

Ensuring that ultrarunners take in adequate fuel and fluid during runs and races in the heat is important to minimize the above dangers and prevent premature fatigue. Unfortunately, as temperatures go up, gastric emptying and nutrient absorption go down,

thus causing a slower rate of calories and liquid entering the blood stream. An ultrarunner, going from a cool or moderate temperature to one that is hot, experiences several shifts in metabolism that must be accounted for during training. Resting metabolic rate is decreased on average by approximately 5 percent because the environment helps maintain body temperature. However, a hot environment can lead to decreased appetite, so athletes need to be careful that they still meet their energy needs. Training in the heat results in increased carbohydrate use and decreased fat utilization due to the athlete working at a higher relative percentage of maximal capacity and because an increase in muscle temperature decreases muscle efficiency. Depending on how well the ultrarunners acclimatization to a hot environment has been, he/she may or may not improve their reliance on fat as a fuel source.

Because the desire to eat can be significantly reduced in hot environments, it is important for an ultrarunner to identify foods and fluids that taste agreeable during exercise. It is best to have a wide variety of palatable foods and fluids available, both in drop bags and at the aid stations. Energy needs can be met through several different options. The types of fluid ingested and the amount of residue a food contains should be considered. The first strategy is to increase the *calorie content* of fluids used to rehydrate. A second option is to increase *low-residue* foods. These foods are easier to digest, do not make you feel "full" and, in addition, these foods produce less heat when metabolized and therefore help control body temperature. See the sidebar for examples.

During an ultramarathon in the heat, it is common for fluid loss to exceed the amount the runner is able to ingest. At the same time, fluid intake is important because it can considerably improve the body's ability to minimize heat storage by helping to maintain sweat rate and providing a cooling sensation when drinking fluids that are below body temperature. The temperature of a beverage can significantly influence how palatable it will be to an athlete and how quickly it can absorbed by the body. Cool to cold fluids are best when training in a hot environment. Electrolytes, either incorporated within a sports drink or taken in capsule or dissolving tablet form, will also increase absorption of fluids and add to the agreeable taste.

Hyperhydration (or Water Loading)

Studies have proven a moderate amount of exercise-induced dehydration has little to no effect on performance, but in situations such as a hot weather race with not (always) enough access to fluids, having additional fluid stores might prove advantageous. Hyperhydrating, or drinking more fluid than is necessary to maintain fluid balance within the body, is effective right before an event but often causes gastric distress. But what if there were a way to hyperhydrate hours before an event? Today sodium-induced hyperhydration is the most promising development. Currently in the testing phase, sodium-induced hyperhydration--essentially, drinking lightly salted water in the several hours preceding hot weather exercise--is clearly showing that it produces good results. The biggest trick is making the substance palatable. During trials, the salt water (just over 1/4 teaspoon of table salt per cup) was blended with Crystal Light and served at roughly 35 degrees. Regardless of your goal, hyperhydration makes sense on a practical level only if

you anticipate not being able to keep your fluid losses to less than 2 percent of your body mass.

Summary and Timeline

A timeline for fluid ingestion is important for coping with the heat. A timeline will help ensure that an ultrarunner starts the training run or race well hydrated and also that rehydration begins immediately after training, as well as incorporating hydration into the run itself. This mechanism is not a failsafe however. It is possible to push "past dehydration" (for awhile anyway) and it is also possible for the brain itself to overheat, causing the usual protective system to fail and heat illnesses' to occur. So be sure to acclimate and try different fueling and hydration strategies to see which one works for you.

Hydration Guidelines for Hot Environments

Upon Waking – consume 20 oz of fluid and make sure half of the volume contains electrolytes (milk, juice, smoothie, carb and protein meal replacement).

Hour Before Training – Consume 20 oz of fluid (if you did not right after waking).

During Training – Try to consume 4-6 oz of fluid every 15-20 minutes.

Immediately Post-Training – Consume 20 oz of water or carbohydrate-electrolyte beverage.

After Training – Consume 4-8 oz of fluid ever 15-20 minutes throughout the day until the amount of sweat lost from training is replaced. Multiple training sessions will most likely require that athletes drink continually throughout the day to keep up with fluid loss.

Before Sleeping – Consume 20 oz of fluid.

From Performance Nutrition by Krista Austin, PhD, CSCS, Human Kinetics

SIDEBAR

Higher Calorie Liquids	Low-Residue Foods
• Ensure, Boost • Carbohydrate Sport Drinks – Carbo Pro, Cytomax, Gatorade, Heed, Ultrima, GuBrew, Perpetuem, Sustained Energy, Accelerade Hydro • Recovery Drinks – GuRecovery Brew, Recoverite, Amino, Endurox, Fluid Recovery • Juices, Sodas, Ice Tea (w/sugar	• Breads & Starches – white bread, rolls, muffins, crackers, white or sweet potatoes (without skin) • Fruits – bananas, melons • Dairy – yogurt, chocolate milk, cheese, even milk • Meats, Meat Substitutes – turkey breast, to-fu, nut butters • Fats – peanut butter • Miscellaneous – pastries, hard candy, cookies • MOST SPORTS BARS – check the fiber amount on the label