Hydration In Active & Healthy Life

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Pee Your Way to a Healthy Day

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In conclusion ...

- The science related to hydration and disease is suggestive of benefits for acute and chronic conditions, but is not conclusive.
- With minimal risks and potentially plentiful benefits, we should recommend that people drink enough each day to avoid dehydration.
- It is always better to be well hydrated than dehydrated.
- The current AI values for daily fluid intake are a good starting point for creating hydration recommendations.
  - Adult females: 2.7 L/d
  - Adult males: 3.7 L/d
No doubt hydration is important.
We are constantly leaking.
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**IN**
- Beverages and foods (water + salt)
- Water from metabolism (water)

**OUT**
- Respiration (water)
- Transpiration (water)
- Saliva (water + salt)
- Sweat (water + salt)
- Urine (water + salt)
- Feces (water + salt)
- Metabolism (water)
- Emesis (water + salt)
- Diarrhea (water + salt)
- Lactation (water + salt)
- Menstruation (water + salt)
Dehydration should be brief and self-limiting.

✓ Thirst-driven drinking (osmotic- and volume-driven)

✓ Spontaneous drinking (meals, meetings, parties)

✓ Easy availability of water & beverages
Dehydration is common.

✓ School children
✓ Older adults
✓ Athletes
✓ Workers
✓ Soldiers
✓ Warm weather
Hydration is in the news.

“Drink just one more glass of water a day and you can make a real difference for your health, your energy, and the way you feel.”

Michelle Obama
September 2013
“There really isn’t data to support this,” said Dr. Stanley Goldfarb of the University of Pennsylvania. “I think, unfortunately, frankly, they’re not basing this on really hard science. It’s not a very scientific approach they’ve taken. … To make it a major public health effort, I think I would say it’s bizarre.”
What is the evidence?
What is the evidence?

- 1933 Physiological Reviews (Adolph): 2.1, 3.4, and 5.1 L/d minimum/moderate/liberal fluid intakes
- NRC 1945: 2.5 L/d or ~ 1 ml/kcal
- NRC 1949: 1.0-1.5 ml/kcal
What is the current thinking?

**European Food Safety Authority**

2.0 L/d female, 2.5 L/d male

### Adequate Intake (AI)

<table>
<thead>
<tr>
<th>Age</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-13 y</td>
<td>2.1</td>
<td>2.4</td>
</tr>
<tr>
<td>14-18 y</td>
<td>2.3</td>
<td>3.3</td>
</tr>
<tr>
<td>19 + y</td>
<td>2.7</td>
<td>3.7</td>
</tr>
</tbody>
</table>
Water is the largest single constituent of the human body and is essential for cellular homeostasis and life. Total water intake includes drinking water, water in beverages, and water that is part of food. Although a low intake of total water has been associated with some chronic diseases, this evidence is insufficient to establish water intake recommendations as a means to reduce the risk of chronic diseases. Instead, an Adequate Intake (AI) for total water is set to prevent deleterious, primarily acute, effects of dehydration, which include metabolic.

Approximately 19 percent of total water intake. Canadian survey data indicated somewhat lower levels of total water intake. As with AIs for other nutrients, for a healthy person, daily consumption below the AI may not confer additional risk because a wide range of intakes is compatible with normal hydration. In this setting, the AI should not be interpreted as a specific requirement. Higher intakes of total water will be required for those who are physically active or who are exposed to hot environments.
Hydration-disease difficult to study.

- Few good studies
- Long-term studies needed
- Large n needed
- Tough to assess fluid intake
- Compliance difficult to monitor
- Hydration status constantly changes
- Hydration difficult to measure
- Daily fluid requirements vary widely
- Diseases are multi-factorial
- Many differences among diseases

• Spotty evidence for hydration-disease link.
• But does lack of evidence mean lack of association?
• Hydration is central to all physiological functions.

With little risk and many potential (but unsubstantiated) benefits ...  
Why not recommend more drinking?
What is the evidence?
## What is the current thinking?

### CONDITIONS WITH (POSSIBLE) LINKS TO HYDRATION

<table>
<thead>
<tr>
<th>Condition</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinary tract infections</td>
<td>Constipation</td>
</tr>
<tr>
<td>Bladder cancer</td>
<td>Arrhythmias</td>
</tr>
<tr>
<td>Colon cancer</td>
<td>Blood clots</td>
</tr>
<tr>
<td>Quality of life</td>
<td>Death</td>
</tr>
<tr>
<td>Hyponatremia</td>
<td>Exercise capacity</td>
</tr>
<tr>
<td>Bladder lesions</td>
<td>Mitral valve prolapse</td>
</tr>
<tr>
<td>Kidney diseases</td>
<td>Heat tolerance</td>
</tr>
<tr>
<td>Kidney stones</td>
<td>Weight control</td>
</tr>
<tr>
<td>Gallstones</td>
<td>Orthostatic hypotension</td>
</tr>
</tbody>
</table>
Coming up ...

1. Hypohydration & heat tolerance

2. Hyperhydration risks

3. Kidney stones

4. Practical recommendations
Coming up ...

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4. Practical recommendations
Regular physical activity improves function.
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## Regular physical activity improves function.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Enhanced endothelial regeneration</td>
<td>All-cause mortality</td>
</tr>
<tr>
<td>✓ Angiogenesis</td>
<td>Cardiovascular disease</td>
</tr>
<tr>
<td>✓ Healthy inflammatory response</td>
<td>Hypertension</td>
</tr>
<tr>
<td>✓ Reduced arterial stiffening</td>
<td>Stroke</td>
</tr>
<tr>
<td>✓ Enhanced neurogenesis</td>
<td>Metabolic syndrome</td>
</tr>
<tr>
<td>✓ Reduced plasma triglycerides</td>
<td>Type 2 diabetes</td>
</tr>
<tr>
<td>✓ Lower blood pressure</td>
<td>Breast cancer</td>
</tr>
<tr>
<td>✓ Autophagy &amp; apoptosis</td>
<td>Colon cancer</td>
</tr>
<tr>
<td>✓ Improved glucose metabolism</td>
<td>Depression</td>
</tr>
<tr>
<td>✓ Increased RMR</td>
<td>Falls</td>
</tr>
<tr>
<td>✓ Muscle regeneration</td>
<td>Post-surgery survival</td>
</tr>
<tr>
<td>✓ Greater muscle strength</td>
<td>Quality of life</td>
</tr>
<tr>
<td>✓ Increased LBM</td>
<td>Life expectancy</td>
</tr>
<tr>
<td>✓ Better bone health</td>
<td></td>
</tr>
</tbody>
</table>

Hydration supports physical activity.

Exercise capacity improved

Exercise feels easier

Heart rate is lower

Recovery is faster
Hydration reduces cardiovascular stress

Absolute + Relative dehydration

(Reduced drinking + Increased capacitance)
Dehydration + heat = greatest risk

U.S. weather fatalities per year

- HEAT-RELATED
- COLD/WINTER
- FLOOD
- TORNADO
- HURRICANE
- LIGHTNING

Average fatalities over 22-year period (1988-2010)
Dehydration + heat = greatest risk

July 1995 Chicago heat wave

Dehydration + heat = greatest risk
Dehydration impairs function.

**INCREASED**
- Incidence of GI discomfort
- Plasma osmolality
- Blood viscosity
- Heart rate
- Resting core temperature
- Skin temperature
- Brain temperature
- Core temp at which sweating begins
- Core temp at which skin blood flow increases
- Core temp at a given VO$_2$
- Carbohydrate oxidation
- Muscle & liver glycogenolysis
- Thermal discomfort

**DECREASED**
- Plasma volume
- Blood flow to internal organs
- Central blood volume
- Central venous pressure
- Cardiac filling pressure
- Stroke volume
- Cardiac output
- Skin blood flow at a given core temp
- Maximal skin blood flow
- Muscle blood flow
- Sweat rate at a given core temp
- Maximal sweat rate
- Glycogen synthesis in muscle & liver
- Physical & mental performance
Dehydration impairs function.

**Cardiovascular**
BP, blood flow, O\(_2\) delivery, metabolite removal

**CNS & Neurobiological**
Cerebral metabolism, neurotransmitters, brain temperature

**Muscular**
Muscle temperature, metabolism, afferent feedback

**Psychological**
RPE, thermal comfort, motivation, focus

**Respiratory**
Hyperventilation, breathing sensations

Dehydration affects the brain.

- Reduced brain volume
- Increased ventricle volume
- Greater cognitive effort

Coming up ...

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3. Kidney stones
4. Practical recommendations
Too much of a good thing is a bad thing.

- Bladder lesions - the bursting bladder
- Hyponatremia - abnormally low blood sodium concentration
  - Psychogenic polydipsia
  - Forced drinking
  - Exercise-associated hyponatremia
  - Clinical hyponatremia
  - Recreational over-drinking
Example 1

“… a healthy 40-year-old woman consumed 3 L of tap water during 3 hours to hasten micturation for a urine drug test, and developed severe hyponatremia ([Na] = 121 mEq/L).”

Example 2

- January 2007 -

Woman Dies After Holding Wee for a Wii

Jennifer Strange, mother of 3, dead at 28
When fluid intake should be limited...

- congestive heart failure
- renal failure
- hypoalbuminemia
- endocrinopathies
- some chemotherapy (e.g., cisplatin)
- hyponatremia
Coming up ...

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Hydration reduces risk of kidney stones.

- Increased daily fluid intake
- Higher urine output
- Less risk of stones
Kidney stones: hydration is just one factor

- Sex
- Age
- Genetics
- Diet
- Stone type
- Medications
- Dietary supplements
- Obesity
- Hydration status
Coming up ...

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Keep an eye on hydration status.

How?
Hydration status is difficult to monitor.

- Isotope dilution
- Neutron activation
- Bioelectrical impedance
- Body weight
- Plasma osmolality
- Urine osmolality
- Urine specific gravity
- Urine color
- Urine conductivity
- 24-h urine volume
- Salivary flow
- Ratings of thirst

Practical recommendations

Morning body weight
Urine specific gravity (or color)
Rating of thirst
Hydration guidelines
Hydration apps

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