

THE Physiologist MAGAZINE

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A RUNNER'S QUEST

Tamara Hew-Butler, DPM, PhD, is fascinated by athlete physiology and the human messiness of applied science.



The Science of Hydration

Uncovering the myth of the 8x8 rule.

BY MARIJKE VROOMEN DURNING, RN

The idea that humans should drink a minimum amount of water for optimal health goes back centuries. Hydrotherapy, a discipline touted by alternative practitioners in the 19th century, claimed that water was a cure-all for much of what ailed humans. Vincent Priessnitz, a farmer in Austria, promoted this notion and opened an institute in 1829 to support the practice. Despite Priessnitz's lack of formal education, his idea became popular, and he was deemed the "father of hydrotherapy."

In 1945, the U.S. Food and Nutrition Board issued guidelines indicating that people should drink two and a half liters of fluid per day. However, there was an added bit of information associated with the recommendation that seems to have been lost over the years, as if people stopped reading before they got to the end: "Most of this quantity is contained in prepared foods."

This resulted in people, including renowned U.S. nutritionist Fredrick J. Stare, PhD, to recommend consuming a minimum of six glasses of water per day. Interestingly, Stare did not offer any support for his recommendation, admitting that the reasoning was not fully understood, according to a 2012 editorial published in the *Australian and New Zealand Journal of Public Health*.

In more recent years, we've all heard recommendations regarding how much water healthy adults should drink. It's eight glasses of eight ounces of water each day, right?

Although 64 ounces a day, which is just shy of two liters, won't hurt a healthy adult, Heinz Valtin, MD, disputed the idea that it was medically necessary in a 2002 article in the APS journal *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*. Valtin, who died in 2019, challenged the evidence: "No scientific studies were found in support of 8x8. Rather, surveys of food and fluid intake on thousands of adults of both genders, analyses of which have been published in peer-reviewed journals, strongly suggest that such large amounts are not needed because the surveyed persons were presumably healthy and certainly not overtly ill."

HOW TO HYDRATE

Most of us have done it: We're out in hot weather and realize we're thirsty. We grab a bottle of water and guzzle it down, often in one go, to satisfy that thirst. But that's not really the best way to hydrate, says Lindsay Baker, PhD, a senior principal scientist at the Gatorade Sports Science Institute.

"In general, it's best to sip a little bit throughout the day," Baker says. "Most people take in larger amounts when they're eating meals and snacks, which helps the body retain the fluid." But sudden ingestion

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of large amounts of plain water by itself generally just ends up being eliminated in the urine pretty quickly.

Chugging a glass of water initiates a bolus response, says Evan C. Johnson, PhD, an associate professor of exercise physiology at the University of Wyoming. A bolus response is the body's protective mechanism against hyponatremia after consumption of a large amount of fluid. It causes the body to excrete a larger proportion of that suddenly introduced fluid.

Sensors in the mouth and throat trigger the oropharyngeal response—which perceives a large, potentially dangerous volume of water coming into the system. "And regardless of your body's need for that water, it will move forward and start the process of diuresis. So, if you consistently drink smaller amounts over the course of the day, it's less of an alert to the body," Johnson says.

In addition, much of our fluid comes from the food we eat. There are the obvious foods, such as soup, but fluid makes up a large part of many of our other foods, such as fresh fruit, yogurt and much more. Often, people who say they rarely feel thirsty are actually getting enough fluid from their overall diet, says Joseph G. Verbalis, MD, a professor of medicine and chief of endocrinology and metabolism at Georgetown University in Washington,

D.C. "People who like soups and other foods that have a high water content are obviously going to get more water than people who eat more dry types of foods," he explains. "But, the combined water content of food, plus your thirst-driven intake, is plenty sufficient to maintain normal hydration."

Despite that, the mantra of drinking eight glasses of water took off, and it's now commonplace to see people toting water bottles as they go about their daily activities. But the initial recommendations never said that the fluid had to be water. In fact, if people want to abide by this rule, most fluids count, including caffeinated drinks, milk, juice and maybe even beer, according to Valtin's 2002 article.

The idea that drinks such as coffee and beer work against hydration rests with the belief that these drinks increase the need to urinate, which could be interpreted as losing fluid. However, this isn't the case. "You can drink a beer and you will probably lose a little bit of it," says Tamara Hew-Butler, DPM, PhD. But it's not enough to affect your hydration, she says. Hew-Butler is an associate professor of exercise and sport science at Wayne State University in Detroit.

Some people believe the same of caffeinated drinks, but this isn't true either. "That's actually another myth," Hew-Butler says. "Studies have shown

that caffeine is not really a diuretic. If you're taking in more coffee or tea, it's the fluid that is driving the urination."

Baker agrees: "All beverages count in terms of hydrating throughout the day. So coffee counts, tea, juices, electrolyte beverages, carbohydrate electrolyte beverages, they all count," she says. That said, athletes are encouraged to be selective when choosing their beverages in relation to their exercise.

"There are some beverages that are better than others," Baker says. "For example, if athletes participate in an exercise where it's a longer duration, high intensity in the heat, then they need to start thinking about including sodium in addition to the water to help replace those losses and help support hydration and plasma volume, which is important for their cardiovascular function and performance."

But while other fluids can count toward the encouraged fluid intake, there may be other issues at play. For example, sugar-sweetened beverages add to caloric intake and could negatively affect blood glucose regulation, Johnson says.

OVERHYDRATION IS RARE

Overall, for the healthy adult, drinking a lot of water is not a big concern and simply leads to more frequent trips to the bathroom, Verbalis says. But every so often, a news outlet describes how someone has died from "water poisoning," or drinking too much water. As tragic as these situations are, they are rare enough that they make the news when they happen. "In the extreme—and I do stress extreme—patients who ingest excess water have died from hyponatremia," Verbalis says. "It takes a lot of water retention to do that." Cases like this are often related to peer-pressure incidents, such as fraternity hazing, or over-the-top contests, like what happened in 2007 in California.

A radio station hosted a contest, offering a Nintendo Wii gaming system to the person who could drink the most water without "wee-ing." A 28-year-old woman died of "water intoxication," according to the coroner. Initially, contestants were given eight-ounce bottles of water, which they were to drink every 15 minutes. After several of these smaller bottles, they were given larger ones. The woman drank roughly two gallons of water in three hours before she died later that day at home.

Hyponatremia occurs when blood sodium drops into the 120s. Normal blood sodium levels range from 135 to 145 mEq/L. "Once it is about 125 or below, you definitely have the risk of fatal brain edema, as a result of the water retention," Verbalis says.

AN IDEAL DAILY FLUID INTAKE?

Much like the recommendation that healthy adults should consume 2,000 calories per day, a recommendation that adults consume 64 ounces of water a day is also a generalization, according to Hew-Butler. "It's a one-size-fits-all that doesn't fit all," she says. "It's not going to work for everybody in all situations."

Everyone's fluid needs will fluctuate depending on their individual circumstances. Some people may have a medical issue that restricts the amount of fluid they should consume on a daily basis, while others may need to increase their fluid intake, such as people with kidney stones or hypercalcemia.

But most people should consider matters such as how active they are, how warm the weather is, their diet and their size. These are all vital issues in helping determine if someone is drinking enough.

Athletes must find that right balance to help them reach their peak performance. "We inform athletes that each athlete is unique, and each athlete loses different amounts of sweat when they're exercising," Baker says.



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While not essential for the average person, timing of fluid consumption is also important for these athletes, she adds. “We recommend athletes start thinking about their hydration before exercise, about four hours before.” She follows the American College of Sports Medicine guidelines, which recommend slow consumption of 5 to 7 mL of fluid per kilogram of body weight at least four hours before exercise.

Thirst is the primary driver for fluid intake. Humans need to maintain a balance between the fluid lost during everyday activities—through sweat, urination and even the vapor in their breath—with what they consume. As people lose that fluid, blood volume decreases, increasing the ratio of salt and other minerals in the blood. Blood osmolality increases, and the brain responds by releasing an antidiuretic hormone, prompting the kidneys to retain fluid and triggering thirst. The feeling of thirst is also activated by the release of the peptide hormone angiotensin II.

Johnson provides an example of how physical activity and environment affect thirst: “Down in Mesoamerica and Central America, the people cutting sugar cane can drink up to 15 liters of water a day. They’re sweating a lot. That’s

meeting their water needs. Would I recommend that same amount for a person who’s working in an office job in an air-conditioned office and maybe walking for an hour a day? No way, that’s way too much water for that person.”

Limiting fluid intake can limit inconvenient trips to the bathroom. Some may limit fluid intake because they’re traveling or don’t want to get up in the middle of the night to urinate. Children may also skip drinks because they don’t want bathroom breaks to interfere with their play, as might people who work in occupations where it may be difficult to get to a bathroom. “Nurses and doctors in hospital settings are notoriously under-hydrated because their job is so busy,” Johnson says. “We’re also starting to notice that female law enforcement officials are reducing their water intake because they have to wear so much gear on their belt. For them to use the restroom is like a 10-minute procedure.”

Is this unhealthy? Not necessarily, not as long as they end up getting the right amount of fluid in the long run. “I think another misconception is that you have to replace everything right away at real time, but a lot of times you make up the difference at your meals,” Hew-Butler says.

There are times when we can’t rely on our feeling of thirst to stay hydrated. People with dementia or brain injuries, such as a stroke, may lose their ability to feel thirst. Caregivers are often left trying to find ways to ensure the person is well-hydrated. This is where a caregiver may want to offer foods that are higher in fluid, rather than relying on drinks that the person may refuse. They may also have to be creative, such as offering one pill at a time so the individual must take several sips of water or juice per pill. This may be particularly important in a heat wave, for example.

Consumer health advice often refers to urine color as a good way to indicate a person’s hydration status—the lighter the urine, the more hydrated. Baker agrees that athletes can check their urine color to quickly assess their status. “If it’s dark or highly concentrated, then drink a bit more,” she says. “If it’s a light or pale yellow color, then that’s an indication that you’re good to go.”

But while this is a practical method, urine color may not be the best way to determine hydration. “Urine is a by-product of your blood trying to maintain a balance between water and salt,” Hew-Butler says. “What comes out doesn’t really reflect what actually is going on in our body.” So, while it doesn’t hurt to monitor your urine color, it’s not necessarily the best indicator.

The general take-away of the hydration debate is to drink as much as your body tells you to. If you’re thirsty, drink. If you’re not thirsty, take sips of water or just wait until you feel thirst. Unless there are specific medical indications or situations, most people won’t overhydrate, nor will they become dehydrated. So while the so-called 8x8 rule isn’t harmful for healthy adults, you can take it off your “must do” list. ☺