Fluids, Electrolytes and Temperature Regulation

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Purpose: To examine the relationship between varying intensity of training and its effect on changes in hydration status, core temperature, sweat rate and composition and fluid intake in professional football players training in the heat

Materials and Methods:
13 high performance male football (soccer) players
3 training sessions within 3 consecutive days with varying intensities under hot conditions (80 degree F)
Measurements of: fluid intake, fluid loss, core temperature, hydration status, sweat composition and movement demands
Hydration, sweat and thermoregulatory responses to professional football training in the heat

**Results:**
- Higher sweat rates associated with higher intensity training and game simulation
- Sodium and potassium losses are associated with increased total distance covered
- Increased mean speed associated with increased core temperature
- Self-selected hydration strategies do not result in adequate hydration
Discussion and Conclusion
Participants rarely consumed adequate fluid to match sweat loss, therefore this study provides evidence and information to coaches and trainers to increase awareness of player activity and environment condition to develop post-session hydration and recovery strategies for team sport athletes.

Limitations
- Increase in humidity on day 3, game simulation- increase sweat rates
- Small sample size
- Doesn’t compare results or findings to a control group
Purpose: Compare the rehydration capabilities between a BCAA-electrolyte beverage, carbohydrate-electrolyte beverage, and flavored water in dehydrated athletes

Materials/Methods:
20 men and women with 1 year endurance/strength training
Dehydration achieved through exercise and sauna until 2% body weight loss
BCAA-electrolyte beverage (AE) (Amino1, MusclePharm Corp.)
Carbohydrate-electrolyte beverage (CE) (Gatorade, Pepsi Corp.)
Flavored water beverage (FW) (Crystal Light, Kraft Foods Corp.)
7 day washout
An amino acid-electrolyte beverage may increase cellular rehydration relative to carbohydrate-electrolyte and flavored water beverages

Materials/Methods cont.:
Measurements for fluid retention and urinary specific gravity- USG (measure concentration solutes in urine) taken at baseline, immediately after dehydration, and 4 hours post dehydration

Results:
All conditions equally capable in rehydration
USG showed that AE beverage returned urine composition back to baseline after 4 hours, suggesting increased cellular absorption
Discussion and Conclusion:
BCAA and/or increased potassium beverage has potential to benefit intracellular hydration more effectively than carbohydrate-electrolyte beverage or water alone.
Total fluid equal to 150% of water lost during hydration will rehydrate, regardless of the fluid.

Limitations:
- Study was funded by MusclePharm Corporation
- Unsure if the additional potassium or BCAA results in additional intracellular absorption
- Short duration for measuring fluid retention
Influence of training frequency on serum concentrations of some essential trace elements and electrolytes in male swimmers


**Purpose:** To determine the relationship between training frequency, proficiency levels and timing on serum levels of trace elements and electrolytes

**Materials:**
35 male volunteers:
- 14 elite swimmers
- 11 amateur swimmers
- 10 sedentary individuals
Blood samples taken pre-test, post-test (immediately after) and 1 hour after, and used to measure serum concentrations of:

- Electrolytes: Na, Mg, K, Ca
- *Trace Elements: Cr, Fe, Cu, Zn, Se
Influence of training frequency on serum concentrations of some essential trace elements and electrolytes in male swimmers


Results:
Discussion and Conclusion:
Changes in Na and K attributed to Na-K pump.
Changes in Mg and Ca attributed to water loss.

Post-test levels for all electrolytes attributed to training frequency.

All electrolytes levels stayed within reference ranges, but if not replenished through diet, may become susceptible to deficiencies.
Purpose: To determine the relationship between water temperature, dehydration status, and voluntary water consumption

Materials and Methods:
6 Taekwondo athletes
4 experimental sessions, each on separate days
Dehydration exercises for 120 minutes total each session
Water at 5, 16, 26, and 58°C
Blood samples taken before dehydration, immediately after dehydration (-3 minutes), and 3, 9 and 15 minutes after drinking.
Water temperature, voluntary drinking and fluid balance in dehydrated taekwondo athletes.


Results:

**Figure 1.** Amount of voluntary drinking in trials with different water temperatures presented as mean (SD). Significantly different amounts have been drunk in different trials.

**Figure 2.** Involuntary dehydration while subjects drink water with different temperatures, presented as mean (SD). Significantly different involuntary dehydration have occurred in different trials.
Discussion and Conclusion:

16°C was consumed the most.  
58°C was consumed the least.

Colder temperatures (5°C) decreased speed of gastric emptying, 16°C still cool enough to act as heat sink.

Plasma osmolality (Posm) was not significantly correlated to voluntary drinking in all trials except 5°C.  
Posm did not decrease until 15 minutes after drinking.

Posm not a motivating factor in drinking in short term, may take 4-24 hours to recover euhydration.
Limitations:

Small sample size

Only tested water at different temperatures. Other beverages should be considered in future research

Unclear on recovery time period between experimental sessions.
Study Objective/Purpose

- To determine the effects of beverage temperature and composition (water vs. carbohydrate-containing beverage) on weight retention and fluid balance following an exercise induced dehydrated state.

Methods

- Subjects:
  - Eight college-aged healthy men
  - no relevant medical history or disease
  - not taking medications at the time of the study

<table>
<thead>
<tr>
<th>Physical characteristics</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>21.5 ± 1.8</td>
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<tr>
<td>Height (cm)</td>
<td>177.0 ± 4.4</td>
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<tr>
<td>Weight (kg)</td>
<td>70.5 ± 4.6</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>22.5 ± 1.0</td>
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<tr>
<td>Body fat (%)</td>
<td>12.7 ± 2.1</td>
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<tr>
<td>Fat mass (kg)</td>
<td>8.99 ± 1.72</td>
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<tr>
<td>Muscle mass (kg)</td>
<td>34.9 ± 2.3</td>
</tr>
<tr>
<td>Body surface area (m²)</td>
<td>1.87 ± 0.08</td>
</tr>
</tbody>
</table>
Effects of rehydration fluid temperature and composition on body weight retention upon voluntary drinking following exercise-induced dehydration.


**Methods Continued…**

- Four experimental trials
- Two types of beverages consumed at two different temperatures
  - 10 degree Celsius water (10W)
  - 10 degree Celsius sports drink (Gatorade, Korea) (10S)
  - 26 degree Celsius water (26W)
  - 26 degree Celsius sport drink (Gatorade, Korea) (26S)
- Subjects to lose 2% of their base body weight with exercise
- Followed by 90 min recovery period in which time each beverage was consumed
Methods Continued…

• Measurements at the start of each experiment:
  – naked body weight
  – internal (rectal) body temperature
  – blood pressure
  – resting heart rate
  – urine and blood samples
Methods Continued…

• Participants entered into 38 degrees Celsius and 50% humidity environmental chamber

• Subjects ran on a treadmill at any speed they chose until they reached an elevated body temperature and the goal weight reduction of 2%

• Measurements during exercise: heart rate, rectal temperature, and running speed
  – There was no fluid consumption allowed during exercise

Effects of rehydration fluid temperature and composition on body weight retention upon voluntary drinking following exercise-induced dehydration.

Methods Continued…

During 90 min recovery, participants drank 1,500 ml of one of the four beverages (10W, 10S, 26W, 26S) at their preference.

• Measurements at the end of each experiment during 90 min recovery period:
  – Volume of each beverage consumed
  – naked body weight after 30, 60, and 90 min
  – Weight retention (measurements of body weight post-exercise and at the end of the recovery periods taking into account the volume of fluid consumed as well as urine excreted)
Effects of rehydration fluid temperature and composition on body weight retention upon voluntary drinking following exercise-induced dehydration.


Results

- No observable differences between heart rate, rectal temperature, and body weight change.
- During dehydration period:
  - rectal temperature increased by 2.4-2.6 degrees Celsius
  - body weight decreased by 1.8%-2.0% from baseline measurements

<table>
<thead>
<tr>
<th></th>
<th>10W</th>
<th>10S</th>
<th>25W</th>
<th>25S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise duration (min)</td>
<td>62.5 ± 7.6</td>
<td>65.0 ± 4.5</td>
<td>64.2 ± 13.6</td>
<td>66.7 ± 7.5</td>
</tr>
<tr>
<td>Treadmill speed (km/h)</td>
<td>8.6 ± 1.9</td>
<td>8.6 ± 1.9</td>
<td>8.3 ± 1.6</td>
<td>8.4 ± 1.6</td>
</tr>
<tr>
<td>Heart rate (beat/min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At base</td>
<td>68.8 ± 3.7</td>
<td>68.8 ± 7.2</td>
<td>67.6 ± 7.8</td>
<td>64.9 ± 7.2</td>
</tr>
<tr>
<td>End of exerc.</td>
<td>188.0 ± 16.7</td>
<td>180.7 ± 16.0</td>
<td>182.8 ± 19.1</td>
<td>183.6 ± 21.7</td>
</tr>
<tr>
<td>Rectal temperature (°C)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>At base</td>
<td>37.2 ± 0.3</td>
<td>37.3 ± 0.3</td>
<td>37.3 ± 0.3</td>
<td>37.2 ± 0.3</td>
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<tr>
<td>End of exerc.</td>
<td>39.8 ± 0.7</td>
<td>39.7 ± 0.6</td>
<td>39.9 ± 0.5</td>
<td>39.6 ± 0.7</td>
</tr>
<tr>
<td>△</td>
<td>2.6 ± 0.4</td>
<td>2.4 ± 0.4</td>
<td>2.6 ± 0.5</td>
<td>2.5 ± 0.5</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At base</td>
<td>71.6 ± 5.4</td>
<td>72.0 ± 5.7</td>
<td>72.1 ± 5.7</td>
<td>71.8 ± 5.4</td>
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<tr>
<td>End of exerc.</td>
<td>70.3 ± 5.5</td>
<td>70.7 ± 5.8</td>
<td>70.7 ± 5.5</td>
<td>70.5 ± 5.2</td>
</tr>
<tr>
<td>△</td>
<td>1.3 ± 0.3</td>
<td>1.3 ± 0.6</td>
<td>1.4 ± 0.2</td>
<td>1.3 ± 0.2</td>
</tr>
<tr>
<td>△ (%)</td>
<td>1.8 ± 0.5</td>
<td>1.8 ± 0.9</td>
<td>2.0 ± 0.2</td>
<td>1.9 ± 0.2</td>
</tr>
</tbody>
</table>
Results continued...

- Blood pressure and urine specific gravity (concentration of solutes in a urine sample) did not change and were sustained a normal range during the experiment.

- % plasma volume decreased after each experiment and did not return to baseline measurement even after the recovery period.

- Weight retention greater in participants who drank the 10 degree Celsius sports drink than those who drank 10 degree Celsius water and 26 degrees Celsius water.

- Volume loss lower with the 10 degree Celsius sports drink, but not significantly different.
Results continued...

**Effects of rehydration fluid temperature and composition on body weight retention upon voluntary drinking following exercise-induced dehydration.**

Discussion and Conclusions

• People are more likely to rehydrate using a cool carbohydrate-containing liquid → allow for more adequate replenishment of fluids

• volume of fluid retention associated with the cool sports drink
• no significant differences observed in blood solute concentration

• water not suggested to be most efficient means of replacing fluid lost during exercise and dehydration

• Proper hydration= extremely important for the optimization of performance and overall health

• Even slight dehydration can cause complications and impair performance, especially in warm environments
Discussion and Conclusions

Limitations:
• 8 participants- small sample size
• study sponsored by The Sports Promotion Fund of Seoul Olympic Sports Promotion Foundation from Ministry of Culture, Sports, and Tourism $$$$
• participants chose which drink to consume and how much after the initial 1500 ml
References


References


