

Rowing in Hot Weather

Author: Fritz Hagerman (USA)

As we move into spring and summer, athletes will be exposed to hot weather and its effects. Dehydration, one of those effects, can lead to some very serious consequences, most notably heat cramps, heat syncope, heat exhaustion, and heat stroke. These conditions can progress rapidly from cramps to a severe stroke in a matter of minutes. Since an athlete's intense concentration during training and competition may cause him to ignore or misinterpret any of the usual warning signs, coaches must be conscious of the effects of hot weather and be prepared to identify signs of heat-produced injury.

Thermal Injury

Athletes are often so focused during training and competition that they don't recognize the symptoms of potential heat problems immediately. They are also prone to overexerting themselves. Rowers should be advised of the early signs of heat injury which may include dizziness, co-ordination impairment, visual disturbances, loss of balance, excessive (or lack of) sweating, chills, nausea, headache, and loss of consciousness. This process can rapidly evolve into a dangerous situation; some emergency room physicians consider heat injury as the ultimate physical insult to the body. Prevention is the most important consideration. The specific heat disorders, in order of severity, are as follows:

1. *Heat Cramps* - This disorder is characterized by uncontrollable muscle spasms, especially in the legs. Although the condition is usually associated with unacclimatized athletes, it frequently occurs in adapted athletes as well.
2. *Heat Syncope* - This condition is characterized by weakness and fatigue, blurred vision, paleness, decreased blood pressure, syncope (loss of consciousness), and elevated skin and core body temperatures. It can affect the acclimatized rower in excessively hot weather but usually occurs in the unacclimatized athlete.
3. *Heat Exhaustion* - This problem can occur as a result of severe water or salt depletion or both. Heat exhaustion due to water depletion is acute and is characterized by reduced sweating, "cotton-mouth," increased skin and body core temperatures, muscular weakness, and loss of co-ordination. Heat exhaustion due to salt depletion can cause headache, dizziness, fatigue, nausea, vomiting, diarrhea and syncope. This condition has a slow response time usually taking three to five days to develop. Both conditions can occur in either the acclimatized or unacclimatized athlete.
4. *Heat Stroke* - The most serious condition, heat stroke is a life-threatening situation. The entire thermal regulating system is seriously compromised. Skin and core temperatures reach their highest levels, with core temperature climbing as high as 40° C (105° F). Other symptoms include muscle

weakness, involuntary muscle contractions, vomiting, diarrhea, rapid and shallow heartbeat, hallucinations, convulsions, and finally coma.

Heat Regulation During Exercise

Moderate exercise by untrained and unacclimatized athletes can be performed safely in temperatures ranging from 10-30°C (50-85°F), but high relative humidity can present a danger at temperatures as low as 21°C (70°F). When environmental temperature and humidity reach very high levels, it is not possible to adequately lose the heat produced during exercise.

Muscle contraction during exercise produces a large amount of heat, and therefore body temperature rises. This rise in body temperature triggers an increase in perspiration and blood flow to the skin. But exercise, even of moderate intensity, requires blood flow to be directed to the working muscles. Shunting blood to the muscles at the expense of the skin in hot weather can cause great harm to athletes; they will not be able to adequately dissipate the extreme heat build-up. Blood simply cannot be in two important places at once - the muscles always win. An athlete's only safe choice under these circumstances is to reduce the intensity of exercise, thereby lowering heat production and allowing more blood to reach the skin.

Heat Adaptation

If an important competitive event is to be conducted in an excessively hot and humid environment, research shows that athletes may acclimatize themselves by training at a light to moderate level. With proper heat adaptation and proper training, rowers can safely increase the intensity and duration of exercise in warmer environments.

For example, coaches should use a progressive training program of gradually increasing intensity performed in the heat for 10 to 15 days (see **Training in Hot Weather** below). The program should begin with 20 to 30 minutes of light to moderate work and end with as much as two to three hours of work (or two workouts) on day 15. By following this regimen, athletes can exercise longer and at a higher intensity, although maximal performances will be difficult given the harsh environment.

Research also shows that heat acclimatization is best when hot weather conditions and training are combined; merely resting in the heat produces very little tolerance. Increases in metabolic rate and compatible heat production during training sometimes cause core temperatures to increase to as high as 40°C (105°F). The increase in core temperature [not to dangerous levels of 39-40°C (103-105°F)] is necessary because it promotes the important circulatory and perspiration adjustments that must occur in acclimatization.

Successful heat adaptation causes the following adjustments: 1.) Lower resting core temperature; 2.) lower skin temperature, 3.) decreased exercise heart rate and metabolism, and 4.) increased sweating and evaporative cooling.

Training in Hot Weather

Athletes who typically train and compete in cool weather and low humidity can be better prepared for hot weather competition by following a few recommendations. If they cannot arrive at the site 10 to 15 days prior to competition, hot weather conditions can be simulated by training in excess clothing. Nylon or rubberized suits are not recommended. The athletes should attempt to lose one to three percent of their body weights through water loss (sweating) daily, then replace lost fluids as suggested.

Also, weigh-ins should be accurately monitored before and after practice. The body's water balance and energy stores must be carefully controlled during the days before competition (part of tapering process) and again immediately before competition. Although specific recommendations are difficult to make because individuals acclimatize to the heat at different rates, volume and intensity of workouts in the heat should be reduced by as much as 10 to 40 percent depending on the severity of the heat. For example, if a tapering workout of 1 x 2000m and 1 x 1000m at maximal capacity is planned, following 3000m of warm-up and ending with 2000m of warm-down - both at about 70 percent of maximal capacity - then it might be wise to reduce the 2000m to 1500m and the 1000m to 500m. Increase the rest interval between the two pieces.

The warm-up and warm-down may also be reduced in volume and intensity. For example, a 2000m warm-up and a 1000m warm-down at 60 percent of maximal capacity might be more appropriate. A few starts, a little technique work, and a minimum number of hard strokes should also be included. These methods should also apply to pre- and post-competition as well. Experimentation with the crew's adaptation to heat must not be delayed until the tapering process or until race day. Again, begin the routine of hot weather rowing, either actual or simulated, at least 10 to 15 days before competition.

Dehydration and Rehydration

Among all animals, humans are least able to respond to excessive water loss from the body. Careful planning for rehydration during hot weather training and competition is essential to ensure optimal performances. Although sweating helps to cool the body, it also removes essential elements such as water and sodium from the body. Because water serves as the great chemical solvent in the muscle cell, body water lost as sweat must be replaced as frequently as possible to avoid dehydration and the accompanying heat injuries described earlier. It is not uncommon for rowers to lose as much as two to four percent of their total body weight through water loss in a single workout, which can adversely impact muscular function. In addition, the reduction in circulating blood volume lowers the amount of blood in the heart and decreases the volume of blood the heart can deliver with each beat (decrease in cardiac output). Significant decreases in cellular water can slow metabolic reactions. In order to maintain blood pressure and cardiac output under these conditions, heart rate must increase.

An athlete's thirst mechanism is not very sensitive when large amounts of water are lost through sweating. Athletes who rely on the body's natural response to drink will remain dehydrated. Therefore, the athlete must drink more than what his thirst stimulus dictates. A liter-size squeeze bottle should be standard equipment for any rower during hot weather. An athlete should drink small amounts at frequent

intervals during a training session [e.g., 120 to 177 ml (four to six fl. oz.) every 10 to 15 minutes]. In addition, athletes should drink frequently and generously between workouts and ingest four to five glasses of fluid during the two hours preceding training; this recommendation can also be applied before competition. Athletes should drink more fluid than normal two to three days prior to competition.

Fluid Replacement

All hot weather experts agree that fluid loss must be replaced, but there is wide disagreement concerning the make up of the fluid replacement. Once an athlete is acclimatized to hot weather, sweat usually will have nearly the same concentration of electrolytes (sodium, chloride, potassium, etc.) as the body fluids. However, recent evidence has shown that rehydration with plain water tends to dilute the blood and causes an increase in urine production, thus leading to further dehydration. Also, intake of plain water seems to inhibit the thirst mechanism, which, as reported earlier, is already sluggish in its response to large water losses. Adding electrolytes, specifically sodium, to fluid will allow more water to be retained and at the same time stimulate the thirst mechanism.

Although water is the most important ingredient, some experts recommend that the best combination for replacement drinks contains both sodium and glucose. If blood and muscle sugars (glucose and glycogen) are not maintained, training performances will suffer. The optimum range of carbohydrate concentration in replacement drinks should contain two and one half percent to eight percent, depending upon 1) time of day, 2) intensity of the workout, 3) temperature and humidity, 4) type of clothing worn, and 5) type of drink. Most successful commercial sport drinks contain an optimal mixture of electrolytes and carbohydrates. Also, contrary to popular belief, cold drinks do not retard emptying of stomach from the stomach or cause stomach cramps. Rather, cold drinks appear to move a little more quickly through the gut and also permit more rapid internal cooling.

Most athletes prefer to drink plain water during training and sport drinks between workouts, because exclusive use of a commercial sport drink for all fluid replacement is not economically feasible. Substituting salted water for the sport drink is less expensive and still effective. Simply dissolve one to two grams of salt in a liter of water; this mixture will not have a salty taste. A mixture of lemonade concentrate (355 ml or 12 oz.), water (1,770 ml or 60 fl. oz.), and four grams of salt can serve as a replacement drink as well. Avoid salt tablets under any circumstances because large amounts of salt can irritate the stomach and induce vomiting and diarrhea.

Since muscle glycogen restoration occurs more quickly if one increases carbohydrate intake immediately after exercise, an athlete may have a sport drink containing sodium and carbohydrate at this time. Again, emphasize rehydration at meals and snacks where water, sport drinks, fruit juices, and carbonated and non-carbonated beverages can be consumed. Avoid drinks containing caffeine or alcohol, which further stimulate urine production. [NOTE: Although the super hydrated athlete suffers no performance impairment, it is important not to train or compete on a full stomach.]

Guidelines for Training and Competition in Hot Weather

1. Schedule training and competition during the coolest parts of the day.
2. Plan shorter and less intense workouts at the scheduled race time, especially if competition is set at a time when heat and humidity is predicted to be extreme.
3. Provide at least 48 hours of recovery (light workouts) between high intensity workouts.
4. Allow at least 15 days for adequate acclimatization if athletes will be competing in the heat.
5. Wear light-colored, loose fitting clothing, preferably of cotton or a cotton-blend fabric with a loose weave design. Do not wear wet clothing because it reduces heat loss.
6. Do not restrict fluids before, during, or after training or competition.
7. Weigh in without clothes before and after each workout to determine extent of water loss. For each kg (two pounds) of body weight lost during a workout, drink at least one liter of fluid, excluding the first kg (e.g., 2 kg lost=1 liter replacement, 3 kg lost=2 liters replacement). Usually athletes with a two percent deficit of water weight before the next practice should be excused from that practice.
8. Note urine color and frequency of urination during hot weather - a lighter urine color and more frequent trips to the toilet indicate adequate rehydration.
9. Emphasize plain water during actual training and sport drinks composed of sodium mixed with two and one half to eight percent glucose or sucrose between workouts (for very long workouts, two hours or more, a six to eight percent concentration is recommended).
10. Drink at least one glass of fluid every 10 to 15 minutes during a workout, and four to five glasses during the two hours preceding a workout or competition.
11. If intense sun exposure is unavoidable during training and/or competition, wear a hat and sunglasses.
12. If symptoms of heat intolerance become evident, suspend exercise and seek medical help immediately.

References

1. Costill, D.L., and K.E. Sparks. Rapid fluid replacement following dehydration. *J. Appl. Physiol.* 34:36-43, 1973.
2. Convertino, V.A., J.E. Greenleaf, and E.M. Bernauer. Role of thermal and exercise factors in the mechanism of hypervolemia. *J. Appl. Physiol.* 48:657-664, 1980.
3. Coyle, E.F. A.G. Coggan, M.K. Hemmert, and J.L. Ivy. Muscle glycogen utilization during prolonged strenuous exercise when fed carbohydrate. *J. Appl. Physiol.* 61: 165-172, 1986.

4. Fox, E.L., R.W. Bowers, and M.L. Foss. The physiological basis of physical education and athletics. 4th edition, Saunders College Publishing, Philadelphia, 1988.
5. Fortney, S.M., C.B. Wenger, J.R. Bove, E.R. Nadel. Effect of blood volume on forearm venous and cardiac stroke volumes during exercise. *J. Appl. Physiol.* 55: 884-890, 1983.
6. Gisolfi, C.V. and C.B. Wenger. Temperature regulation during exercise: Old concepts, new ideas. In Terjung, R.;J. (ed), *Exercise and Sport Sciences Reviews*. Vol. 12. The Collamore Press, Lexington, 1984.
7. Gisolfi, C.V. (ed). Symposium on the thermal effects of exercise in the heat. *Med. Sci. Sports.* 11 (1): 30-71, 1979.
8. Morimoto, T., K. Miki, H. Nose, S. Yamada, K. Hirakawa, and C. Matsubara. Changes in body fluid and its composition during heavy sweating and effect of fluid and electrolyte replacement. *Jpn. J. Biometer.* 18: 31-39, 1981.
9. Nadel, E.R., S.M. Forney, and C.B. Wenger. Effect of hydration state on circulatory and thermal regulations. *J. Appl. Physiol.* 49: 715-721, 1980.
10. Nose, H., G.W. Mack, T. Yawata, and T. Morimoto. Recovery of blood volume and osmolarity after thermal dehydration in rats. *Am. J. Physiol.* 251: 492-498, 1986.
11. Nose, H., G.W. Mack, X. Shi, and E.R. Nadel. Role of osmolarity and plasma volume during rehydration in humans. *J. Appl. Physiol.*, in press.
12. Rowell, L.B. Human cardiovascular adjustment to exercise and thermal stress. *Physiol. Rev.* 45 (1): 75-159, 1974.