Rehydration strategies for maximizing sports performance

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Water & Its Function

- As structure to cells
- As body fluids:
  - saliva, blood, digestive juices, etc.
- As solvent & transport for nutrients and waste products
- As padding/lubrication:
  - joints, spinal cord, GI tract
- As thermoregulation media

Without these functions, we cannot survive!
Water: 60-70% of body weight

Water = 2/3 of body weight
Terms in Water Balance

- **Euhydration**
  - Water in = Water out

- **Dehydration**
  - Water in < Water out
  - *body doesn't have enough water and other fluids to carry out its normal functions.*
  - *Without replenish lost fluids, you may suffer serious consequences*

- **Overhydration (Over 1.5 L/hr)**
  - Water in >> Water out
  - Hyponatremia induces feeling blotted and cause too frequent urine brakes that may interfere with pregame activities

- **Rehydration**
  - What we have to do during and after the game
  - Too little may lead to dehydration during completion and therefore, decreased performance
Shall we trust “thirst”?

- The body’s thirst mechanism *lags behind* dehydration
- By the time you are thirsty, you are already dehydrated
- Therefore, thirst is not a good indicator of hydration
Urine Color: A Good Indicator

**ARE YOU DEHYDRATED?**

<table>
<thead>
<tr>
<th>Check Your Urine</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 3</td>
<td>1</td>
</tr>
<tr>
<td>Well hydrated</td>
<td></td>
</tr>
<tr>
<td>4, 5</td>
<td>2</td>
</tr>
<tr>
<td>Hydrated but not well</td>
<td></td>
</tr>
<tr>
<td>6, 7, 8</td>
<td>3</td>
</tr>
<tr>
<td>Dehydrated - You need to</td>
<td></td>
</tr>
<tr>
<td>drink more</td>
<td>4</td>
</tr>
</tbody>
</table>

- Consume adequate fluids daily
  - clear urine every 2-4 hours
  - dark colored, infrequent urination indicates dehydration

https://www.slideshare.net/mrrobbo/dehydration-fluid-presentation
Main Regulators on Body Water

- **Skin:** Surface area, Sweat Gland Density
- **Kidneys:**
  - excrete 60 ml/hr (lower at night & during exercise)
  - Void 1-2 hrs after drink
- **Lungs:**
  - Water (vapour) loss during breathing out
  - Thus, more water loss during exercise
- **Heart:**
  - Dehydration $\rightarrow$ Viscous blood $\rightarrow$ Higher Cardiac Work
- **Hormones:**
  - ADH: Anti-diuretic Hormone
    - Secreted when blood concentration of ions rises
  - Aldosterone:
    - Regulate Sodium
- **Thirst center:**
  - Late responses
<table>
<thead>
<tr>
<th>Source</th>
<th>Amount (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLUID INTAKE</td>
<td>1.5</td>
</tr>
<tr>
<td>IN FOOD</td>
<td>0.8</td>
</tr>
<tr>
<td>METABOLIC</td>
<td>0.3</td>
</tr>
<tr>
<td>INSENSIBLE</td>
<td>0.8</td>
</tr>
<tr>
<td>SWEAT</td>
<td>0.1</td>
</tr>
<tr>
<td>FECES</td>
<td>0.2</td>
</tr>
<tr>
<td>URINE</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2.6</strong></td>
</tr>
</tbody>
</table>

**Total** 2.6
Skin: Major site for Water Loss

- Skin surface area (BSA, m$^2$) = $0.20247 \times \text{height (m)}^{0.725} \times \text{weight (kg)}^{0.42}$
- Sweat glands are not equally distributed throughout the skin.
Water for Heat Transfer

**Evaporation**
Loss of heat by evaporation of water

**Radiation**
Emission of electromagnetic radiation

**Convection**
Moving air removes radiated heat

**Conduction**
Direct transfer by contact

Exhalation with Warm & Moist gases

Skin

Air

H₂O

Wet air

Dry air

25°C

35°C

Journal of Medical Engineering & Technology  Volume 33, 2009.
Water Regulates Balance between Heat Gain & Heat Loss

[Diagram showing the balance between heat gain and heat loss through various mechanisms such as metabolic heat, environmental heat (conduction, convection, radiation), radiation, conduction, convection, and evaporation.]
To Estimate Heat Loss

Efficiency = output/input * 100

~ 20-25% as work done
~ 75-80% as heat loss
We Loss More Water during Exercise.

- Water loss to environment as sweat
- Water vapour (47 mmHg at 37°C) loss via moisten air during breathing out
- Thus, ↑ breathing rate during exercise increases water loss via the lungs
- Amounts of sweat & vapour loss will depend on
  - Exercise intensity, Body surface area, air temp, humidity

Sweating is the primary avenue of heat loss during exercise.

Types of Food Intake Adds Body Water

- 100 gms of fat oxidation gives 113 gms of water
  - \( C_{16}H_{32}O_{2} + 230_{2} \rightarrow 16CO_{2} + 16H_{2}O \)
- 100 g of protein combustion gives 42 gms of water
  - \( C_{362}H_{86}N_{104}O_{104}S + 380O_{2} \rightarrow 52H_{2}NCONH_{2} + 310CO_{2} + 188H_{2}O + H_{2}SO_{4} \)
- 100 g of Carbohydrate combustion gives 55 gms of water
  - \( C_{6}H_{12}O_{6} + 6O_{2} \rightarrow 6CO_{2} + 6H_{2}O \)

This is why carb and protein diets were popular for weight reduction
But we still need complex carbs for energy & brain food!!

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2) g H\textsubscript{2}O produced per g oxidized</th>
<th>(3) g H\textsubscript{2}O produced per 10,000 kcal</th>
<th>(4) mol O\textsubscript{2} needed per 10,000 kcal</th>
<th>(5) g H\textsubscript{2}O lost in breath for 10,000 kcal</th>
<th>(6) g H\textsubscript{2}O lost in breath per g oxidized</th>
<th>Column (2) minus Column (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>glycogen</td>
<td>4.1</td>
<td>0.55</td>
<td>1341</td>
<td>90</td>
<td>1700</td>
<td>0.70</td>
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<tr>
<td>fat</td>
<td>9.3</td>
<td>1.13</td>
<td>1215</td>
<td>98</td>
<td>1800</td>
<td>1.72</td>
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<td>0.42</td>
<td>1021</td>
<td>115</td>
<td>2110</td>
<td>0.86</td>
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<tr>
<td>ethanol</td>
<td>7.1</td>
<td>1.17</td>
<td>1650</td>
<td>92</td>
<td>1700</td>
<td>1.24</td>
</tr>
</tbody>
</table>

Columns (1) standard energy values uncorrected for losses in digestion, (2) calculated from oxidation schemes in text, (3) calculated from (1) and (2), (4) calculated from oxidation schemes in text and (1), (5, 6) calculated from (1) and figures given by Schmidt-Nielsen for respiration of camel.
H₂O Intake for Normal Person

For a 70 kg person;
- Male: 3000-3500 ml/day
  250 ml * 12 to 14 cups
- Female: 2000-2500 ml/day
  250 ml * 8 to 10 cups

Formula for daily water intake (DWI):
- Non-athlete: DWI = 30+ ml per Kg body weight
- Athlete: DWI = 40+ ml per Kg body weight
Water & Performance

- Water loss affects performance
  - Diminished water content in the blood causes:
    - ↓ ability to transport oxygen and nutrients to cells/organs
    - ↓ ability to get rid of carbon dioxide from metabolism
      - Accumulation of CO2 causes ↓ muscle contraction
    - ↓ ability to get rid of excess heat from working muscles causing increased body temperature
      - Core temp > 39.5 °C……..risks of heat stroke
  - Body/cells must have a consistence temperature to function properly (homeostasis)
  - Loss of fluid causes cells to shrink (crenation) which affects their normal function

During heavy exercise: losses up to 4 lb/hour possible

Thermoregulation is immediately affected.
Paradigm Shift

- Before the 1970s, athletes were advised not to drink during competitive events.
  - It is believed to cause “stomach cramp”

- During the following two decades,
  - Published data indicating that dehydration, defined as an exercise weight loss greater than 2%, could impair performance.

Thus, new drinking guidelines emphasized on the importance of early and regular drinking to stay ahead of thirst, minimize weight loss, and maintain performance.

- Unfortunately, these early recommendations led some people to overhydrate, resulting in gastric discomfort and water intoxication or hyponatremia.
Sites of Water Loss during Exercise

Exercise

Muscle contraction

↓

Heat produced

compensation

↓

Water loss via sweating

Limited by skin surface, numbers of sweat gland

Exercise

Needs of Oxygen

↓

↑Gas Ventilation

compensation

↓

Water loss via expiration

Limited by highest respiratory rate

Water loss
Sweat Glands & Physical Training

- Approximately 2–3 million glands
- Constant by 2–3 years of age
- Sweat gland density decreases with skin expansion during growth and is generally inversely proportional to body surface area
- With habitual activation, sweat glands show some plasticity in their size and neural/hormonal sensitivity, which in turn impact sweat rate and sweat [Na]

Athletes & Non-Athletes

- With compensations of active Sweat glands
- Athletes greatly increase their water loss
  - Large increases in sweat loss
  - With decreases in urine loss
- Athletes need to greatly increase water intake than non-athletes

Incorrect methods in athletes’ weight reduction:
- Smaller increases in food water and metabolic water
- Ignore adequate amounts of fluids to maintain optimal hydration status
Sweating

- Evaporate 1 L of sweat = 580 Cal (heat out)
- Maximally, approx 2 L of water can be evaporated

How many L of water we can safely lose?
Heat Production during Exercise

For a 70 kg subject, running for 1 hr

- 900 Cal expended
- Mechanical efficiency = 20% or 180 Cal movement,
- Another 720 Cal as heat

Since body specific heat = 0.83 Cal/kg/deg C
Then 720 Cal in a 70 kg man would produce heat = \((720/70)/(0.83)\) = 12.4 deg C (or 22 deg F)
A man can not tolerate with 37 + 12.4 °C……………………….Death

Evaporation via Sweating is critical to prevent excessive heat build up!
Not only water, but also electrolytes

- The main way to regulate body water gain is by adjusting the volume of water intake, mainly by drinking more or less fluid.
- Thirst center in the hypothalamus governs the urge to drink.

- While water out:
  - Amounts of water and solutes are lost through urine, sweating and exhalation
  - Amount of urinary Na (and Cl) loss is the main determinant of body fluid volume
First Water, then Electrolytes Loss

Absolute whole-body sweating rate (L/h)

Relative whole-body sweating rate (mL/kg/h)

Forearm sweat [Na+] (mmol/L)

Predicted whole-body sweat [Na+] (mmol/L)
Water Loss & Exercise: How serious?

- Pre – Post-exercise body weight
- Degrees of water loss:
  - Estimated from Pre and post-exercise body weight diff.
  - 2-3% body weight water loss: optimal, most preferred
    - May cause ↓ muscle endurance
    - Just simply drink until the pre-work out weight is reached.
  - 4-6% body weight water loss
    - muscle strength, endurance, muscle cramping
    - conscious deterioration
  - > 7% body weight water loss → medical emergency
    - Severe heat cramp, exhaustion, heat stroke
    - ↑ risk of severe & permanent brain damage……death

Less Water, Low Performance

3-5% drop in body weight
8-10% drop in performance
↓ Stroke volume
↓ Cardiac output
↓ Oxygen to cells
↓ Muscle cramping

Water
Heart
Muscle

Journal of Sport and Health Science Volume 4, Issue 4, 2015, Pages 357-363
Signs of Dehydration

Mild Dehydration
- Thirst
- Sudden wt. Loss
- Dry mouth, throat, body linings
- Rapid pulse
- ↓ B.P.
- Weakness
- Dark, infrequent urination

Severe Dehydration
- Pale skin
- Bluish lips and fingertips
- Confusion
- Rapid, shallow breathing
- Weak, rapid, irregular pulse
- Shock; seizures
- Coma; death
Athletes’ Habit & Water Balance

“While it is possible to live for several weeks or even months without food, our bodies can feel the effects of water deprivation within as little as 30 minutes.”

“Athletes do not voluntarily drink sufficient water to prevent dehydration during physical activity.”

Thirst is a delayed response to dehydration.
Thirsty athletes are already dehydrated.

Water & Calories Needed during Activity

- 1 ml / Calorie expended
  - When you exercise, look at Cals expended of the activity
  - Approximately, Water needed (ml) = Your Cals

- For example: Participated in a 200 Calories exercise
  - Your Water needed during that activity = 200 ml
  - Before, during and after?

### Table

<table>
<thead>
<tr>
<th>Activity</th>
<th>Men 150 lbs</th>
<th>190</th>
<th>230</th>
<th>125 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>volleyball</td>
<td>134</td>
<td>152</td>
<td>175</td>
<td>109</td>
</tr>
<tr>
<td>ping pong</td>
<td>134</td>
<td>152</td>
<td>175</td>
<td>109</td>
</tr>
<tr>
<td>golf</td>
<td>150</td>
<td>171</td>
<td>197</td>
<td>122</td>
</tr>
<tr>
<td>tennis</td>
<td>234</td>
<td>266</td>
<td>307</td>
<td>190</td>
</tr>
<tr>
<td>basketball</td>
<td>268</td>
<td>304</td>
<td>350</td>
<td>218</td>
</tr>
<tr>
<td>touch football</td>
<td>268</td>
<td>304</td>
<td>350</td>
<td>218</td>
</tr>
<tr>
<td>soccer</td>
<td>334</td>
<td>380</td>
<td>438</td>
<td>272</td>
</tr>
</tbody>
</table>

### Ladies

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<td>272</td>
</tr>
</tbody>
</table>

### Sports

- WhyExercise.com
Strategies for Avoiding Dehydration

As a coach:

- Understand each athlete’s sport dynamics
- Fluid accessibility
- Establish athlete’s acclimatized state
- Non-Acclimatized athletes → sweat more, lose more electrolytes
- Establish a hydration protocol for athletes
- Determine individual sweat rate: 2% wt loss is optimal
- Tracking changes in body weight (pre-post)
- Anticipate high risk conditions
  - High temperature
  - Uniform/clothing effects
  - High humidity, Indoor sports, Low air movement, Bright sun,
Strategies for Avoiding Dehydration

Monitoring tools:

- Dark-Salty colored clothing
  - Sweat-stain black T-shirt is easily recognized
- May also account for urine volume
- Urine color or urine specific gravity

<table>
<thead>
<tr>
<th>1, 2, 3 Well hydrated</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>4, 5 Hydrated but not well</td>
<td>2</td>
</tr>
<tr>
<td>6, 7, 8 Dehydrated - You need to drink more</td>
<td>3</td>
</tr>
</tbody>
</table>

Table:

- 1:
- 2:
- 3:
- 4:
- 5:
- 6:
- 7:
- 8:
Strategies for Avoiding Dehydration

Practical Tips:

- Emphasize continual fluid replacement
- Individual practice fluid replacement
- Gradually increase fluids
- Body adapts to increase fluid consumption
- Generally, cold fluids more rapidly absorbed
- Use individual clear bottles for visual monitoring
- Old Rule of Thumb: 0.5-1 cup per min
Preventing Dehydration before Exercise:

Before exercise:
- Recommend 5-7ml/kg water about 2-3 hrs before exercise
  - To ensure well-hydrated condition
- Prior to exercise:
  - Void urine (to unload extra weight)
    - Kidneys need 90 min to process fluids
  - Drink 1/2-1 cup of water just before the game
  - Cold water absorbed more quickly
- Start exercise

**ACSM’s HEALTH & FITNESS JOURNAL. 17(4); 2003.**
During Exercise:

- **During exercise**
  - Drink when feel thirst as early as possible
  - Don’t rely on thirst alone (mechanism blunted during ex)
  - After 1 hr of the run,
    - Small amount at a time (Sip): 150 - 350 ml fluid every 15 to 20 min during endurance activity
    - Drinking not >800 mL per hr, to prevent the risk for developing dilutional hyponatremia
    - Electrolytes plus 6-8% CHO drink is possibly needed.
  - During extreme weather conditions, fluid intake and pace may require additional adjustment

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ACSMT’s HEALTH & FITNESS JOURNAL. 17(4); 2003.
Additional Daily Water Requirements

- **Dryness of climate**
  add + 16 oz (500 ml)

- **Have caffeinated beverages**
  add + 8 oz (250 ml)

- **Strenuous exercise**
  add + 16 oz (500 ml)

- Not in just 1 time but divided by the number of hours you're awake

- Therefore, a 70 kg person who works out under dry condition
  - should drink extra water \( 500 + 500 = 1000 \text{ ml} \)
After Exercise:

- **Drink 16 to 24 oz of fluid for every pound lost** to replace fluid loss in 2 hrs.
- Complete fluid replacement needs 8-12 hrs for the next exercise training.
- CHO repletion after exercise: 1g/Kg within first 2 hrs, then high CHO diet thereafter (65-70%).
- Post exercise fluids should be high glycemic index fluids (low fructose).
- Protein-CHO combination may increase glycogen re-synthesis (3g CHO:1g prot) ............ will speed rehydration.
- Salt supplement tablets are not generally recommended (gastric irritation and excess fluid retention).

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[Image: Electrolyte drink after exercise, Next meal]

[Source: https://www.slideshare.net/mrrobbo/dehydration-fluid-presentation]
After Exercise:

After exercise:

- Metabolic waste products are mostly acids.
- Drinks at immediate post-exercise should considerably minimized acidity.

The pH Scale

- Hydrochloric acid: Most acidic
- Vinegar: Tomato
- Water: Baking soda
- Milk: Blood
- Soap: Drain cleaner

Source: https://www.slideshare.net/mrrobbo/dehydration-fluid-presentation
To estimate individual’s sweat rate

- **Step 1:** Pre-exercise body weight = \( \ldots \cdot x \ldots \) kg
- **Step 2:** Post-exercise body weight = \( \ldots y \ldots \) kg
- **Step 3:** Pre – Post exercise body weight = \( \ldots x - y \ldots \) unit kg
- **Step 4:** Convert \((x - y)\) kg to ml = \((x - y) \times 1000\) ml
- **Step 5:** Enter the amount of fluid consumed during the run = \( z \) ml
- **Step 6:** Add \( z \) ml to Step 4 = \((x - y) \times 1000 + z \ldots \) unit ml
- **Step 7:** Total duration of the run = \( t \) min
- **Step 8:** Sweat rate = \(\frac{(x - y) \times 1000 - z}{t} \ldots \) unit ml / min

https://www.slideshare.net/mrobbo/dehydration-fluid-presentation
Water & Electrolytes: Lessons Learnt

- 1999 New Zealand Ironman Ultradistance
  - 18% of finishers were hyponatremic (low Na)
    - 45% females .......... hyponatremic
    - 14% males ............. hyponatremic
  - *Adequate water intake but inadequate electrolytes replacement*

- 2002 Boston Marathon
  - 13% with hyponatremia
  - 0.6% with critical hyponatremia (3 runners)
Low Sodium (Hyponatremia)

- **Causes:**
  - Excessive sodium loss in sweat via sweating “salty sweaters” or
  - Drink too much water (Overhydrated)
    - Thus, fluid intake should not *too much* exceed losses
- **Risk Factors**
  - When exercises under heat stress environment
  - Repeated days of hard training
- **How to recognize?**
  - Athletes become slower, take too long duration to finish
  - Athletes who are non-acclimatized to training
  - Athletes with small body weight (females)

*In well-trained athletes: 4 liters of sweat contains 3-7g sodium*

1 teaspoon Salt contains 2g Na

*hard repeated training athletes may need 2 teaspoons a day.*
Sweat is always more diluted than blood

During 1\(^{st}\) hr exercise:
  - we loss water > electrolytes
  - Blood becomes hypernatremia (less water, high Na)
  - Thus, no need to add electrolytes at this phase

During 2\(^{nd}\) hr of exercise:
  - we loss more and more electrolytes (Kidneys can not reabsorp Na, Cl properly)
  - Blood becomes hyponatremia (less Na, high water)
  - We, now, need to add electrolytes at this phase

Na and Cl (ECF) are lost in sweat

Losses of Na, K, Ca, Mg and P are easily replaced in normal diet

Sports drinks supply electrolytes just in the event of heavy losses
  - Severe sweating
  - Mostly at the end of an exhaustive run
Electrolytes

- Charged atoms (ions) that conduct electrical current
- Involved with fluid balance:
  - Sodium (Na+) extracellular fluid
  - Potassium (K+) intracellular fluid:
    - Very important in:
      - the generation of electrical impulses to nerves
      - muscle contraction
      - transport of glucose into the muscle cells
      - glycogen storage

Electrolytes Imbalance → Performance ↓
Do all athletes need electrolytes?

- Most athletes do NOT need additional electrolytes
- Exception is for very high sweat losses (> 1 hr or under heat stress conditions)
- Replacement with excessive amounts of pure water can lead to hyponatremia (water intoxication)
  - Fainting, seizures, death (brain swelling)
- When lots of sodium loss in sweat occurs (= fails compensation)
- This also significantly decreases glycogen stores
- Sports drinks may be a good option for fluid replacement during exercise lasting over 2 hours and for exercising in the heat
Sodium Facilitates Glucose Absorption

- **With Sodium**, Glucose (G) rapidly absorbed in our gut and utilized by muscle
- Fructose (F) more slowly absorbed and utilized by liver to replace liver glycogen
- Sucrose (G-F), Glucose Polymers lower osmolarity than simple sugars and may allow for more rapid water absorption
Sports Drink Helps

- Sports drinks may help to replenish lost sodium and glycogen stores
- Sports drinks during exercise helps to reduce muscle cramping during exercise especially in salty and heavy sweaters.
  - One cause of muscle cramping is an electrolyte imbalance caused from fluid and sodium loss from sweating.
- Another cause of muscle cramping is muscle fatigue
- It is vital to assure proper intensities during training that match intensities during competition to prevent fatigue that may lead to cramping
Sports Drink

- contain CHO to maintain glycogen
- more than 8-10% CHO
  - water drawn osmotically into the intestine
  - bloating, cramping, and diarrhea (osmosis)
- 6-8% CHO solution is best (less gastric distress)
  - encourages more consumption and is absorbed quickly (12-20g CHO/cup)
    - Application: fruit juice diluted 1:2 with water
- Glucose polymers in sports drinks are quickly absorbed
- Sodium content of 460-690mg/liter is recommended to replace sodium loss and encourage further drinking since sodium tend to induce thirst
- Exercise >60 min, CHO drinks are needed to enhance endurance
Sports Drink Works After Exhaustion

<table>
<thead>
<tr>
<th>Compositions</th>
<th>Sports drink</th>
<th>Placebo</th>
<th>Water</th>
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<tbody>
<tr>
<td>Volume per bottle ml</td>
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<td>250</td>
<td>250</td>
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<tr>
<td>Total energy</td>
<td>120</td>
<td>120</td>
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<tr>
<td>CHO, %, g.</td>
<td>10, 29</td>
<td>10, 29</td>
<td>-</td>
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<tr>
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<td>7.0, 18.45</td>
<td>-</td>
</tr>
<tr>
<td>Dextrose, %, g.</td>
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<td>4.0, 10.55</td>
<td>-</td>
</tr>
<tr>
<td>NaCl, %, g.</td>
<td>0.13, 0.33</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>KCl, %, g.</td>
<td>0.03, 0.075</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Osmolarity m.Osm/L</td>
<td>153-168</td>
<td>100-155</td>
<td>-</td>
</tr>
</tbody>
</table>

* Manufactured products from T.C. Pharmaceutical Industries CO., LTD.
Sports Drink Works After Exhaustion

- Sports drink enhanced/offered
  - Better Cardiac function (EF) but lower work of breathing (VE)
  - Higher Fat and Carb oxidation rates
  - Higher work done
  - Longer time to exhaustion

**Figure 3** Comparisons of work done up to 70% VO_{2peak}, work done up to exhaustion and total work done during endurance exercise in Water Blue, Placebo Red and Sports drink Green.  *a*: p < 0.05 between WT-PL;  *b*: between WT-SD.

**Figure 4** Comparisons of time to exhaustion during endurance exercise in Water WT, blue, Placebo PL, red and Sports drink SD, green.  *b*: p < 0.05 between WT-SD
Sports Drink Works After Exhaustion

- Sports drink enhanced/offered
  - Better Cardiac function (EF) but lower work of breathing (VE)
  - Higher Fat and Carbohydrate oxidation rates
  - Higher work done
  - Longer time to exhaustion
Make Your Own Sports Drink

- Example of a sports drink recipe
- 1/3 cup sugar
- 1/4 teaspoon table salt
- Flavor to taste – use orange juice, lemon juice, etc
- *Keep refrigerated, WHY?*
Effective Drinking Temperature

- Comparing among drinking waters with different temperatures:
  - **NW**: no water supplementation
  - **AW**: ambient temp water (27°C)
  - **BW**: body temp water (37°C)
  - **CW**: cold water (4°C)
  - **WW**: warm water (45-50°C)
Core and Skin Temperatures

Skin thermistors
(New YSI 400 series, Japan)

Core thermistors
(Ingestible Thermometer Pills HQ Inc)
Temperatures of Sports Drink

- Cold drink offers lower core temperature and facial sweat rate
- Cold drink minimizes risk of overheated in those who covered most of skin surface.
Conclusion on Rehydration Strategies

■ Aims:
  ● To prevent performance declined is to prevent early fatigue
  ● To prevent fatigue is to reduce chance of dehydration.

■ Training with Pre – Post Body Wt > 2% is not good.

■ Prior to exercise:
  ● Always begin exercise with well hydrated.
  ● No need to try to super-hydrate at pre-exercise.
    ● Over-drink will inconveniently cause frequent urination.
  ● A wise tactic is to tank-up two or more hours pre-exercise;
    ● Allows time for kidneys to work and eliminate excess fluid
    ● But ensure well-hydrated condition.
  ● Then drink 1 cup again 5 to 15 minutes pre-exercise.
Conclusion on Rehydration Strategies

- During exercise:
  - Thirst is not a good indicator,
  - Unsalty sweat appears during the 1\textsuperscript{st} hour
    - Provide clear water
    - Regularly Sip small amount at a time (150 - 350 ml) fluid every 15 to 20 min during endurance activity
    - But not >800 mL per hr,
  - For the 2\textsuperscript{nd} hour: salty sweat phase
    - Drink Electrolytes plus 6-8\% CHO (yellowish water)
    - Under extreme weather conditions, may require more fluid-electrolytes
Conclusion on Rehydration Strategies

- After exercise:
  - Drink 16 to 24 oz of fluid/pound lost
  - Finish this fluid replacement in 2 hrs
  - Wait for 8-12 hrs before the next exercise training
  - CHO 1g/Kg within first 2 hrs, then high CHO diet
  - Speed up rehydration with Protein-CHO combination
  - No need for Salt supplement tablets
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