

Preventing Heat-Impaired Performance

- Running a marathon in hot weather is very difficult.
 - NY Marathon: November
 - Boston Marathon: April
 - Las Vegas Marathon: December
- Pre-cooling of active muscles prolongs endurance time to exhaustion.
 - Keeps core temperature low
 - Elevated core temperature leads to exhaustion
 - ...Or, cooling of blood to the brain

Preventing Heat-Impaired Performance

- Sponging the body
 - Seems to be an effective cooling technique
 - Lowers skin temperature

Ingesting Fluids

- Before exercise
 - Humans cannot store fluid (to any great extent) to reduce future dehydration.
 - Camels can store water up to 30% of their BW.
 - Humans cannot exercise if they are dehydrated by more than 10% BW.
 - Death occurs at dehydrated states of 20% BW or greater.
 - Goal of pre-exercise drinking:
 - Ensure appropriate levels of hydration at the start of exercise.
 - Overdrinking simply leads to more frequent bathroom breaks.
 - Potentially leading to a loss of sodium.
 - Monitor hydration levels via urine color.
 - Very lightly colored.
 - It takes about 1-2 hours for fluid to be fully absorbed and influence urine color.
 - Suggestion: Drink up to 2 hours before the race then 400-500 ml of fluid as close to start.

Ingesting Fluids

- During exercise
 - Joseph Forshaw, 4th 1908 Olympic Marathon:
 - "I know from actual experience that the full race can be covered in creditable time without so much as a single drop of water being taken or even sponging the head."
 - Jim Peters, Elite Marathon runner:
 - "...there is no need to take any solid food at all and every effort should also be made to do without liquid, as the moment of food or drink is taken, the body has to start dealing with its digestion, and in so doing some discomfort will almost invariably be felt."

Ingesting Fluid

- Current recommendations:
 - 150 – 300 ml every 15 minutes (ACSM).
 - 600-1200 ml per hour
 - Rate of fluid ingestion should match sweat rate (ACSM).
 - Runners are encouraged to consume the maximum amount that can be tolerated.
- *Evidence based?*

Ingesting Fluid

- What changed?
 - Wyndham and Strydom (1969) reported that body temperatures increased in runners who became dehydrated by more than 3% of their body weight.
 - Runners took in about 100 ml of fluid per hour.
 - Conclusion: dehydration is detrimental to endurance performance.
 - Challenge: there are several parameters that change as body temperature increases.
 - Intensity of exercise is an important factor that influences body temperature.

Ingesting Fluid

- During exercise
 - High body temperatures leads to detrimental endurance performance.
 - Ingesting fluid during exercise is a mechanism to help maintain body temperature.
- How much?
 - Ingestion equal to sweat rate
 - For each liter of unreplaced fluid
 - Rectal temperature increases by 0.3 °C
 - HR increases 8 bpm
 - Qc decreases by 1 L/min
 - Laboratory vs. Competitive experiment models
 - Finishing BW are higher than athletes who do not drink as much.
 - Does the extra BW have a detrimental effect on performance?
 - How much loss in weight is dehydration?
 - A portion of weight loss is fuel used.
 - If BW is maintained, then athletes are actually overhydrated.

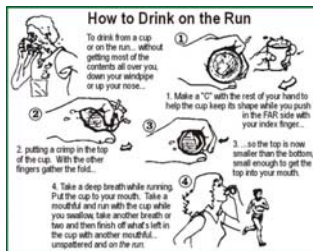
Calculating Sweat Rate

- WB: Weight before exercise
- WA: Weight after exercise
- F: Fluid intake during exercise
- RT: Running time (hours)

$$\text{Sweat Rate (L/hr)} = (\text{WB} - \text{WA} + \text{F}) / \text{RT}$$

Fluid Ingestion

- It is a challenge to drink 600 ml of fluid per hour during running.



Fluid Ingestion

- You probably get about 200 ml per cup of water handed out at aid stations.
- For a marathon, there may be an aid station every 1-2 miles.
- For other events (e.g., ½ marathon, 10 K) aid stations may not be as frequent.
- Noakes suggests drinking ad libitum may be sufficient.
 - Have a fluid intake plan pre-race.
- There is some evidence that runners may benefit from 'swishing' water and spitting it out.
 - Evidence supporting Central Governor Model?

Hyponatremia

- Decreased concentration of sodium in blood.
- Can be caused by over-hydration.
 - Excessive fluid intake before and during exercise.
 - It does not seem that hyponatremia is caused by excessive loss of sodium.
- Can lead to death.
- Hyponatremia is a bigger problem than dehydration.
 - Especially for the non-elite runners who are running at slower speeds.
 - The slower speeds allows them to drink more at aid stations.
 - Hydration strategies must be adjusted.

Hyponatremia

- Noakes:
 - "The reason why athletes drink too much is almost certainly due to hysteria attached to the supposed dangers that dehydration poses to athletes and the belief that fatigue is caused by dehydration so that replacing more fluid than is lost during exercise will ensure optimum performance. I find no scientific support for either belief."

Ingesting Fluid

- Electrolyte content of fluid
 - It would seem reasonable to match the electrolyte lost in sweat.
 - Electrolytes are chemical substances that are vital for the normal functioning of cells.
 - E.g., Sodium, potassium, magnesium, chloride
 - Most sports drinks have 20 mmol of sodium per liter.
 - ~400 mg/L
 - Noakes argues that this is inadequate and should be as high as 60 mmol of sodium per liter.
 - » Taste problem.
 - » Anecdotal stories: Chicken broth, pretzels

Ingesting Fluid

- Carbohydrate and Fat content of fluid
 - Factors that influence gastric emptying rate (Table 4.1)

- The data are based on drinking one time vs. repeated drinking.
- With repeated drinking, the stomach remains distended and higher rates of gastric emptying can be achieved.
 - Differences in gastric emptying rates can be minimized by repeatedly drinking.
 - The most important factor determining gastric emptying rate is volume of solution in the stomach, not carbohydrate content.
 - How do you drink enough but not be at risk of hyponatremia?
 - Most runners are not at risk ... only those consuming more than 1 L/hr for long periods of time.

Fluid Ingestion

- During recovery
 - Increasing the sodium content of the fluid during recovery increases rate of rehydration.
 - Drink should have about 25 mmol per liter of sodium.
 - Volume should be about 25-50% of the total fluid deficit.

The Ideal Sports Drink

- Carbohydrate content: 7.5-12% (depending on rate of drinking)
- Carbohydrate type:
 - Anything but fructose
- Sodium content
 - 60 mmol/L

The Ideal Sports Drink

- Something that is palatable.
 - It is no good if you can't drink it.
- Carbohydrate concentrations:
 - 5-10%
 - What can be tolerated?
 - Higher concentrations may be more appropriate near the end of a race when the athlete does not want to drink anymore.
- Carbohydrate type:
 - A mixture of carbohydrate sources.
 - Increases palatability.
- Sodium concentration:
 - 20-60 mmol/L